Chapter 6

Combined Spinal-Epidural-General Anesthesia (CSEGA): The Anesthesia of the Future?

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Introduction

Each one of the three kinds of anesthesia (spinal, epidural, general) has its advantages and disadvantages. A new concept of combined spinal-epidural-general anesthesia (CSEGA) is illustrated with the objective of producing a new kind of anesthesia. The aim is to draw out the good from each compartment. CSEGA can be based on muscle relaxation and anesthesia on its spinal part with the epidural augmentation. The endotracheal intubation can be kept in place with a very small dose of an inhalational anesthetic. There is no need for muscle relaxant drugs, i.v. opioids or benzodiazepines. For postoperative analgesia serves the epidural catheter. Very small doses of local anesthetic drugs injected into the spinal or epidural compartments could be all that is needed for operations on any part of the body, including thorax and head. CSEGA is a new concept in anesthesia. The mixing of regional anesthesia with general anesthesia affords the anesthesiologist the opportunity to lower the local anesthetic doses, avoid using many kinds of intravenous drugs (muscle relaxants, opioids, benzodiazepines, etc.) and to approach a kind of anesthesia that is closer to the ideal.[1]

What is anesthesia?

Definitions of the state of anesthesia: a) Drug-induced unconsciousness; the patient neither perceives nor recalls noxious stimulation.[2] b) Reversible oblivion and immobility.[3] c) Paralysis, unconsciousness, and attenuation of the stress response.[4] d) Sensory block, motor block, blocking of reflexes, and mental block.[5] e) All separate effects used to protect the patient from the trauma of surgery.[6] Jorgensen et al.[7] studied the anesthetic choice of 705 patients of outpatient surgery candidates prior to speaking to the anesthesiologist. Sixty five percent preferred general anesthesia, 22% spinal anesthesia, and 12% were unsure. Of those who had spinal anesthesia previously, only 33% would select it in the future. Conversely, 70% of patients who had general anesthesia would prefer it again. Concerns about spinal anesthesia were: paralysis, nerve damage, being awake, infection, inadequate anesthesia, backache, fear of needle and headache. The use of regional anesthesia in residency training programs has increased from 21.3% in 1980 to 29.8% in 1990, primarily because of a two-fold rise in the use of epidural anesthesia.8 Advantages of spinal anesthesia: obviates the need for deep general anesthesia, profound muscle relaxation, cheap, easy to perform, danger of toxic drug signs, negligible. Disadvantages of spinal anesthesia: hypotension, postoperative headache, some patients prefer to be asleep during operation. The combined spinal-epidural anesthesia (CSE) combines the rapid onset and good muscle relaxation of subarachnoid block with the ability to supplement analgesia through the epidural catheter, intraoperatively and after the operation. Reynolds et al.9 using plain lumbar x-rays and CT after injection of iodized oil into the extradural space of 19 subjects recorded the depth of the extradural space at the caudal end: 8.3 ±1.95 mm (at the level of T12). Westbrook et al.10 found even a smaller ligamentum flavum-dura mater depth at the L2-3 level: 3.95±1.1 mm by using the magnetic resonance imager of 39 subjects. Pitkin11 describing spinal anesthesia in 1928 wrote that "in 1912, its use was confined to very elderly people, those considered as bad risks and to whom we were afraid to give ether". Koster[12] described in 1928 his experience of spinal anesthesia also in operations of the head, neck and thorax. He wrote: "Any one who can do a lumbar puncture can induce spinal anesthesia; the method is reasonably fool proof ". Babcock[13] in 1928 summarized his experience of 24 years with spinal anesthesia: "In no other known way can so profound and extensive an anesthesia be produced by so small a dose of a drug and with so little general toxicity". Bromage[14] stated in 1967 that "the beautiful precision and economy of a subarachnoid block is lacking in epidural anesthesia". Greene and Brull[15] in their preface to the fourth edition of Physiology of Spinal Anesthesia have written: "Epidural and spinal anesthesia are indeed related to each other, but only to the same extent as cousins or, at best, siblings; monozygotic twins they are not".

The synergism between regional and general anesthesia

Clinically, patients require surprisingly low end-tidal concentrations of volatile agents during combined epidural-general anesthesia. Neuraxial anesthesia exhibits sedative properties that may reduce requirements for general anesthesia. Hodgson et al.[16] tested whether epidural lidocaine reduces volatile anesthetic requirements as measured by the minimum alveolar concentration (MAC) of sevoflurane for noxious testing cephalad to the sensory block. In a prospective, randomized, double-blind, placebo-controlled trial, 44 patients received 300 mg epidural lidocaine (group E), epidural saline control (group C), or epidural saline-intravenous lidocaine infusion (group I) after premedication with 0.02 mg/kg midazolam and 1 µg/kg fentanyl. Tracheal intubation followed standard induction with 4 mg/kg thiopental and succinylcholine 1 mg/kg. After 10 minutes or more of stable end-tidal sevoflurane, 10 seconds of 50 Hz, 60 mA tetanic electrical stimulation were applied to the fifth cervical dermatome. Predetermined end-tidal sevoflurane concentrations and the MAC for each group were determined by the up-and-down method and probit analysis based on patient movement. MAC of sevoflurane for group E, 0.52 ± 0.18% (± 95% confidence interval [CI]), differed significantly from group C, 1.18 ±.18% ($P < 0.0005$), and from group I, 1.04 ± 0.18% ($P < 0.001$). The plasma lidocaine levels in groups E and I were comparable (2.3 ± 1.0 vs. 3.0 ±1.2 µg/mL ± SD). Lidocaine epidural anesthesia reduced the MAC of sevoflurane by approximately 50%. This MAC sparing is most likely caused by indirect central effects of spinal deafferentation and not to systemic effects of lidocaine or direct neural blockade. Thus, lower concentrations of volatile agents than those based on standard MAC values may be adequate during combined epidural-general anesthesia.

Perimedullary anesthetic techniques (epidural or spinal anesthesia), by themselves or combined with general anesthesia offer several advantages in the postoperative period when compared with general anesthesia alone.[17] The incidence of postoperative respiratory and cardiovascular complications is decreased. The physiologic stress reaction, with its associated hypercoagulable state and immune depression, is attenuated. Finally, the resumption of gastrointestinal function is hastened. These benefits of central neural blockade are noted most clearly when the techniques are used for several days postoperatively, most often by catheter based epidural analgesia. The use of local anesthetic agents in the analgesic mixture would appear to be important. This is likely because these substances inhibit the sympathetic nervous system and spinal reflex axes. The role of this inhibition in the advantages of perimedullary techniques is probably important. It is important to note that inhibition of the sympathetic nervous system can be associated with undesirable consequences in certain patients. These techniques must therefore be used cautiously, and patients who benefit from them must receive careful surveillance.

Lipophilic opioids, especially fentanyl and sufentanyl, are increasingly being administered intrathecally as adjuncts to spinal anesthesia. Hamber and Viscomi[18] analyzed the efficacy of these opioids for subarachnoid anesthesia. Medline search of the literature from 1980 to the present and a survey of recent meeting abstracts were reviewed. A significant number of citations regarding intrathecal lipophilic opioids as adjuncts to spinal anesthesia were found: 59 were cited in this review. Most clinical experience has been in obstetric surgery, but lipophilic spinal opioid administration is being used with greater frequency for other surgical procedures as well. The benefits include reduction of MAC when general anesthesia is combined with spinal anesthesia and enhancement of the quality of spinal anesthesia without prolongation of motor block. Intrathecal fentanyl and sufentanyl allow clinicians to use smaller doses of spinal local anesthetic, yet still provide excellent anesthesia for surgical procedures. Furthermore, lipophilic opioid/ local anesthetic combination permits more rapid motor recovery; short outpatient procedures are therefore more amenable to spinal anesthesia. Finally, the side-effect profiles of intrathecal lipophilic opioids are now well characterized and appear less troublesome than intrathecal morphine. The anesthesia-enhancing properties and side-effect profile of lipophilic opioids administered intrathecally suggest significant roles for these agents as adjuncts to spinal anesthesia for obstetric and outpatient procedures.

Endoh and Matsuda[19] compared the efficacy of epidurally administered buprenorphine (0.2 mg) after CSE anesthesia (CSE group) and that after general anesthesia combined with epidural anesthesia (EPI + GEN group). Postoperatively epidural buprenorphine was administered for initial pain relief significantly later in CSE group than in EPI + GEN group. The duration of pain relief with epidural buprenorphine was similar in both groups (about 11 hours). The time period until postoperative first walk and the number of pain relief medication were also similar in both groups. There was the impression that the onset of pain relief was faster in CSE group, probably because there might be flux of buprenorphine through a dural hole just after epidural administration.

New justification for the use of regional anesthesia, either alone or in combination with general anesthesia, has been provided with reports of some unexpected influences on outcome. A reduction in the incidence of postoperative thrombotic episodes and vascular graft occlusion is strongly suggested in patients with generalized vascular disease. Application of a variety of drugs, including local anaesthetics, opioids and adrenergic agonists, in the region of the spinal cord reduces afferent input during surgery and also the metabolic stress response. Evidence is increasing that this multimodal approach to anesthesia has important consequences in the spinal cord which result in modification of the postoperative requirement for analgesia. Premedication with opioid and other analgesics may also enhance this pre-emptive effect. New general anesthetic and analgesic drugs are available that are more suited to these combined techniques. They have shorter duration of action so that plasma concentration can be rapidly adjusted to match a variable surgical stimulus.20

The neuroprotective potential of halothane anesthesia was explored in a weight-drop model of spinal trauma in the rat (N = 252).21 In initial experiments, animals were subjected to 25, 50 or 100 g cm impact injuries at T10 during pentobarbital or halothane anesthesia and their outcomes determined using somatosensory-evoked potentials, blinded neurologic evaluations for two weeks, and post-mortem analysis of spinal serotonin levels. Subsequently, halothane anesthesia was combined with either pentobarbital or nitrous oxide or given as a late treatment to pentobarbital anesthetized rats subjected to 50 g cm injuries. A series of acute studies were then performed in order to assess the hemodynamic and respiratory concomitants of halothane vs. pentobarbital, as well as the effect of mechanical ventilation and bicarbonate treatment upon halothane neuroprotection. Finally, the effect of a 50 g cm impact upon local white matter spinal cord blood flow was measured during halothane or pentobarbital anesthesia using laser-Doppler flowmetry. Results demonstrate an active neuroprotective action for halothane anesthesia that is not altered by the presence of other anesthetics and is most prominent at severe injury levels. The data suggest the importance of immediate injury responses in this action. Late halothane treatment was ineffective when given as early as 10 minutes post injury while both the electrophysiological and hemodynamic effects of halothane vs. pentobarbital were apparent during this 10 minute period. Thus, halothane was associated with the prevention of spinal ischemia during the first 10 minutes after trauma in comparison to pentobarbital.

Lo Presti et al.22 reviewed the advantages and disadvantages of general and regional anesthesia in bad clinical conditions. The purpose of this study was to evaluate the efficacy of blended anesthesia (association of general anesthesia with a regional technique) in 25 patients belonging to ASA II-III-IV, undergoing surgery for various diseases. General anesthesia was provided by perfusion of propofol, after a peridural or subarachnoid continuous anesthesia was started. Patients were either in spontaneous or controlled ventilation. There were no cases of hypotension or other important side effects and the majority of patients judged good the anesthetic technique in regard to lack of pain, exhaustion and recall of operation. Morley et al.23 conducted a prospective, randomized, controlled trial to establish the effect of epidural blockade on isoflurane requirements for equivalent intraoperative electroencephalographic (EEG) suppression. Fifty patients undergoing abdominal hysterectomy received combined epidural and general anesthesia or general anesthesia alone with isoflurane and alfentanil. Isoflurane was administered by computer-controlled closed-loop feedback to maintain an EEG 95% spectral edge frequency of 17.5 Hz, a target chosen on the basis of a pilot study. In epidural patients, end-tidal isoflurane concentration (FE'(ISO)) was 0.19% smaller (95% confidence interval [CI], -0.32% to -0.06%; $P < 0.01$), mean arterial blood pressure was 17 mm Hg lower (95% CI, -24 to -9 mm Hg; $P < 0.0001$), and body temperature was 0.4 °C lower (95% CI, -0.7 to 0 °C; $P < 0.05$) than in controls. EEG bispectral index (BIS) was 4 points higher (95% CI, 1 to 7; $P < 0.05$). EEG median frequency and heart rate were similar in both groups. Epidural patients were 76% more likely (95% CI, 58% to 94%; $P < 0.001$) to require metaraminol for hypotension and were 28% more likely (95% CI, 3% to 53%; $P < 0.05$) to require glycopyrrolate for bradycardia. After surgery, the time to eye opening in epidural patients was 2.3 min shorter (95% CI, -4.2 to -0.5 min; $P < 0.05$). Time to eye opening correlated better with FE'(ISO) in the last 30 seconds of anesthesia (FE'(ISO) = 0.07 x time to eye opening + 0.31; r(2) = 0.59; $P < 0.0001$) than with BIS from the same period (BIS = 64 - 1.25 x time to eye opening; r(2) = 0.22; $P < 0.001$) ($P < 0.0001$). To maintain similar intraoperative spectral edge frequency, patients receiving combined epidural and general anesthesia require 21% less isoflurane than those receiving general anesthesia alone. This smaller isoflurane dose is associated with faster emergence from anesthesia. The dose of general anesthetic required to maintain similar intraoperative suppression of brain electrical activity is 21% less in patients with nerve blockade than in those without. This dose reduction results in faster waking times in patients with nerve blockade, which may reflect lighter intraoperative anesthesia.

Total spinal anesthesia: The origin of CSEGA

Evans24 described in 1928 the possible complications of spinal anesthesia. Concerning respiratory paralysis he wrote: " If respiration should cease, keep cool. Raise the lower jaw, pull the tongue forward and begin artificial respiration at a uniform rate. Mouth to mouth insufflation is the most convenient and efficacious method of artificial respiration". Twenty years before, in September 1908, before the Congress of the International Society of Surgery, in Brussels, Thomas Jonnesco25 from Bucharest, described his new method of general spinal anesthesia and reported 14 cases operated upon by his method. Bier, who 100 years ago established the first human surgical spinal anesthesia, rejected it.25 In a later paper in 1910 Jonnesco wrote: "It is an error to confuse lumbar rachianesthesia, conceived by Corning and popularized by Bier, with my method. As I have many times emphasized , my method is a new one and altogether distinctive, because I have generalized spinal anesthesia , adopting it to all operations on any part of the body".26 Patients given high spinal anesthesia frequently either lapse into what appears to be normal sleep or may actually lose consciousness.27,28,29,30 If patients with high spinal anesthesia are given an inhalational anesthetic such as N_2O- O_2, very low concentrations of anesthetic gases are required to maintain unconsciousness.31 Reduction in the strength of nociceptive input may contribute to loss of consciousness by diminishing the strength of arousing stimuli arriving at cortical structures.32 Studies with C14 labeled lidocaine in dogs have shown that the foramen magnum is not a physiological barrier, for autoradiographs and tissue samples reveal the presence of radioactivity in intracranial parts of the CNS after a relatively modest epidural dose.33 Total spinal anesthesia has been used as a method of general anesthesia for abdominal surgery34 and for the treatment of intractable pain.35 Gillies and Morgan36 described a patient in whom a total spinal anesthesia resulted after 18 mL of inadvertent subarachnoid injection of 0.5% bupivacaine. Spontaneous respiration was noted 120 minutes later and consciousness regained after further 65 minutes. Return of respiration after 17 mL 1.5% lidocaine which resulted in total spinal analgesia occurred after 45 minutes and consciousness after further 80 minutes.37 Four patients with intractable pain were treated by total spinal anesthesia. Power spectral analysis of heart rate and peripheral blood flow variations were studied. Vagal activity was depressed as well as the sympathetic activity innervating the cardiovascular system, so the heart rate and peripheral blood flow variations were totally eliminated.38 Total spinal block can be elicited even after an epidural test dose like the 36-year-old parturient of Palkar et al.[39] who developed hypotension and extensive sensory and motor block including respiratory paralysis and aphonia after injection via the epidural catheter of 3 mL lidocaine 1.5% with 1:200,000 epinephrine (15 µg). The patient remained fully conscious and alert and spontaneous respiration recommenced in five minutes. Three patients were studied to determine the changes in regional skin temperature and blood flow during extensive sympathetic blockade following total spinal anesthesia. The temperature of the truncal area, arm and leg decreased by 1 °C, whereas the temperature of the hand and foot increased by 3 °C.40 Total spinal block was induced by 2% lidocaine in adult mongrel dogs. Heart rate, mean arterial pressure (MAP), cardiac index (CI) and left ventricle dp/dt max decreased significantly.[41] Ephedrine 0.5 mg/Kg elevated heart rate, MAP, LV dp/dt max and systemic vascular resistance (SVR).[42] Total spinal anesthesia blocks the vagus as well as the sympathetic nervous system and decreases heart rate variation, suggesting that neural control of the heart via the autonomic nervous system is abolished after total spinal anesthesia.[40] Matsuki et al.[43] described a patient with primary aldosteronism who was anesthetized by total spinal anesthesia using an epidural catheter inserted at L3-4 into the subarachnoid space. The trachea was intubated after intravenous injection of thiopentone 250 mg and suxamethonium 40 mg, and oxygen 3 L/minute and N_2O 2 L/minute inhaled. The intraoperative course was smooth and intraoperative muscle relaxation excellent. Adrenaline, noradrenaline and dopamine in the plasma remained within normal ranges. Mets et al.[44] described a case of an unplanned version of CSEGA: a 24-year-old parturient received an epidural analgesia during labor. Then she was scheduled for Cesarean section for failure to progress. A total dose of 30 mL 0.5% bupivacaine was administered incrementally via the epidural catheter which resulted in a patchy block that was inadequate for surgery. Twenty minutes after the last injection of epidural local anesthetic a spinal anesthesia was done which resulted in a high block that necessitated tracheal intubation and ventilation. Controlled ventilation maintained with 50% N_2O and 0.5% isoflurane in oxygen until delivery of the baby after which the isoflurane was stopped and 70% N_2O in oxygen was administered. No further muscle relaxation was required for the remainder of the operation which lasted 45 minutes. The patient was extubated at the end of the operation uneventfully.

Use of ephedrine in CSEGA

Ephedrine is the sympathomimetic drug which is most widely used to sustain blood pressure during spinal anesthesia. The active principal was isolated from the Chinese herb ma huang in 1885 by Yamanashi.[45] Butterworth et al.[46] found that a mixed adrenergic agonist such as ephedrine more ideally corrected the noncardiac circulatory sequelae of total spinal anesthesia in dogs than did either a pure alpha (phenylephrine) or a pure beta-adrenergic agonist (isoproterenol). Butterworth et al.[47] also demonstrated in dogs the effectiveness of dobutamine and dopamine as possible alternatives to ephedrine for the pharmacologic correction of the noncardiac circulatory sequelae of total spinal anesthesia. Goertz et al.[48] investigated the effect of ephedrine on left ventricular function in patients without cardiovascular disease under high thoracic epidural analgesia combined with general anesthesia. Ephedrine improved left ventricular contractility without causing relevant changes of left ventricular afterload.

Cardiovascular effects of CSEGA

Combining epidural analgesia with general anesthesia in humans reduces the hemodynamic demand on the heart[49,50,51] and provides more stable intraoperative hemodynamics.[52] In animal experiments epidural analgesia has inhibited sympathetic coronary constriction secondary to a flow-limiting stenosis,[53] reduced infarct size[54] and reduced ST-segment changes on the electrocardiogram in an acute coronary artery occlusion model.[55] However, Mergner et al.[56] investigated epidural analgesia combined with general anesthesia in a swine model with a tight coronary artery stenosis. Distal to the coronary stenosis was a moderate decrease in regional myocardial function and a severe reduction in blood flow. The epidural analgesia reaching the level of T1 was added to an animal which already had a decreased blood pressure and sympathetic tone from the isoflurane/fentanyl anesthesia. No correction of the reduced blood pressure was done in this study. Stenseth et al.[57] investigated the cardiovascular and metabolic effects of T1-T12 epidural block in 18 patients receiving chronic beta-adrenergic blocker medication and scheduled for aortocoronary bypass surgery. Thoracic epidural analgesia induced a moderate decrease in MAP, coronary perfusion pressure, free fatty acids and myocardial consumption of free fatty acids. Blomberg et al.[58,59] also found no cardiac effects after a T1-T8 or T1-T6 block in beta-adrenergic blocked patients with ischemic heart disease. Christensen et al.[60] evaluated myocardial ischemic events by Holter monitoring of ST segment depression in 14 patients with angina pectoris given spinal analgesia for minor surgery. Ephedrine in dose of 5 mg was given, if rapid infusion of saline did not improve the arterial pressure. The first ischemic event occurred at a mean of 338 minutes after spinal analgesia, and not in association with the onset of block, with the decrease in MAP after spinal analgesia or with the administration of ephedrine. This could be explained by increased cardiac pre and afterload, probably further aggravated by the volume load.

Cord ischemia and preemptive analgesia

Breckwoldt et al.[61] investigated the effect of intrathecal tetracaine on the neurological sequelae of spinal cord ischemia and reperfusion with aortic occlusion in rabbits. They found that intrathecal tetracaine significantly and dramatically abrogated the neurological injury secondary to spinal cord ischemia and reperfusion after aortic occlusion at 30 minutes. Peripheral tissue injury provokes two kinds of modification in the responsiveness of the nervous system: peripheral sensitization and central sensitization. The optimal form of pain treatment may be one that is applied both pre, intra, and postoperatively to preempt the establishment of pain hypersensitivity during and after surgery. Woolf and Chong[62] in their review of preemptive analgesia concluded that "although evolution has conserved sensitization in humans, the capacity to inflict `controlled injury` during surgery has clearly not been anticipated".

The Serbian experience

Type and technique of anesthesia have an important effect on perioperative surgical course.63 The aim of the study by Malenkovic, Zoric and Randelovic64 was prospective analyses of advantages of CSEGA vs. general anesthesia in abdominal surgery according to: 1. Operative course (hemodynamic stability of patients, quality of analgesia, undesirables effects), 2. Postoperative course (quality of analgesia, unfavorable effects, temporary abode of patients in intensive care). Using prospective randomized double blind controlled study, Malenkovic et al. evaluated two groups of patients whom the same type of abdominal surgical intervention was planned and the only difference was the type of technique of anesthesia. First group of patients (n = 34), was treated with CSEGA and second group of patients (n = 33), was treated only with standard general anesthesia. Both groups had intraoperative and 24 hours long postoperative continued monitoring of blood pressure, central venous pressure, and diuresis. In the 24 hours postoperative period, the following parameters were analyzed: vigilance conditions, motor block level, pain intensity in rest and movement, necessity for a complementary analgesia, side effects and final subjective effect of analgesia. There was important difference in waking up the patients after general anesthesia. In the first group this period was shorter. In the first 24 hours, patients from the first group did not get any systemic analgesic, while the patients from the second group needed fractionary application of parenteral analgesics in the period of 4-6 hours. Patients from the first group were also physically faster and easier recovered and they had less respiratory complications and there was not any example of thromboembolism and the intestine motility was faster re-established. First group of patients spent less time in intensive care (three days) than second group (six days). Final subjective effect of analgesia, according to verbal descriptive scale (VDS) of pain was satisfying with 75% of patients of the first group and 15% of patients of the second group. According to results investigation, advantages of CSEGA vs. general anesthesia in abdominal surgery were manifold: better hemodynamic stability and perfusion of operative region, decrease of single doses of opioid analgesics, local and general anesthetics followed by the decrease of their side effects, better intensity and longer duration of analgesia and improved total functional capability of patients.64

Zoric et al.65 have been routinely practicing their technique of CSEGA in big abdominal and thoraco-abdominal surgery, since 1997. Their study is a retrospective analysis of the technique and its clinical observations, during 4.5 years, which include 293 patients. They performed CSE in one or two interspinal spaces, depending on the type of surgery, but always before induction of general anesthesia. For preemptive and intraoperative analgesia they used 0.25% plain bupivacaine, both for spinal and epidural blockade. The most important detail in their technique is analgesic solution which contained bupivacaine 4.5 mg, fentanyl 50 μg and morphine hydrochloride 0.2 mg, in total volume of 3 mL, in spinal anesthesia. After the epidural test dose with 2% lidocaine 60 mg, before the induction of general anesthesia, they injected more 10 mL bupivacaine, but intraoperative analgesia was almost performed with bupivacaine 3 to 5 mL in intermittent bolus doses. This epidural bolus doses was particularly important, partly to sufficiently cephalic migration of the spinal anesthesia somatosensory block, as well as for intraoperative analgesia. For very light general anesthesia only artificial ventilation with 66% N_2O in O_2 and muscle relaxation with pancuronium was needed. Co analgesia with intravenous fentanyl, was exceptionally seldom needed, except for induction. Intraoperative drugs consumption was very small. With adequate liquid compensation, this technique achieved exceptionally intraoperative hemodynamic stability in patients, despite too long and big operations. Postoperative analgesia are supplied by the spinal block the first 24 hours, but for the next 72 hours it was performed with intermittent epidural bolus doses of 0.12% bupivacaine with 2 mg morphine in total volume of 15 mL and 10 mL, depending on the epidural catheter position in lumbar or thoracic part of spine. The breakthrough of postoperative pain was between 20% to 34%, which was suppressed with metamisol. According to the verbal rating scale (VRS < 1) 90% of patients were satisfied with this analgesia, which gave possibilities to mobilization and rehabilitation even in the first postoperative day. All clinical signs showed that thanks to inhibition of spinal and supraspinal sensitization, all principles of the preemptive analgesia, inhibition of neuro-hormonal stress reaction were met and postoperative outcome was improved and satisfied. The complications were insignificant, in time observed and without any consequences.65

CSEGA for urologic operations

The appropriate anesthesia for renal transplantation requires minimal toxicity for patients and for the transplanted organ, as well as sufficient pain relief and maintenance of vital functions. The aim of the study by Hadimioglu et al.66 was to determine how the anesthetic technique influences the outcome in patients after renal transplantation in terms of preoperative and intraoperative hemodynamic changes and blood gas changes. Fifty adult patients undergoing renal transplantation were randomly divided into two groups receiving standardized general anesthesia or CSE. Demographically both groups were similar. Total anesthesia time (202 ± 53 vs. 186 ± 37 minutes) and surgical time (191 ± 52 vs. 162 ± 31 minutes) did not differ between the groups. The heart rate and systolic blood pressure values of the groups as measured before induction and 5, 15, 20, 30, as well as 60 minutes thereafter did not differ between the groups. Neither the frequency of bradycardia (4 vs. 2) nor of hypotension (6 vs. 4) during anesthesia differed between regional vs. general anesthesia groups. Regional is an important alternative to general anesthesia during renal transplantation surgery in adult patients.

Nakano et al.67 evaluated the efficacy of combined lumbar spinal and epidural (CLSE) anesthesia in retropubic radical prostatectomy. Twenty consecutive patients who underwent radical retropubic prostatectomy by a single surgeon under CLSE anesthesia were selected as subjects. They were compared with 20 consecutive patients who underwent radical retropubic prostatectomy performed by the same surgeon under combined general and epidural (CGE) anesthesia. Both groups were carefully selected to exclude radical prostatectomies with intraoperative complications to evaluate genuine effects of anesthesia. For lumbar spinal anesthesia, 0.5% hyperbaric bupivacaine hydrochloride or 0.5% hyperbaric tetracaine hydrochloride (dissolved in a 10% glucose solution) was used. An epidural catheter was inserted for both lumbar spinal anesthesia and general anesthesia mainly for the purpose of controlling pain after operation. Intraoperative blood loss was significantly less in the CLSE anesthesia group compared with CGE anesthesia group (P= 0.024). Postoperative water drinking was started at 0.4 days (average) for CLSE anesthesia and at 1.1 days (average) for CGE anesthesia (P < 0.0001). Postoperative diet was begun at 0.7 days (average) for CLSE anesthesia and at 1.5 days (average) for CGE anesthesia (P < 0.0001). Compared with the CLSE anesthesia group, the mean of the highest intraoperative mean blood pressure was significantly higher in the CGE anesthesia group (P = 0.002). Intraoperative blood loss was less, intraoperative change in blood pressure was less and recovery of postoperative intestinal peristalsis was earlier in patients who underwent prostatectomy under CLSE anesthesia than in patients who underwent prostatectomy under CGE anesthesia.

Various general and regional anesthesia methods are used successfully in living donor kidney transplantation. Sener et al.68 compared kidney graft function after general vs. CSE anesthesia for donor nephrectomy. The study groups included recipients who received grafts from donors who had undergone nephrectomy under general anesthesia (GA group; n=10), and recipients who received grafts from donors who had CSE anesthesia (CSE group, n=10). Standard continuous epidural anesthesia was administered during all transplantations. Graft function was assessed using scintigraphy and Doppler ultrasonography on days 3 and 7. Urine levels of microalbumin, creatinine, and creatinine clearance rate were measured/calculated in 24 hour urine samples collected on postoperative days 3 and 7. There were no differences on either day 3 or day 7 with respect to glomerular filtration rate, microalbuminuria, or creatinine clearance rate (P >.05 for all). There were also no differences between the groups with respect to other scintigraphic findings on day 3 or day 7 (P >.05 for all). Ultrasonography on day 7 showed significantly higher mean peak systolic flow in the main renal artery in the CSE group than in the GA group (P=.035). The results suggest that general anesthesia and CSE anesthesia for donor nephrectomy have similar effects on kidney graft function in recipients.

Fichtner et al.[69] evaluated the possibility of a perineal radical prostatectomy under spinal anesthesia, as although it is usually done under general anesthesia, there is currently a need to minimize costs and morbidity. Between January and December 2003, there were 337 perineal radical prostatectomies at their institution, of which 47 were on patients under CSE anesthesia administered via a standard L3-4 or L4-5 approach. They analyzed the feasibility of perineal radical prostatectomy under CSE and evaluated perioperative morbidity, including blood loss and hospital stay. All 47 procedures were done under CSE anesthesia with no need for conversion to general anesthesia. The mean (range) duration of surgeries was 56 minutes (43-112), the mean blood loss 270 mL, and the transurethral catheter was removed at 7 days in 40 and at 14 days in the remaining seven patients. There were no complications during surgery, e.g. rectal or ureteric lesions. The mean hospital stay was 8.2 days. Perineal radical prostatectomy is safe under CSE anesthesia; this may be helpful in minimizing morbidity and medical costs, as well as providing an alternative in patients in whom general anesthesia is not recommended.

Kararmaz et al.[70] designed a double-blinded, randomized, controlled study to evaluate the effect of small-dose ketamine i.v. in combination with epidural morphine and bupivacaine on postoperative pain after renal surgery. An epidural catheter was inserted, and the administration of morphine and bupivacaine was started before surgery. Forty patients were assigned to one of two groups (ketamine or control). The ketamine group was administered a ketamine bolus and infusion during surgery. The median visual analog pain scale (VAS) scores at rest were significantly lower in the ketamine group during the first 6 hours (P < 0.01). VAS pain scores on coughing were also significantly lower in the ketamine group (P < 0.01). Cumulative postoperative total analgesic consumption was less in the ketamine group on days 1 and 2 (P < 0.001). The first analgesic demand time was shorter in the control group (9.2 ± 11.5 min) than in the ketamine group (22.3 ± 17.1 min) (P < 0.0001). The incidence of nausea and pruritus was more frequent in the control group (P < 0.05). In conclusion, postoperative analgesia was more effective when spinal cord and brain sensitization were blocked by a combination of epidural morphine/bupivacaine and i.v. ketamine. Renal nociception conducted multisegmentally by both the spinal nerves (T10 to L1) and the vagus nerve cannot be blocked by epidural analgesia alone. It was demonstrated that i.v. ketamine had an improved analgesic or opioid-sparing effect when it was combined with epidural bupivacaine and morphine after renal surgery.

A variety of drugs and techniques have been introduced into ambulatory anesthesia. The technique as well as the drugs used may hasten or delay home discharge. Erhan et al.[71] compared recovery profiles and side effects of spinal anesthesia and total intravenous anesthesia (TIVA). Forty unpremedicated ASA I-II patients (18-65 years) undergoing varicocele repair were randomly divided into two groups. Spinal anesthesia (26-gauge atraumatic needle) with hyperbaric bupivacaine 0.5% 5 mg and fentanyl 25 µg were given to patients in group spinal (n = 20). Patients in group TIVA (n = 20) received i.v. anesthesia with propofol and remifentanil given by continuous infusion, a laryngeal mask was used to secure the airway. The duration of surgery, time to home readiness and side effects were recorded. The two groups were comparable with respect to patients' characteristics and duration of surgery. The times to achieve ambulation were similar between groups (spinal = 78.4 ± 40.9 minutes, TIVA = 75.9 ± 13.8 minutes). Urinary voiding was a requirement for discharge after spinal anesthesia and the time for home readiness was longer in group spinal (158.0 ± 40.2 vs. 94.9 ± 18.8 minutes) (P < 0.05). Two patients reported pruritus and one reported postdural puncture headache (PPDH) in group spinal, whereas two patients reported nausea in group TIVA. Patients in group TIVA had a greater need for analgesia postoperation (P < 0.05). In healthy unpremedicated men undergoing minor urological operations, TIVA with remifentanil and propofol provided as safe and effective anesthesia as spinal block with the advantage of earlier home readiness.

Liu et al.[72] compared the analgesic effect of lumbar intrathecal 0.5 mg morphine (group M, n = 10), 50 µg sufentanyl (group S, n = 10), and their combination (group S-M, n = 10) given before general anesthesia and patient-controlled analgesia (PCA) with i.v. morphine (group C, n = 19) in a randomized, double-blinded study performed in patients undergoing thoracotomy. Pain VAS and morphine consumption were assessed for 24 hours. In group S-M the number of patients initially titrated with i.v. morphine was less than in group C (30 vs. 84%, P < 0.05). Morphine requirement was higher in group C (71 ± 30 mg) than in groups S (46 ± 34 mg, P < 0.05), M (38 ± 31 mg, P < 0.05) and S-M (23 ± 16 mg, P < 0.01). VAS scores were significantly decreased during the first 0 - 11 postoperative hours at rest and during the first 0-8 postoperative hours on coughing in groups M and S-M rather than in group C. The incidence of side effects was infrequent, except for urinary retention. Preoperative intrathecal morphine or combined sufentanyl and morphine could be given as a booster to achieve rapidly effective analgesia in the immediate postoperative period. As compared with i.v. patient-controlled analgesia, intrathecal morphine or combined sufentanyl and morphine provided superior postoperative pain relief both at rest (11 hours) and on coughing (8 hours) than did i.v. PCA morphine alone. Intravenous morphine requirement was decreased during the first postoperative day after posterolateral thoracotomy.

Urologic patients have overlap disturbances in many organ systems, especially in urinary system with cardiovascular and respiratory system. During extensive urologic operations Ladjevic and Vesovic[73] perform general anesthesia in most cases. General anesthesia provides organ vital function under best control. Patients with severe respiratory disease undergoing surgery in regional anesthesia (spinal or epidural with or without epidural catheter, or in CSE anesthesia).

The effect of combined epidural anesthesia and epidural morphine injection is discussed.[74] A group of 98 patients (group A) was operated on under such combined anesthesia and compared to a similar group of 98 patients (group B), operated on under either spinal or general anesthesia with no epidural morphine added. Over 87% of group A needed no narcotic drugs for postoperative pain. All patients in the group B needed 60-80 mg of morphine during the first 48 postoperative hours. The quantity of morphine required was the main parameter for comparison. The postoperative course in group A was considerably easier while the operative results were equal in both groups.

CSEGA for obstetric and gynecologic operations

Spinal anesthesia is the technique most often applied in cases of scheduled Cesarean section. Many authors have tried decreasing the local anesthetic dose by adding opioids to achieve adequate analgesia with greater hemodynamic stability, although the ideal dose remains to be established. Guasch et al.[75] analyzed hemodynamic stability and quality of analgesia with two different regimens for administering spinal hyperbaric bupivacaine. They designed a controlled, double-blind trial comparing two doses of spinal hyperbaric bupivacaine with fentanyl in 42 patients undergoing elective Cesarean section randomized to two groups to receive either the low dose or the conventional one. One group received 11 mg dose of bupivacaine and the other group received 6.5 mg dose, combined with 20 µg of fentanyl in both cases. The hemodynamic profile and the level of maximum sensory block obtained were similar in the two groups. The motor block was less intense in patients receiving the lower dose and it was necessary to convert two patients (10%) to general anesthesia in that group. Spinal anesthesia with low doses of bupivacaine and fentanyl provides acceptable intraoperative conditions for a high percentage of patients undergoing Cesarean section, with a similar incidence of hypotension. The low dose generates a less intense intraoperative motor blockade with similar spread of the sensory block. The low dose was not efficacious for 10% of the patients who received it. A prospective survey of anesthesia for Cesarean section was performed for the year 1997.76 Two hundred and fifty maternity hospitals were sent questionnaires from which 129 responses were obtained. The data provided information on anesthesia for 60,455 cesarean sections. Overall 78% of sections were performed with regional anesthesia: 47% single shot spinal; 22% epidural; 9% CSE; 22% general anesthesia. For elective Cesarean sections (39% of all sections) regional anesthesia was used for 87% of cases: 68% single shot spinal; 3% epidural; 15% CSE; 13% general anesthesia. For emergency procedures regional anesthesia was used for 72% of cases: 34% single shot spinal; 34% epidural; 4% CSE; 28% general anesthesia. There was a wide range of regional anesthesia use among the units, varying from an overall rate of 95% at one extreme to 41% at the other. Similarly, there was a wide range of conversion of regional anesthesia to general anesthesia, varying from 0% to 88%. Overall, 10.6% of the general anesthetics were the result of regional to general anesthesia conversion.

Machado-Joseph disease is a form of progressive spino-cerebellar ataxia with both bulbar and peripheral neurological manifestations. General anesthesia may be problematic because of the risk of pulmonary aspiration and hypoxia. Teo et al.[77] described their experience with the successful use of CSE anesthesia in a patient with Machado-Joseph disease. A 38-year-old woman complicated by significant bulbar and peripheral neuropathy presented for an elective vaginal hysterectomy. She had no other medical history of note. After informed consent, CSE block was performed at the L2-3 lumbar intervertebral space with hyperbaric bupivacaine 12 mg, morphine 100 µg, and fentanyl 10 µg. Surgery proceeded uneventfully, with excellent postoperative analgesia. There was full recovery of preinduction neurologic function by the sixth postoperative hour. Central neuraxial anesthesia is an option for patients with Machado-Joseph disease presenting for lower abdominal and lower extremity operations. CSE anesthesia confers hemodynamic stability yet allows for augmentation of intraoperative anesthesia and postoperative analgesia.

Pre-eclampsia is a multisystemic disorder that is characterized by endothelial cell dysfunction as a consequence of abnormal genetic and immunological mechanisms. Despite active research for years, the exact etiology of this potentially fatal disorder remains unknown. Although understanding of the pathophysiology of pre-eclampsia has improved, management has not changed significantly over the years. Anesthetic management of these patients remains a challenge. Although general anesthesia can be used safely in pre-eclamptic women, it is fraught with greater maternal morbidity and mortality. Currently, the safety of regional anesthesia techniques is well established and they can provide better obstetrical outcome when chosen properly. Thus, regional anesthesia is extensively used for the management of pain and labour in women with pre-eclampsia. Mandal and Suprapaneni[78] highlighted the advantages and disadvantages of regional anesthetic techniques including epidural, spinal and CSE analgesia, used as a part of the management of pre-eclampsia.

Petropoulos et al.[79] compared general, epidural and CSE anesthesia with respect to short-term outcome of newborns delivered by elective Cesarean section of healthy parturients with normal pregnancies. A total of 238 pregnant women admitted for elective Cesarean section were grouped according to the kind of anesthesia used for the procedure. Maternal characteristics, birth weight, Apgar scores, and maternal and umbilical artery (UA) acid-base parameters were analyzed. Maternal pH was significantly lower and pCO_2 and pO_2 were significantly higher in the general anesthetic group, compared to the other two groups (7.38 ± 0.03 vs. 7.43 ± 0.02 and 7.43 ± 0.05, respectively; 35.03 ± 3.88 mmHg vs. 29.25 ± 5.05 mmHg and 29.64 ± 4.16 mmHg, respectively; and 224.56 ± 86.77 mmHg vs. 151.28 ± 38 mmHg and 157.36 ± 53.51 mmHg, respectively, $P < 0.05$). The pH of the UA was higher in the general anesthetic group, compared to the spinal-epidural group (7.29 ± 0.02 vs. 7.26 ± 0.06, $P < 0.05$). The pO_2 as well as O_2 saturation of the UA were higher when general anesthetic was administered, compared to the two regional modalities (15.60 ± 5.48 mmHg vs. 9.29 ± 4.41 mmHg and 9.20 ± 4.06 mmHg, respectively; and 17.37 ± 9.79% vs. 7.87 ± 4.98% and 6.90 ± 5.22%, respectively, $P < 0.05$). UA O_2 saturation fell to zero in some cases in the CSE group, without an evident effect on fetal well-being. No fetal acidemia was noted in any group. Neonatal outcomes were similar in the three groups studied. Type of anesthesia does not influence short-term outcomes in infants born via elective Cesarean section, although differences in acid-base status of both the mother and especially the newborn recommend careful use of spinal anesthesia.

Epidural blockade is an important option for anesthesia in parturients undergoing abdominal delivery. Despite the multiple benefits of this method, there is at least one significant downside - a relatively high occurrence of unsatisfactory anesthesia that requires intervention. Depending on the presumed mechanism of epidural block failure and other clinically relevant factors (e.g., timing of diagnosis, urgency of the procedure, and so forth), certain effective measures were recommended to successfully manage this demanding situation. In general, it is important to make every effort to make the pre-existing epidural effective or replace it with another regional technique, because overall, regional anesthesia is associated with significantly lower maternal mortality. It is important to identify a dysfunctional epidural block preoperatively before a maximum volume of local anesthetic has been administered. If catheter manipulation does not produce substantial improvement, and there is no time constraint, it is safe and reasonable to replace the epidural catheter. However, risks associated with excessive volume of local anesthetic should be kept in mind. Additional epidural injections or a second catheter placement might be considered under special circumstances. Single-shot spinal anesthesia after a failed epidural may provide fast onset and reliable surgical anesthesia. Available data, although limited and contradictory, suggest the possibility of unpredictably high or total spinal anesthesia. Many authors, however, believe that appropriate precautions and modifications in technique make this a safe alternative. These modifications include limiting the amount of epidural local anesthetic administered when diagnosing a nonfunctioning epidural and decreasing the dose of intrathecal local anesthetic by 20% to 30%. If there is no documented block when the spinal is inserted, and more than 30 minutes have passed from the last epidural dose, it is probably safe to use a normal dose of local anesthetic. Continuous spinal anesthesia with a macro catheter might be a dependable alternative, particularly if large amounts of local anesthetic have already been used or the patient's airway is a cause for concern. Although there are no reports of CSE anesthesia being used in this context, it would appear to be an attractive alternative. It allows the anesthesiologist to give smaller doses intrathecally, while still offering the flexibility of augmenting the block if needed. When inadequate epidural block becomes apparent during surgery there are limited alternatives. Depending on the origin and the pattern of inadequate anesthesia, options may include psychological support, supplementation with a variety of inhalational and intravenous agents, and local anesthetic infiltration. Induction of general anesthesia is typically left as a backup option, but must be strongly considered if the patient continues to have pain and or discomfort.[80]

Danelli et al.[81] compared the preparation and discharge times, the side-effects and patient satisfaction after gynecological outpatient procedures performed using either spinal block or total intravenous anesthesia with propofol and remifentanil. Forty healthy females scheduled for hysteroscopic ablation of endometrial neoplasm were randomly allocated to receive either a spinal block with bupivacaine 0.5% hyperbaric solution 10 mg (n = 20) or TIVA with propofol and remifentanil (n = 20). Preparation and discharge times, as well as occurrence of untoward events and anesthesia related costs, were recorded. The median (range) preparation time was 7 (7-10) minutes with general anesthesia, and 11 (7-21) minutes with spinal block ($P = 0.00005$). No differences in discharge time from the post anesthesia care unit and incidence of hypotension or bradycardia, or both, were reported between the two groups. Hospital discharge times were 156 (101-345) minutes after general anesthesia and 296 (195-720) minutes after spinal anesthesia ($P = 0.0005$). Acceptance of the anesthesia technique was better after general (100%) than after spinal anesthesia (75%) ($P = 0.04$). No differences in total costs were reported between spinal block and propofol-remifentanil general anesthesia. Accurate titration of short acting intravenous anesthetic drugs such as propofol and remifentanil results in shorter preparation times and earlier home discharge after outpatient gynecological procedures compared with spinal anesthesia with hyperbaric bupivacaine 10 mg, with better patient acceptance and no increased costs.

Ramanathan et al.[82] evaluated the quality of anesthesia for Cesarean delivery, analgesia for labor, hemodynamic changes, and neonatal effects of CSE with low intrathecal doses of bupivacaine and fentanyl in patients with severe pre eclampsia. Of the 85 patients with severe pre eclampsia (systolic pressures [SBP] ≥ 160 mm Hg or diastolic pressures [DBP] ≥ 110 mm Hg, and proteinuria ≥ 100 mg/dL), 46 underwent Cesarean delivery and 39 delivered vaginally. The Cesarean delivery group received 7.5 mg of hyperbaric bupivacaine and 25 µg fentanyl intrathecally with a goal of obtaining a T4 sensory block. Those with levels less than T4 received 2% lidocaine epidurally to extend the block. In the labor analgesia group, the intrathecal dose was 1.25 mg of plain bupivacaine with 25 µg of fentanyl, followed by epidural infusion of 0.0625% to 0.125% bupivacaine with 2 to 4 µg fentanyl/mL at 12 to 15 mL/hour. In the Cesarean group, all but 4 patients had ≥ T4 block, and these 4 patients received 2% lidocaine epidurally. None required conversion to general anesthesia. In the labor analgesia group, sensory levels were T10 (range, T6-L2) with adequate analgesia. The baseline MAP was 122 ± 13 mm Hg in the Cesarean delivery group and 117 ± 12 mm Hg in the labor analgesia group. After CSE, MAP decreased significantly and reached a nadir within 5 minutes in both groups (103 ± 12 mm Hg in the Cesarean group and 96 ± 13 mm Hg in the labor analgesia group, $P < .05$). The maximum decrease in MAP was similar in the 2 groups (-15% ± 8% in the Cesarean delivery group and -16% ± 9% in the labor analgesia group). The neonatal Apgar scores and UA pH were similar, and there were no significant correlations between UA pH and lowest MAP before delivery or the maximum percentage change in MAP in either group. The results indicate that CSE with low intrathecal doses of bupivacaine and epidural supplementation, when needed, produces adequate anesthesia for Cesarean operation and analgesia for labor in patients with severe pre eclampsia. The maximum decreases in MAP after CSE were modest and quite similar in the two groups. Expert and aggressive pre-operative preparation of the woman with severe pre-eclampsia will ultimately determine her intraoperative outcome. Such considerations as the effect of endotracheal manipulation on intracranial pressure, of thrombocytopenia on the potential to produce a compressive epidural hematoma following epidural or CSE neuraxial block and of adequacy of invasive monitoring for Cesarean section loom large in the eyes of an anesthetist preparing such a patient for surgery. Time spent pre-operatively in fluid volume optimization, in assessment of ventricular function, filling pressures and systemic vascular resistance (SVR), on aspiration pneumonitis and seizure prophylaxis, on control of hypertension, on correction of coagulopathy and on attenuation of pressor responses is time well spent and will have profound effects on the peri operative course. The choice of agents and techniques for control of hypertension and reduction of vascular resistance, for induction and maintenance of general anesthesia, for eclampsia prophylaxis and for regional anesthesia or analgesia for operative or spontaneous delivery is, likewise, important and, at times, problematic.[83]

Postoperative nausea and vomiting (PONV) are major problems after gynecological surgery. Callesen et al.[84] studied 40 patients undergoing total abdominal hysterectomy, allocated randomly to receive opioid free epidural-spinal anesthesia or general anesthesia with continuous epidural bupivacaine 15 mg h-1 or continuous bupivacaine 10 mg h-1 with epidural morphine 0.2 mg h-1, respectively, for postoperative analgesia. Nausea, vomiting, pain and bowel function were scored on 4 point scales for 3 days. Patients undergoing general anesthesia had significantly higher nausea and vomiting scores ($P < 0.01$) but significantly lower pain scores during rest ($P < 0.05$) and mobilization ($P < 0.01$). More patients undergoing general anesthesia received antiemetics (13 vs. 5; $P < 0.05$), but fewer received supplementary opioids on the ward (8 vs. 16; $P < 0.05$). It was concluded that opioid free epidural-spinal anesthesia for hysterectomy caused less PONV, but with less effective analgesia compared with general anesthesia with postoperative continuous epidural morphine and bupivacaine.

Incomplete anesthesia is a major clinical problem both in single spinal and in single epidural anesthesia. The clinical efficacy of epidural anesthesia with augmentation (aEA) and CSE for Cesarean section was investigated in a prospective randomized study on 45 patients.[85] Anesthesia extending up to T5 was aimed for. Depending on the patient's height, epidural anesthesia was administered with a dose of 18-22 mL 0.5% bupivacaine and spinal anesthesia with a dose of 11-15 mg 0.5% bupivacaine. Augmentation was carried out in all cases in epidural anesthesia, initially with 7.5 mL 1% lidocaine with epinephrine 1:400,000, raised by 1.5 mL per missing segment. The epidural reinjection in CSE was carried out as necessary with 9.5-15 mL 1% lidocaine with epinephrine, depending on the height and difference from the segment T5. The extension of anesthesia achieved in epidural anesthesia after an initial dose of 101.8 mg bupivacaine and augmenting dose of 99 mg lidocaine reached the segment T5. The primary spinal anesthesia dose up to 15 mg corresponding to height led to a segmental extension to a maximum of T3 under CSE. Augmentation was necessary in 13 patients; in 5 cases because of inadequate extent of anesthesia and 8 cases because of pain resulting from premature reversion. The augmenting dose required was 13.9 mL. Readiness for operation was attained after 19.8 minutes (aEA) and after 10.5 minutes (CSE). No patient required analgesics before delivery. The additional analgesic requirement during operation was 63.6% (aEA) and 39.1% (CSE). Taking into account pain in the area of surgery, the requirement of analgesics was 50% (aEA) vs. 17.4% (CSE). Antiemetics were required in 18.2 (aEA) and in 65.2% (CSE). The systolic blood pressure fell by 17.7% (aEA) and in 30.3% (CSE). The minimum systolic pressure was observed after 13.4 minutes in aEA, and after 9.5 minutes in CSE. The Apgar score and the umbilical pH did not show any differences. General anesthesia was not required in any case. Albright and Forster[86] reviewed if patients who receive CSE analgesia with subarachnoid sufentanyl have an increased incidence of emergency Cesarean delivery for fetal distress when compared with patients who receive systemic or no medication (S/NM) for labor analgesia. A retrospective computerized analysis of data on all 2,560 deliveries at Bellevue Woman's Hospital for 14 months summarized practice parameters for 1,240 patients who received regional analgesia (98% CSE analgesia), identified 1,140 patients who received S/NM, and classified the urgency of 479 Cesarean deliveries. In the CSE group there were 168 Cesarean deliveries (emergency 16, urgent 58, semi urgent 70, and no urgent 24) as compared with a total of 128 (emergency 16, urgent 43, semi urgent 69, no urgent 0) in the S/NM group. Scheduled Cesarean sections (180) were excluded from the study. The incidence of emergency Cesarean delivery in 1,217 patients who received CSE analgesia with subarachnoid sufentanyl (10-15 µg) compared with 1,140 patients who received S/NM for labor analgesia was 1.3% vs. 1.4%, respectively. More importantly, there was no case in which emergency Cesarean delivery was required for acute fetal distress in the absence of obstetric factors during the 90 minutes following administration of subarachnoid sufentanyl. General anesthesia was required for emergency Cesarean delivery in only one patient (6%) in the CSE group, as against eight patients (50%) in the S/NM group who required general anesthesia for emergency Cesarean section ($P < .05$). This experience indicates that patients who receive CSE analgesia do not have a higher incidence of emergency Cesarean delivery than patients who have S/NM for labor analgesia. Emergency Cesarean section for fetal distress within 90 minutes of the administration of intrathecal sufentanyl only occurred in association with obstetric factors. However, caution should be exercised in extrapolating these results to other practice settings, particularly high-risk referral centers.

Forty five patients scheduled for intra-abdominal gynecological surgeries, ranging in age from 30 to 60 years, were anesthetized with CSE method using combined spinal-epidural needles inserted at the L2-3 interspace.[87] Ten minutes after intrathecal administration of 0.4% isobaric tetracaine solution (2.5 mL) the upper level of analgesia was examined by pin prick method and the patients were divided into the group A (N = 7; anesthetic level ≥ T7), B (N = 7; T8-10) and C (N = 31; T11-L1) according to their anesthetic levels. Target anesthetic level (T4-7) was obtained in group B by peridural administration of 2% mepivacaine in a dose of 5 mL and the surgery was performed. However, in group C, mepivacaine 7 mL was insufficient to obtain the target anesthetic level and additional mepivacaine was necessary for the surgery. In group A, no mepivacaine was used in the first hour of the surgery. In all patients, except one in group C, in whom general anesthesia was used after insufficient segmental analgesia, anesthesia was maintained by the CSE technique. It was concluded that adequate anesthetic level for the intra-abdominal surgery can be obtained by intrathecal isobaric tetracaine administration combined with peridural mepivacaine of a dose calculated according to the anesthetic level ten minutes after the spinal block. Regional anesthesia for abdominal hysterectomy is commonly combined with heavy sedation or light general anesthesia in order to avoid the occurrence of visceral pain. Clinical experience has indicated that this pain can be controlled using regional anesthesia techniques alone. In an effort to find the optimal technique, Mihic and Abram[88] randomly assigned 200 ASA I-II patients who requested regional anesthesia for abdominal hysterectomy (with or without elective appendicectomy) to one of five groups: 1) subarachnoid bupivacaine; 2) subarachnoid bupivacaine plus intravenous midazolam and buprenorphine; 3) epidural bupivacaine; 4) epidural bupivacaine plus epidural morphine; 5) subarachnoid bupivacaine plus epidural morphine and bupivacaine. The last combination provided by far the best analgesia. Only two of 40 patients complained of slight discomfort, and this was easily controlled. Success rates correlated also with the height of the blockade. It was concluded that the combination of subarachnoid bupivacaine plus epidural morphine and bupivacaine represents an effective and reliable technique for abdominal hysterectomy with or without elective appendicectomy.

A prospective study was carried out to compare the qualities of spinal block with those of CSE anesthesia.[89] It included 63 patients, ASA I-II, aged 35 to 75 years, scheduled for gynecological surgery due to last more than 2 hours, and randomly allocated to two groups. In the first group (n = 34), spinal anesthesia was carried out with the patients sitting, in the L3-4 interspace, using 15 mg of hyperbaric bupivacaine with 0.4 mg of adrenaline. In the second group (n = 29), a catheter was inserted in the epidural space through the L2-3 interspace, and spinal anesthesia carried out as in the first group, using plain bupivacaine. Once the highest level of analgesia had been reached, aliquots of 0.5% plain bupivacaine were injected through the epidural catheter, until anesthesia of T5 was obtained. In the spinal group, general anesthesia was required in 3 cases, as anesthesia only reached the T12 level in 2 cases, and as surgery lasted longer than the spinal in the third one. In the CSE anesthesia group, excellent analgesia was obtained in all patients. Sensory blockade lasted 308 ± 48 minutes at the T12 level, vs. 162 ± 51 minutes in the spinal group ($P < 0.025$), and 361 ± 51 minutes at the L2 level, vs. 210 < 44 minutes in the other group ($P < 0.025$). "Topping up" was possible with the epidural catheter only, thus raising the level of sensory blockade, making it deeper, and increasing its duration. It avoids the use of general anesthesia in case of failed spinal blockade.

Dyer et al.[90] studied the neonatal outcome after spinal vs. general anesthesia for Cesarean delivery in preeclamptic patients with a nonreassuring fetal heart trace. This study examined both markers of neonatal hypoxia and maternal hemodynamics. Seventy patients were randomized to general (n = 35) or spinal anesthesia (n = 35). The general anesthesia group received thiopentone, magnesium sulfate, and suxamethonium intravenously before intubation, followed by 50% N_20 in oxygen, 0.75-1.5% isoflurane, and morphine after delivery. The target end tidal partial pressure of $PaCO_2$ was 30-34 mmHg. The spinal anesthesia group received 1.8 mL hyperbaric bupivacaine plus 10 µg fentanyl at the L3-L4 interspace. Heart rate and blood pressure were measured at specific time points. Hypotension was treated with ephedrine. Maternal arterial and neonatal UA blood gas samples were taken at delivery. Resuscitation requirements were recorded. In both groups, hemodynamic measures remained within acceptable limits. Spinal anesthesia patients required more ephedrine (13.7 vs. 2.7 mg). Maternal $PaCO_2$ was lower in the spinal group (28.9 vs. 32.4 mmHg). One minute Apgar scores were lower after general anesthesia. Base deficit was greater (7.13 vs. 4.68 mEq/L) and neonatal umbilical arterial pH was lower (7.20 vs. 7.23) after spinal anesthesia. Post hoc analysis showed that if maternal diastolic blood pressure on admission was greater than 110 mmHg, neonatal UA base deficit was greater after spinal anesthesia. There was no difference in the number of patients with Apgar scores less than 7 at 1 or 5 minutes or UA pH less than 7.2 or in the requirements for resuscitation. In preeclamptic patients with a nonreassuring fetal heart trace, spinal anesthesia for Cesarean delivery was associated with a greater mean neonatal umbilical arterial base deficit and a lower median umbilical arterial pH. The clinical significance remains to be established. Maternal hemodynamics were similar and acceptable with either anesthetic technique.

Most anesthetic and analgesic agents in current use traverse the placental barrier in varying degrees, but are well tolerated by the fetus if judiciously administered. For labor analgesia, many options are available. Systemic administration of opioids and sedatives is one such option. Repeated maternal administration of opioids such as pethidine (meperidine) results in significant fetal exposure and neonatal respiratory depression. PCA with synthetic opioids such as fentanyl, alfentanil, and the new ultra short acting remifentanil may be used for labor analgesia in selected patients. Other options for labor analgesia include epidural and CSE techniques. With such techniques, neonatal exposure to opioids and sedatives can be minimized or totally avoided. While limiting the fetal exposure to the harmful effects of depressant drugs, epidural anesthesia and/or analgesia improves placental perfusion and oxygenation of the fetus, which is beneficial, especially in conditions such as pregnancy induced hypertension. Regional blocks are also administered for the majority of Cesarean deliveries because of the overwhelming and unequivocal evidence of maternal and fetal safety compared with general anesthesia for this indication. However, in some instances, administration of general anesthesia is unavoidable. Neonatal respiratory depression with low Apgar scores, and UA and venous pH associated with general anesthesia, is often transient. A properly administered anesthetic, whether regional or general, has no significant adverse fetal or neonatal effects.[91]

CSEGA for abdominal operations

The choice of anesthesia for groin hernia repair is between general, regional (epidural or spinal), and local anesthesia. Existing data from large consecutive patient series and randomized studies have shown local anesthesia to be the method of choice because it can be performed by the surgeon, does not necessarily require an attending anesthesiologist, translates into the shortest recovery, bypassing the post anesthesia care unit (PACU), has the lowest cost, and has the lowest postoperative morbidity regarding risk of urinary retention. Spinal anesthesia has no documented benefits for this small operation and should be avoided owing to the risk of rare neurologic side effects and the high risk of urinary retention. General anesthesia with short acting agents may be a valid alternative when combined with local infiltration anesthesia, although an anesthesiologist is required. Despite sufficient scientific data to support the choice of anesthesia, large epidemiologic and nationwide information from databases show an undesirable high (about 10-20%) use of spinal anesthesia and low (about 10%) use of local infiltration anesthesia. Surgeons and anesthesiologists should therefore adjust their anesthesia practices to fit the available scientific evidence.[92]

Although endoscopic totally extra peritoneal inguinal hernioplasty (TEP) confers superior early outcomes compared to those of open repair, the requirement of general anesthesia has been held as an argument against the application of TEP by opponents of laparoscopic surgery. To date, the literature on TEP performed under spinal anesthesia remains scarce. Six male patients underwent attempted TEP under spinal anesthesia.[93] Selection criteria for the procedure included reducibility of the inguinal hernia and concomitant medical conditions precluding general anesthesia, such as impaired lung function. All patients were conscious and able to communicate verbally during the operation. TEP was successfully completed in four patients, with a mean operative time of 33 minutes. All four patients were asymptomatic and experienced no pain throughout the procedure. Conversion to open repair was required in two patients because of uncooperative movement in one, and inadequate neural blockade by spinal anesthesia in the other. Intraoperative cardio respiratory parameters were stable in all patients. Postoperative urinary retention occurred in one patient. Successful performance of TEP under spinal anesthesia requires the combined efforts of an experienced anesthesiologist, a skilled surgeon, and a cooperative patient. TEP under spinal anesthesia may have a role in selected patients who are medically unfit for general anesthesia but are otherwise suitable for TEP.

Pre incisional ilioinguinal and iliohypogastric nerve block reduces postoperative analgesics after inguinal herniorrhaphy. The effect of an ilioinguinal and iliohypogastric nerve block on postoperative pain and discharge profile was therefore studied in day surgery patients undergoing inguinal herniorrhaphy with general or spinal anesthesia.[94] Seventy ASA I-II adult patients scheduled for inguinal herniorrhaphy received an ilioinguinal and iliohypogastric nerve block before the surgical incision with 15 mL of 0.5% bupivacaine. In a randomized fashion half of them received general anesthesia with spontaneous breathing via a laryngeal mask (GA-group) and the other half received spinal anesthesia with 5 mg of bupivacaine diluted with sterile water to 2.5 mL volume (SPIN-group). In the PACU, pain was assessed on a VAS from 0 to 10 and ketorolac 30 mg i.v. (VAS < 5), or fentanyl 0.05 mg i.v. (VAS ≥ 5) was administered as scheduled. In the day surgery unit and at home the analgesic was a tablet of ibuprofen 200 mg plus codeine 30 mg (VAS ≥ 3). Patients in the SPIN-group reported lower postoperative pain scores at 30, 60 minutes ($P < 0.0001$) and 120 minutes ($P < 0.05$) after surgery, and longer time to first analgesic use ($P < 0.0001$). Patients in the general anesthesia group had a shorter time to discharge without voiding ($P < 0.001$) and with voiding ($P < 0.05$). After discharge, there were no significant differences between the groups regarding pain scores at rest and at walking, or the doses of analgesic. Adverse events were rare in both groups. Only a relatively short immediate analgesic benefit could be demonstrated by a combination of ilioinguinal and iliohypogastric nerve block with spinal anesthesia compared with ilioinguinal and iliohypogastric nerve block combined with general anesthesia. The use of general anesthesia facilitated an earlier postoperative discharge than spinal anesthesia.

Zoric et al.[95] have been routinely practicing their technique of CSEGA in big abdominal and thoraco-abdominal surgery since 1997. Their study is a retrospective analysis of the technique and clinical observations, during 4.5 years, which include 293 patients. They performed CSE anesthesia in one or two interspinal spaces, depending on the type of surgery, but always before induction of general anesthesia. For preemptive and intraoperative analgesia they used 0.25% plain bupivacaine, both for spinal and epidural blockade. The most important detail in their technique is analgesic solution which contains bupivacaine 4.5 mg, fentanyl 50 µg and morphine hydrochloride 0.2 mg, in total volume of 3 mL, in subarachnoid anesthesia. After the epidural test dose with 2% lidocaine 60 mg, before the induction of general anesthesia, they inject 10 mL bupivacaine, but intraoperative analgesia is almost performed with bupivacaine 3 to 5 mL in intermittent bolus doses. This epidural bolus dose is particularly important, partly to sufficiently cephalic migration of the spinal anesthesia somatosensory block, as well as for intraoperative analgesia. For very light general anesthesia only artificial ventilation with 66% N_2O in O_2 and muscle relaxation with pancuronium is needed. Co analgesia with intravenous fentanyl, was exceptionally seldom needed, except for induction. Intraoperative drugs consumption was very small. With adequate liquid compensation, this technique achieved exceptionally intraoperative hemodynamic stability in patients, despite long and big operations. Postoperative analgesia is supplied by spinal anesthesia (morphine effect) for the first 24 hours, but for the next 72 hours it is performed with intermittent epidural bolus doses of 0.12% bupivacaine with 2 mg morphine in total volume of 15 mL and 10 mL, depending on the epidural catheter position in lumbar or thoracic part of spine. The breakthrough of postoperative pain was between 20% to 34%, which was suppressed with metamisol. According to the verbal rating scale (VRS < 1) 90% patients were satisfied with this analgesia, which gave possibilities to mobilization and rehabilitation even in the first postoperative day. All clinical signs showed that thanks to inhibition of spinal and supraspinal sensitization, all principles of the preemptive analgesia, inhibition of neuro-hormonal stress reaction is met and postoperative outcome is improved and satisfied.

Type and technique of anesthesia have an important effect on perioperative surgical course. Malenkovic et al.[96] analyzed the advantages of CSEGA vs. general anesthesia in abdominal surgery according to: 1. Operative course (hemodynamic stability of patients, quality of analgesia, undesirables effects), 2. Postoperative course (quality of analgesia, unfavorable effects, temporary abode of patients in intensive care). Using prospective randomized double blind controlled study, they evaluated two groups of patients whom the same type of abdominal surgical intervention was planned and the only difference was the type of technique of anesthesia. First group of patients ($n = 34$), was treated with CSEGA and the second group of patients ($n = 33$), was treated only with standard general anesthesia. Both groups had intraoperative and 24 hours long postoperative continued monitoring of blood pressure, central venous pressure, and diuresis. In the 24 hours postoperative period, the following parameters were analyzed: vigilance conditions, motor block level, pain intensity in rest and movement, necessity for a complementary analgesia, side effects and final subjective effect of analgesia. There was important difference in waking up the patients after general anesthesia. In the first group this period was shorter. In the first 24 hours, patients from the first group did not get any systemic analgesic, while the patients from the second group needed fractionary application of parenteral analgesics in the period of 4-6 hours. Patients from the first group were also physically faster and easier recovered and they had less respiratory complications and there was not any example of thromboembolism and the intestine motility was faster re-established. First group of patients spent less time in intensive care (three days) than second group (six days). Final subjective effect of analgesia, according to verbal descriptive scale of pain was satisfying with 75% of patients of the first group and 15% of patients of the second group. According to results investigation, advantages of CSEGA vs. general anesthesia in abdominal surgery were manifold: better hemodynamic stability and perfusion of operative region, decrease of single doses of opioid analgesics, local and general anesthetics followed by the decrease of their side effects, better intensity and longer duration of analgesia and improved total functional capability of patients.

Dobrydnjov et al.[97] made a randomized double-blinded study in order to see whether the addition of small dose clonidine to small dose bupivacaine for spinal anesthesia prolonged the duration of postoperative analgesia and also provided a sufficient block duration that would be adequate for inguinal herniorrhaphy. They randomized 45 patients to three groups receiving intrathecal hyperbaric bupivacaine 6 mg combined with saline (group B), clonidine 15 µg (group BC15), or clonidine 30 µg (group BC30); all solutions were diluted with saline to 3 mL. The sensory block level was insufficient for surgery in five patients in group B, and these patients were given general anesthesia. Patients in groups BC15 and BC30 had a significantly higher spread of analgesia (two to four dermatomes) than those in group B. Two-segment regression, return of S1 sensation, and regression of motor block were significantly longer in group BC30 than in group B. The addition of clonidine 15 and 30 µg to bupivacaine prolonged time to first analgesic request and decreased postoperative pain with minimal risk of hypotension. It was concluded that clonidine 15 µg with bupivacaine 6 mg produced an effective spinal anesthesia and this dose was recommended for inguinal herniorrhaphy, because it did not prolong the motor block. The addition of clonidine 15 µg to 6 mg of hyperbaric bupivacaine increases the spread of analgesia, prolongs the time to first analgesic request, and decreases postoperative pain, compared with bupivacaine alone, during inguinal herniorrhaphy under spinal anesthesia.

To appraise the clinical impact of CSE in patients undergoing total extraperitoneal laparoscopic hernia repair, Hirschberg et al.[98] performed a prospective study in 40 patients. These patients were randomized to receive either CSE (n = 20) or a balanced general anesthesia with controlled ventilation (n = 20). The aim of the study was to determine the impact of the intraoperative gas insufflation on compensatory respiratory reactions during regional anesthesia. Therefore, blood gas samples were drawn and additional parameters were assessed as follows: noninvasive hemodynamic, lactate and glucose levels, differential blood count, and the patients' level of comfort during the perioperative setting, which was determined by a questionnaire. In this study it was clarified that the respiratory compensation of extraperitoneal gas insufflation is not decreased by regional anesthesia. The hemodynamic state of the patients was stabilized by early interventions. In addition, there was no evidence that the anesthesia regime used had any influence on the so called stress parameters. Most of the patients with regional anesthesia showed severe agitation often accompanied by chest pain. Hence, regional anesthesia is not recommended in this setting.

The laryngeal mask airway is selected as an alternative to the endotracheal tube when rapid recovery from general anesthesia is considered. However, the clinical significance of this airway for abdominal surgery is unclear. Thus, Azma et al.[99] evaluated whether the laryngeal mask airway, in combination with regional anesthesia, facilitates the induction of and emergence from general anesthesia in patients undergoing elective colorectal surgery. Anesthesia controlled time in an endotracheal tube/epidural anesthesia group [n = 11; general anesthesia, combined with epidural anesthesia, was maintained by sevoflurane (< 3%) supplemented with a fixed rate of propofol (3 mg/kg/h) under controlled ventilation using the endotracheal tube] was compared with that in a laryngeal mask airway-CSE anesthesia group [n = 10; in combination with spinal-epidural anesthesia, general anesthesia was maintained as the same protocol as the endotracheal tube/epidural anesthesia under spontaneous ventilation using the laryngeal mask airway]. Time for airway placement in the laryngeal mask airway/CSE anesthesia group was significantly shorter than that in the endotracheal tube/ epidural anesthesia group. Intervals from the end of surgery until the removal of the airway or the decision to exit the operating room in the laryngeal mask airway/CSE anesthesia group were shorter than those in the endotracheal tube/epidural anesthesia group. No practical sign of aspiration pneumonia and/or atelectasis was found in patients in either group. Under the circumstance of regional anesthesia being requested for post surgical pain management, it was concluded that the laryngeal mask airway facilitated the emergence from as well as the induction of anesthesia without any practical complication when used for patients in colorectal surgery.

Michaloudis et al.[100] determined prospectively the safety of continuous spinal anesthesia combined with general anesthesia and the efficacy of postoperative pain relief with continuous spinal analgesia for morbidly obese patients undergoing vertical banded gastroplasty. Twenty seven patients (13 men, 14 women) with a mean body mass index (BMI) of 50.4 ± 7.8 and several co-morbidities were studied. All patients were anesthetized with the same anesthetic regimen, which included midazolam, fentanyl, propofol, muscle relaxants, N_2O, isoflurane and intrathecal bupivacaine. Postoperative pain relief was provided for 5 days and all patients received the same regimen, which included intrathecal bupivacaine, fentanyl and intravenous tenoxicam. The intrathecal analgesic regimen was administered continuously through a pump which had the facility of providing bolus doses when requested in predetermined lockout intervals. Intra operative monitoring included hemodynamic and respiratory parameters. Additional postoperative monitoring included respiratory rate, degree of sedation, sensory level of anesthesia, motor response and intensity of pain. Intraoperative anesthetic technique was safe and provided satisfactory results in the immediate postoperative period. Furthermore, the postoperative analgesia regimen provided effective analgesia in all patients. The mean doses of fentanyl and bupivacaine infused intrathecally for the first 24 postoperative hours were 14.1 ± 2.0 µg/h-1 and 0.7 ± 0.1 mg/h-1 respectively, while the requirements of analgesia decreased progressively with time. The technique provided effective analgesia with low pain scores, which was reflected by ease in mobilizing and performing physical exercises with the physiotherapist. Only minor complications related to anesthesia and analgesia were encountered.

Asthma and heavy smoking are the risk factors for postoperative respiratory distress, especially after general anesthesia. Yokoyama et al.[101] experienced a case of sigmoidectomy in a geriatric patient with severe obstructive lung disease accompanied by asthma and a long history of smoking. The patient was a 70-year-old man with 1 second volume of less than 0.6 l, because of asthma and long smoking history of 40 pieces of cigarettes a day for 50 years. Yokoyama and coworkers considered that general anesthesia with tracheal intubation might worsen the respiratory state after surgery and chose CSE anesthesia. He received sigmoidectomy under spinal anesthesia with 0.3% dibucaine 2.4 mL combined with epidural anesthesia. As the level of analgesia went up to T4, the patient complained of dyspnea and he discharged a plenty of sputum. Without any special treatment his dyspnea disappeared spontaneously. During and after the surgery, no exacerbation occurred in his respiratory state. It is suggested that spinal anesthesia combined with epidural anesthesia is useful for a patient with severe obstructive lung disease.

Attempts to reduce central sensitization after tissue injury have led to the concept of preemptive analgesia. A study was done to evaluate the effect of spinal vs. general anesthesia on postoperative pain and analgesic requirements in patients undergoing lower abdominal surgery.[102] Sixty women scheduled for lower abdominal surgery were randomly assigned to two groups of 30 patients each to receive spinal anesthesia or general anesthesia. In the spinal anesthesia group, 3 mL of hyperbaric 0.5% bupivacaine was injected into the subarachnoid space through the third or fourth lumbar interspace. In the general anesthesia group, anesthesia was maintained with isoflurane and nitrous oxide. Postoperative pain was assessed for 48 hours by a VAS of pain at rest and during cough and by patient controlled cumulative morphine doses. The pain score at rest was significantly lower in the spinal anesthesia group than in the general anesthesia group 6-24 hours after surgery. The cough associated pain score was also lower in the spinal anesthesia group than in the general anesthesia group at 6-30 hours after surgery. Furthermore, the subarachnoid anesthesia group consumed less patient controlled morphine than did the control group within the first 24 postoperative hours. Postoperative pain after lower abdominal surgery can be significantly decreased if the surgery is performed with use of spinal anesthesia. Fourteen patients undergoing colorectal surgery received an intraoperative afferent neural block with combined intrathecal and extradural local anesthetics plus a balanced postoperative low dose regimen of extradural bupivacaine 10 mg h-1-morphine 0.2 mg h-1 and systemic piroxicam 20 mg/24 hours.103 Postoperative pain, assessed repeatedly during the initial 48 hours, was prevented during rest, mobilization from the supine to the sitting position and during walking, in all but one patient; slight pain was observed intermittently during coughing in four patients.

Intraoperative surgical stress may markedly increase adrenergic nerve activity and plasma catecholamine concentrations, which causes peripheral vasoconstriction and decreased tissue oxygen partial pressure possibly leading to tissue hypoxia. Tissue hypoxia is associated with an increased incidence of surgical wound infections. Thoracic epidural anesthesia blocks afferent neural stimuli and inhibits efferent sympathetic outflow in response to painful stimuli. Consequently, Kabon et al.[104] tested the hypothesis that supplemental thoracic epidural anesthesia during major abdominal surgery improves tissue perfusion and subcutaneous oxygen tension. Thirty patients were randomly assigned to two groups: general (n = 15) or combined general and epidural anesthesia (n = 15). Anesthesia technique and fluid management were standardized. Subcutaneous tissue oxygen tension was measured continuously in the upper arm with a Clark type electrode. Data were compared with unpaired, two-tailed t-tests, Wilcoxon's ranked sum test, or repeated measures analysis of variance and Scheffe F tests as appropriate; $P < 0.05$ was considered statistically significant. After 60 minutes, intraoperative tissue oxygen tension was significantly larger during combined anesthesia than during general anesthesia (54.3 ± 7.4 mm Hg versus 42.1 ± 8.6 mm Hg; P = 0.0002). Subcutaneous tissue oxygen tension remained significantly higher in the combined general/epidural anesthesia group throughout the observation period. Hemodynamic responses and global oxygen variables were similar in the groups. Thoracic epidural anesthesia improved intraoperative tissue oxygen tension outside the area of the epidural block. Supplemental neural nociceptive block blunts generalized vasoconstriction caused by surgical stress and adrenergic responses. Thoracic epidural anesthesia blunts the decrease of subcutaneous tissue oxygen tension caused by surgical stress and adrenergic vasoconstriction during major abdominal surgery. Consequently, combined general and epidural anesthesia helps to provide sufficient tissue oxygenation.

CSEGA for lumbar disc operations

General and regional anesthesia (spinal and epidural) can be performed successfully for lumbar disc surgery. Demirel et al.[105] assessed the superiority of general anesthesia or epidural anesthesia techniques in lumbar laminectomy and discectomy. Sixty patients undergoing lumbar partial hemilaminectomy and discectomy were randomly divided into two groups receiving standardized general anesthesia or epidural anesthesia. Demographically, both groups were similar. Surgical onset time (36.72 ± 5.47 vs. 25.40 ± 7.83 minutes) was longer in the epidural block group, but total anesthesia time (154.32 ± 35.73 vs. 162.40 ± 26.79 minutes) did not differ between the two groups. Surgical time (118.80 ± 35.42 vs. 139.60 ± 26.80 minutes) was longer in the general anesthesia group. The heart rate and MAP values of the epidural group measured 15, 20, and 25 minutes after local anesthetic administration to the epidural catheter were found to be lower than in the general anesthesia group measured after induction of general anesthesia. The frequency of bradycardia (epidural vs. general anesthesia, 3 vs. 2), tachycardia (3 vs. 7), and hypotension (6 vs. 4) during anesthesia did not differ between the groups, but the occurrence of hypertension (1 vs. 7) was higher in the general anesthesia group. Blood loss was less in the epidural anesthesia group than in the general anesthesia group (180.40 ± 70.38 vs. 288.60 ± 112.51 mL). PACU heart rate and MAP were higher in the general anesthesia group. Peak pain scores in PACU and postoperative 24 hours were higher in the general anesthesia. Nausea was more common in patients in the general anesthesia group both in PACU and 24 hours after surgery. There was no difference between the hospitalization duration of the groups. It is suggested that epidural anesthesia is an important alternative to general anesthesia during lumbar disc surgery.

General or regional anesthesia may be used for lumbar laminectomy. One hundred and twenty two patients were randomly assigned to receive either a standard general anesthetic or spinal anesthesia supplemented with intravenous propofol sedation.106 Data from the intraoperative period through hospital discharge were collected and compared. Demographically, both groups were similar. Total anesthesia (131.0 ± 4.3 vs. 106.6 ± 3.2 minutes) and surgical times (81.5 ± 3.6 vs. 67.1 ± 2.8 minutes) were longer in the general anesthesia patients. Intraoperative hemodynamics changes were similar between groups except that the incidence of increased blood pressure was more frequent with general anesthesia (26.2% vs. 3.3%). Blood loss was less during spinal anesthesia (133 ± 18 mL vs. 221 ± 32 mL). PACU heart rates and MAP were higher in the patients managed with general anesthesia. Peak pain scores in the PACU were higher after general anesthesia compared with spinal block (58 ± 4 vs. 22 ± 3) as were the number of patients who required analgesics. Severe nausea was more common in the general anesthesia group both in the PACU and during the 24 hours after surgery. Analgesic requirements after discharge from the PACU, urinary retention, and days in the hospital did not differ between groups. It is suggested that spinal anesthesia may be superior to general anesthesia both intraoperatively and postoperatively for lumbar spine procedures lasting less than two hours.

CSEGA for pediatric operations

Total spinal anesthesia is a rare complication of lumbar epidural anesthesia through inadvertent spinal injection of local anesthetics following an undiagnosed dural breach or spinal placement of the catheter. Total spinal anesthesia has rarely been reported in children. Total spinal anesthesia occurred during epidural anesthesia in a 7 year-old child undergoing abdominal surgery.[107] Recent previous lumbar punctures and intrathecal chemotherapy for Burkitt's lymphoma at the same level may have facilitated dural breach. Epidural anesthesia should not be attempted at the same intervertebral level as prior recent lumbar punctures. Two groups of 40 homogeneous patients, ASA I-II with idiopathic scoliosis undergoing spinal fusion with CD instrumentation were studied prospectively.108 Group A (intrathecal) received a mixture of morphine and sufentanyl administered intrathecally at the level of L3-L4 after the induction of anesthesia. Group B (control) had inhalation and intravenous narcotic anesthesia. The use of intrathecal opioids resulted in a significant reduction of blood pressure without the use of any hypotensive agents and produced prolonged postoperative analgesia. There was no adverse effect on somatosensory evoked potentials. The dose requirement for the anesthetic agents was significantly reduced and the blood loss was 27% of their blood volume compared with 53% in the control group. No long or short term impairment of cerebral or spinal function was observed. The use of intrathecal opioids supplemented with other anesthetic agents is an alternative method with multiple benefits for any major surgery such as spinal fusion.

Subarachnoid anesthesia is becoming increasingly popular in neonates and infants. However, single dose spinal anesthesia is of limited value for major abdominal surgery in infants due to its short duration of action and inability to provide analgesia in the post operative period. A new technique CSE anesthesia for major abdominal surgery in the infant was described by Williams et al.[109] Data were gathered prospectively from 19 infants presenting for upper and lower abdominal surgery. Anesthesia was induced with a subarachnoid injection of tetracaine. After the subarachnoid block was established, an epidural catheter was placed for further intraoperative and postoperative management. Data collected included age and weight of the patients, type and duration of the surgical procedure. Doses of local anaesthetics as well as the need for intraoperative and postoperative supplements were recorded. Infants studied represented a wide range of weights (1520-7840 g). Spinal anesthesia was successful in all 19 patients. A variety of extensive surgical procedures including small bowel resections and various genitourinary procedures were successfully performed. In 17 patients a functioning epidural catheter was in place postoperatively. In these patients effective analgesia was maintained with dilute solutions of epidural bupivacaine. Only three doses of narcotic were required for pain control. No patient required postoperative mechanical ventilation or tracheal intubation. CSE anesthesia is a potential option to general anesthesia for major abdominal surgery in infants.

The physiologic immaturity of respiratory musculature and central respiratory control centers leads to an increased risk of apnea and respiratory complications following general anesthesia in the neonate. Regional anesthetic techniques such as spinal and caudal epidural anesthesia may obviate the need for general anesthesia and lessen the risks of perioperative morbidity. Although these techniques have been previously described in infants, the majority of reports focus on regional anesthesia during herniorrhaphy in the former, preterm infant. There is relatively little or no information concerning regional anesthesia during urologic surgery in infants, especially during the actual neonatal period (0 to 28 days). Tobias et al.[110] reported on three neonates (2.17 to 3.8 kg) who required anesthetic care during the neonatal period for various urologic procedures including cystoscopy, incision of an ureterocele, and vesicostomy placement. Either caudal or spinal anesthesia was successfully used in the awake infant without the need for supplemental anesthetic agents.

CSEGA for orthopedic operations

Casati et al.[111] compared the efficacy, efficiency and surgeon's satisfaction of TIVA with propofol and remifentanil with those of spinal or peripheral nerve blocks for outpatient knee arthroscopy. One hundred and twenty patients undergoing elective outpatient knee arthroscopy were randomly allocated to receive TIVA, combined sciatic-femoral nerve block, or spinal anesthesia. Preparation times, surgeon's satisfaction, and discharge times with the three anesthesia techniques were measured. Anesthesia related costs were also compared based on costs of drugs, disposable materials, and anesthesia and nurse staff. Preparation time was 13 minutes (8-22 minutes) with general anesthesia, 15 minutes (5-30 minutes) with spinal anesthesia and 15 minutes (5-25 minutes) with sciatic-femoral blocks (P=0.006). Surgeon's satisfaction was similar in the three groups, but 17 patients receiving peripheral nerve block (42%) and 12 receiving spinal anesthesia (30%) by-passed the PACU after surgery as compared with only two general anesthesia patients (5%) (P=0.01). Discharge from the PACU required 5 minutes (5-20 minutes) after peripheral block as compared with 15 minutes (5-25 minutes) with spinal and 15 minutes (5-80 minutes) with general anesthesia (P = 0.005); however, stay in the Day Surgery Unit was shorter after general anesthesia [170 (100-400) minutes] than peripheral [265 (110-485) minutes] or spinal blocks [230 (95-800) minutes] (P = 0.026). Urinary retention was reported in 3 spinal patients only (8%) (P = 0.03). Regional anesthesia techniques reduce the rate of admission and the duration of stay in the PACU as compared with general anesthesia. Peripheral rather than spinal nerve blocks should be preferred to minimize the risk for urinary retention.

Deep venous thrombosis is the most common complication in patients having elective total knee replacement. Pneumatic compression devices play an important role in the prophylaxis of deep venous thrombosis and effectively decrease the risk of distal deep venous thrombosis. The combination therapy with pharmacologic agents has the benefit of decreasing the rate of proximal deep venous thrombosis and therefore is recommended. In the absence of clinical data, recent in vivo flow studies suggest that calf or combined foot and calf compression are superior to foot compression alone. Epidural anesthesia in comparison with general anesthesia decreases the incidence of thromboembolic disease after total knee arthroplasty. Although hypotensive anesthesia and intraoperative heparin have been proven to substantially lower the incidence of deep venous thrombosis after total hip arthroplasty, the current literature does not support its application during the implantation of a total knee replacement. Pneumatic compression devices are an important part of deep venous thrombosis prophylaxis especially in the early postoperative period considering that pharmacologic anticoagulation is contraindicated in the first 12 hours after spinal anesthesia and in the presence of an epidural line.[11] de Visme et al.[113] designed a prospective randomized study to determine the hemodynamic effects and quality of combined lumbar and sacral plexus block compared with plain bupivacaine spinal anesthesia in the elderly for repair of proximal femoral fractures. Twenty nine elderly patients ranging in age from 68 to 97 years were randomly assigned to two groups: a spinal anesthesia group with single shot 3 mL 0.5% plain bupivacaine, and a combined block group with 30 mL lidocaine 1.33% with epinephrine for the posterior lumbar plexus block and 10 mL same mixture for the parasacral block and an iliac crest block with 5 mL lidocaine 1%. No need for general anesthesia was encountered in either group. Anesthesia was judged unsatisfactory in 1 of 15 patients in the combined block group. The initial decrease of MAP was 38% in the spinal group and 27% in the block group and was not significantly different. A more prolonged hemodynamic effect was found in the spinal group, indicated by the more frequent use of ephedrine to stabilize blood pressure (P<.05). Patients over 85 years had a significantly larger decrease in blood pressure than younger patients (P<.01). Plain bupivacaine spinal anesthesia and combined lumbar/sacral plexus block provided adequate anesthesia for repair of hip fracture in the elderly. Hypotension was induced by both the combined peripheral nerve block and plain bupivacaine spinal anesthesia in aged patients; hypotension was found to be longer lasting after spinal anesthesia and of a larger magnitude in patients over 85 years of age. Ninety total hip replacements performed by one surgeon were reviewed to compare the effects of different anesthetic techniques on the perioperative bleeding.114 Half of the total hip replacements were performed under either CSE anesthesia with lidocaine or general anesthesia with N_2O/ O_2, vecuronium, enflurane or isoflurane. Deliberate hypotensive technique was not employed in any total hip replacements. All patients were female and had suffered from osteoarthritis of the hip joints. The patients in the two anesthesia groups were similar as to age, body weight, height, perioperative hemoglobin level, duration of anesthesia and operation, and blood transfusion requirement. A positive linear correlation existed between total operative blood loss and operation time in each group (P < 0.01). The rate of operative blood loss was significantly higher in the CSE anesthesia (6.2 ± 3.0 mL/min-1) than in the general anesthesia (5.1 ± 2.0 mL/ min-1), while the amount of blood loss itself was without statistical difference. A significant increase in total volume of perioperative blood loss was also observed in the group with CSE anesthesia (1520 ± 90 mL) compared with the general anesthesia group (1279 ± 58 mL). These results show that spinal and/or epidural anesthesia can not always lead to reductions in operative blood loss during total hip replacement surgery.

The effect of hypobaric spinal anesthesia or narcotic-halothane-relaxant general anesthesia on the incidence of postoperative deep vein thrombosis was studied in 140 elective total hip replacements in a prospective randomized manner.[115] Deep vein thrombosis was diagnosed using impedance plethysmography and the 125I fibrinogen uptake test, combined, in selected cases, with ascending contrast venography. The overall incidence of deep vein thrombosis was 20%. Nine patients (13%) developed deep vein thrombosis in the spinal group and nineteen (27%) in the general anesthetic group (P < than 0.05). The incidences of proximal thrombosis and of bilateral thrombi were also less with spinal anesthesia than with general anesthesia. It was concluded that spinal anesthesia reduces the risks of postoperative thromboembolism in hip replacement surgery. The presence of varicose veins, being a non-smoker and having a low body mass index were associated with an increased incidence of deep vein thrombosis. Fifty five patients presenting with fractured neck of femur were randomly allocated to either a standard general anesthetic or spinal block in the lateral position combined with light sedation.[116] The comparability of the two groups was established. There was little difference in the intra operative course of postoperative morbidity in the two groups. There was a statistically significant difference in post-operative mortality between two groups, the general anesthetic group showing a much higher mortality than the spinal group.

Efficient perioperative analgesia is more comfortable, allows earlier mobilization and better functional results for lower limb arthroplasties. Cazeneuve et al.[117] reported on their 60 cases prospective study of CSE anesthesia, and exposed interests of this technique to control perioperative pain. Sixty patients ASA I were operated: 45 total hip replacement total hip replacements, 15 total knee replacements. The average age was sixty-five-years (range thirty nine to eighty five years). CSE anesthesia was performed in every case. In lateral decubitus position, a 25-gauge needle was introduced in L2-L3 interspace. In the first time a spinal anesthesia was made with 20 mg bupivacaine. In the second time, a lumbar epidural catheter was inserted. All patients received an epidural postoperative analgesia with 4 mg morphine once a day during two days and intravenous paracetamol. Pain VSA were recorded after the third post operative hour and every twelve hours. During this period satisfaction mark was also recorded (1 to 3). They did not observe any case of respiratory depression or infection with the epidural catheter. There were 10 cases of pruritus (one needed to stop protocol) and 18 urinary retentions. Six urethral catheters were necessary; they had one case of pyelonephritis. The first micturition was obtained 13.5 hours after the end of surgery. For the 59 remaining patients, pain VSA was always inferior or equal to 2/10 and the satisfaction mark to 1/3. Different techniques allow perioperative analgesia, but a few are efficient during the first two days. Plexus nerve blocks are simple and reliable but post operative anesthesia is short (inferior to 15 hours). Intravenous morphine controlled by patients themselves with programmed display needs expensive and sophisticated material. The principal risk is respiratory depression. Epidural morphine has a lower respiratory depression risk, but needs a heavier technique. The principal problem is higher incidence of urinary side effects. Epidural anesthesia might tend to show a greater efficacy with the best pain VAS and satisfaction mark. The results indicate that CSE anesthesia for the management of perioperative pain provides an excellent pain control with a daily morphine injection. For lower limb arthroplasties, VAS is always inferior or equal to 2 and satisfaction mark equal to 1.

CSEGA for cardiac operations

Major surgery evokes a stress response that can produce deleterious consequences, especially in a population at high risk for those complications. Fleron et al.[118] tested the hypothesis that decreasing or eliminating one of the sources of stress by providing intense analgesia in the immediate postoperative period via application of neuraxial opioids would decrease major nonsurgical complications. Two hundred and seventeen patients scheduled to undergo abdominal aortic surgery were randomly allocated to receive either general anesthesia alone (control) or general anesthesia combined with intrathecal opioid (1 µg/kg sufentanyl with 8 µg/kg preservative free morphine injected at the L4-5 interspace). Postoperative care was identical in the two groups, including PCA. Each patient provided an assessment of postoperative pain using a VAS. Postoperative complications were recorded according to criteria established a priori. The administration of intrathecal opioid provided more intense analgesia than PCA during the first 24 hours postoperatively ($P < 0.05$). There was no difference between groups for the incidence of combined major cardiovascular, respiratory, and renal complications ($P > 0.05$) or mortality ($P > 0.05$). The incidence of myocardial damage or infarction, as defined by abnormal plasma concentration of troponin I, did not differ between the two groups ($P > 0.05$). In patients undergoing major abdominal vascular surgery, decrease of one contributor to postoperative stress, by provision of intense analgesia for the intraoperative and initial postoperative period, via application of neuraxial opioid, does not alter the combined major cardiovascular, respiratory, and renal complication rate.

The presence of chronic obstructive pulmonary disease (COPD) should not be considered a contraindication to operation but should rather identify those patients that require special preoperative and postoperative pulmonary care. Flores et al.[119] reported their experience in the use of CSE anesthesia for open aorto-abdominal-aneurysm repair in such patients. Three patients with severe COPD underwent elective open infrarenal aorto-abdominal-aneurysm repair under CSE anesthesia. All the patients satisfied one or more of the following criteria: a room air $PaO_2 \leq$ 60 mmHg, $PaCO_2 \geq 45$ mmHg, FEV1 ≤ 50% of predicted, and/or FVC ≤ 75% of predicted, and one of them was on home oxygen preoperatively. Preoperative preparation of the patients consisted of breathing exercises with incentive espirometry, elimination of underlying pulmonary infections and usage of bronchodilator therapy. All the patients tolerated surgery safely. None of them developed postoperative complications, including pneumonia and other respiratory conditions. No significant changes in room air arterial blood gas or pulmonary function was recognized before and after surgery. CSE anesthesia is a viable anesthetic option for conventional aorto-abdominal-aneurysm surgery in patients with severe COPD since it can preserve spontaneous breathing and provide additional respiratory benefits over general anesthesia. An audit of 100 patients undergoing elective abdominal aortic surgery either by open aortic repair (OAR group 50 patients) or endovascular aortic repair (EAR group 50 patients) was undertaken to document changes in anesthetic technique and perioperative outcome.[120] The data for the OAR group was collected retrospectively and that for the EAR group prospectively. Combined general anesthesia and thoracic epidural anesthesia was used in 44 of the OAR group whereas lumbar central neural blockade alone was used in 47 of the EAR group. The major differences between the two groups were that intraoperative blood loss was significantly less in the EAR group (OAR 1,674 ± 1,008 mL, EAR 459 ± 350 mL, $P < 0.001$) and that no patient in the EAR group required admission to the ICU, whereas ICU time for the OAR patients was 29 ± 22 hours. Hospital stay was also significantly different between the two groups (OAR 13 ± 6 days, EAR 5 ± 3 days, $P < 0.001$). Major complications occurred in 20 patients in the OAR group but only 4 patients in the EAR group ($P<0.001$). Endovascular aortic repair reduces blood loss, the requirement for ICU admission and hospital stay.

Neuraxial blockade (spinal or epidural anesthesia) is still widely used in patients undergoing vascular surgery. However, the combined administration of anticoagulants and antiplatelet agents may compromise the safety of this technique with regards to the potential occurrence of a spinal or of an epidural hematoma. Samama and Baillard[121] reviewed the benefits and risks of neuraxial blockade in light of the evolution of anticoagulation for vascular surgery. Vascular surgery generally requires a high level of intraoperative anticoagulation. An increasing number of patients are also treated pre and postoperatively with antiplatelet agents. Their administration cannot be interrupted without serious risks to the patients' cardiovascular system and, further their continued use during surgery may improve graft permeability. Recent reports have emphasized the danger of neuraxial anesthesia in patients receiving low dose anticoagulation. So, high doses of heparins should carry an ever higher risk of serious complications in patients undergoing neuraxial blockade. Furthermore, no published data has ever demonstrated convincingly the benefit of either epidural or spinal anesthesia over general anesthesia. No differences have ever been documented in terms of cardiovascular morbidity, graft patency, and mortality. Routine neuraxial blockade cannot be recommended in patients undergoing vascular surgery. The decision to perform a neuraxial block in such a patient may only be taken on a case by case basis, after careful consideration of expected benefits and potential risks. Serious neurological complications of abdominal aortic vascular surgery are rare but devastating for all involved. When epidural blockade is part of the anesthetic technique such complications may be attributed to needles, catheters or drugs. Rutter et al.[122] presented a patient who developed paraplegia following an elective abdominal aortic aneurysm repair. Continuous epidural blockade was part of the anesthetic technique and postoperative analgesia. In this case the spinal cord damage was explained by ischemia caused by the aortic surgery.

Endovascular aortic stent grafts were first introduced in clinical trials in 1991. Endovascular aortic stent grafts are now being used to repair thoracic and abdominal aneurysms in patients not eligible for open repair because of severe medical coexisting diseases.

Previously described anesthetic techniques in the literature for aortic stent graft placement include general anesthesia, epidural anesthesia, combined single-shot spinal and epidural anesthesia, and direct local anesthesia. Mathes and Kern[123] reported the use of a continuous spinal anesthetic technique as a viable anesthetic option for patients with severe coexisting medical diseases undergoing abdominal aortic stent graft placement.

The efficacy of CSE anesthesia for femoral to distal artery bypass surgery was assessed by Gallinguer and cols.[124] Thirty eight patients were divided into 3 groups. CSE block was performed at L3-L4 (26-gauge pencil-point spinal needle and 18-gauge catheter). In group I (n = 14) blocking was induced with 20 mg of 1% lidocaine and maintained with 2% lidocaine through an epidural catheter. Group II (n = 15) received spinal plain 20 mg of 0.5% bupivacaine. In group III (n = 9) the initial dose of plain 0.5% bupivacaine was 5 mg; 5 minutes after the first bolus the incremental dose of plain bupivacaine 15 mg was injected and spinal needle was withdrawn. Epidural 0.5% bupivacaine was injected as needed. Sensory blockade was assessed by the pinprick test. Two patients in group I (18.2%) were in need of general anesthesia (inadequate dissemination of solution in one case and catheter kinking in the other). In group II general anesthesia had to be performed in one case because surgery was longer than planned. In group III anesthesia was effective in all cases. The mean level of sensory block in group I was T11.2 ± 0.4, in group II T9.4 ± 0.5, and in group III T8.6 ± 0.55 ($P > 0.05$). The mean dose of bupivacaine per segment in groups II and III was 1.47 ± 0.08 and 2.08 ± 0.01, respectively ($P < 0.05$), use of epidural catheter during surgery 40 and 11%, respectively ($P < 0.05$). Arterial pressure drop was 10.8, 14.1, and 11.6% in groups I, II, and III, respectively. The mean total dose was 735 ± 89 mg (172 ± 14 mg/hour) in the lidocaine group, in group II 38.5 ± 6.4 mg (10.25 ± 1.15 mg/hour), and in group III 32.8 ± 2.8 mg (7.46 ± 1.67 mg/hour) ($P < 0.05$). No neurological problems or PDPH were observed in any of the patients and no vasoactive drugs were needed. CSE anesthesia is fit for anesthesia for peripheral vascular surgery. CSE anesthesia with double spinal injection is preferable, for it provides a longer anesthesia and hemodynamic stability.

The hemodynamic changes associated with intrathecal morphine compared to intrathecal sufentanyl as a supplement to general anesthesia for elective bypass grafting in patients with aortoiliac occlusive disease were studied.[125] Thirty six, ASA II, patients randomly received morphine hydrochloride (0.1%) 50 µg/ kg-1 (n = 18) or undiluted sufentanyl, 150 µg (n = 18) intrathecally at T12-L1, combined with light general anesthesia. Hemodynamics changes were measured before and after endotracheal intubation, abdominal incision, aortic cross-clamping and the first revascularization. The major differences were recorded after abdominal incision. Heart rate, systemic blood pressure and coronary perfusion pressure were significantly lower in the intrathecal sufentanyl group. The probable cause was greater systemic absorption of sufentanyl and its faster binding to the specific opiate receptors, resulting in a more efficacious supraspinal and spinal blockade during the first surgical period. However, both opioids provided adequate analgesia during the whole surgical procedure.

Inberg et al.126 evaluated the usefulness, safety, and efficacy of the combined plexus brachial, spinal, and epidural blocks in free toe to hand transplantations. The duration of operations varied between 8 and 18 hours. No major complications occurred. Vasodilatation in the operated hand was maintained during the entire operation as well as in the postoperative period, and the surgical results were satisfactory. The mean skin temperature was 5 °C higher in the blocked extremity compared to the opposite hand. In every patient the skin temperature of the transplant was over 32.4 °C after the operation. Blood pressure, heart rate, temperature and oxygen saturation were well maintained during the entire procedure. All patients were satisfied with their anesthesia. Back pain occurred in 11 patients and in two it was considered severe. One patient may have had a systemic toxic reaction (shivering) due to high plasma levels of bupivacaine, but the symptom was transient. Combined regional anesthesia is an alternative to general anesthesia in prolonged microsurgical operations and it appears to improve perfusion of the transplanted extremity.

Extra anatomic axillofemoral bypass is a surgical procedure that is indicated in cases of occlusive aortoiliac pathology in which the transabdominal way is not feasible or in patients of high risk. Sopena et al.[127] presented a preliminary study in which they have prospectively evaluated 14 patients who were received an axillofemoral bypass. After preoperative evaluation two groups were identified: Group ALR (5 patients) with combined anesthetic blockade of supraclavicular brachial plexus and continuous subarachnoid blockade. Group AG (9 patients) who received balanced general anesthesia. In all cases they obtained a good anesthetic level for surgery. The incidence of complications was similar in both groups. One patient subjected to general anesthesia died. Combined blockade induces a satisfactory analgesia in all surgical interventions without exceeding in any case the maximal doses of anesthetic drugs. Additionally, this technique affords the advantages of regional anesthesia and can be used as an alternative anesthetic procedure in patients of high risk who undergo axillofemoral bypass.

Houweling et al.[128] evaluated the influence of epidural sufentanyl and intrathecal sufentanyl on the perioperative hemodynamic responses during abdominal aortic surgery. Twenty four ASA II patients without clinical symptoms of coronary artery disease received, randomly, epidural (n = 12) or intrathecal (n = 12) sufentanyl combined with light general anesthesia for elective bifemoral grafting for aortoiliac occlusive disease. The intrathecal sufentanyl group contained significantly more hypertensive patients than the epidural sufentanyl group. This resulted in a significantly higher systolic and MAP, which remained constant from the start to the end of the study. Following a single bolus injection of 150 µg of sufentanyl epidurally or intrathecally, there was a significant decrease in heart rate, systolic, mean and diastolic blood pressure, systemic vascular resistance (SVR) and coronary perfusion pressure in both groups. This suggests that intrathecal and epidural sufentanyl must be used with caution in patients with cardiovascular disease. The abdominal incision restored the hemodynamic changes produced by sufentanyl administration, but these did not exceed pre sufentanyl values. There were no significant changes in filling pressure, cardiac index and left ventricular work after aortic cross-clamping in the two groups. Revascularization produced significant differences in heart rate, SVR and CI in both groups in comparison with the pre-declamping period. Notable was the maintenance of systemic blood pressure following revascularization due to preservation of sympathetic activity. It was concluded that both epidural and intrathecal sufentanyl produce comparable and stable hemodynamics in this category of patients. Christopherson et al.129 examined the degree of success at maintaining patients randomized to epidural or general anesthesia for peripheral vascular surgery within predetermined blood pressure and heart rate limits and investigated associations between such hemodynamic control and intraoperative myocardial ischemia and postoperative major cardiac morbidity in 100 patients undergoing elective lower extremity revascularization for atherosclerotic peripheral vascular disease. Patients were randomized to receive either epidural anesthesia or general anesthesia. Blood pressure and heart rate limits were determined prior to randomization. Hemodynamic monitoring and management of anesthesia was standardized. Myocardial ischemia and major cardiac morbidity were diagnosed by a blinded cardiologist, based on continuous ambulatory ECG monitoring, cardiac enzymes, and 12 lead ECGs. Intraoperative blood pressure and heart rate data were analyzed by investigators masked to the type of anesthesia given. A greater percentage of patients randomized to general anesthesia had intraoperative blood pressure more above their limit (95% vs. 72%, $P = 0.002$) and/or more rapid changes in heart rate (75% vs. 48%, $P = 0.008$) or blood pressure (100% vs. 93%, $P = 0.04$) than those randomized to epidural anesthesia. Intraoperative ischemia and major cardiac morbidity were similar in the two anesthesia groups. Patients experiencing intraoperative ischemia, regardless of anesthetic type, more frequently had blood pressure greater than 10% above their upper limit (90% vs. 60% $P = 0.04$) and/or more rapid heart rate changes (90% vs. 58%, $P = 0.03$) compared with patients without ischemia. These vital sign abnormalities, however, were not necessarily temporally related to the ischemic episodes. Patients experiencing subsequent major cardiac morbidity were not different from other patients with respect to excursions out of blood pressure or heart rate limits. Prevention of elevated intraoperative blood pressure and/on rapid changes in blood pressure or heart rate may be more successful with epidural than with general anesthesia. Such vital sign abnormalities may occur more frequently in patients who have had intraoperative ischemia or are at risk for having it later in the procedure.

Damask et al.130 examined whether epidural anesthesia is more effective than general anesthesia using an inhalation agent in controlling cardiovascular responses during femoral-popliteal bypass surgery. Nineteen patients were randomized into two groups: general anesthesia (n = 10) and epidural anesthesia (n = 9). The patients who underwent general anesthesia received sodium pentothal and succinylcholine for induction of anesthesia and 60% N_2O, 40% O_2, and 1% to 1.5% isoflurane for maintenance. Fifteen minutes before extubation, the patients received morphine sulfate 0.05 mg/kg i.v. The group that underwent epidural anesthesia received anesthesia to T10 (through a catheter placed in the L4-5 interspace using 3% 2-chloroprocaine). Thirty minutes after the last dose, morphine sulfate 0.05 mg/kg i.v. was administered. Hemodynamic variables were recorded at selected intervals during the operation and for 60 minutes in the recovery room. In the general anesthesia group, MAP and rate pressure product (RPP) significantly decreased (P less than 0.05) during the operation as compared with preoperative values. Following intubation and skin incision, 5 minutes after extubation, and after 60 minutes in the recovery room, MAP, heart rate, and RPP were significantly greater (P < than 0.05) as compared with intraoperative periods. In the epidural anesthesia group, there were clinically important decreases in MAP and RPP after reaching T10 and skin incision. The general anesthesia patients showed higher MAP, heart rate, and RPP 5 minutes after extubation and after 60 minutes in the recovery room. Epidural anesthesia patients showed stable hemodynamic patterns throughout the study. Garnett et al.131 made a randomized study to determine whether combined general and epidural anesthesia with postoperative epidural analgesia, compared with general anesthesia and postoperative intravenous analgesia, reduced the incidence of perioperative myocardial ischemia in patients undergoing elective aortic surgery. Patients were randomly assigned to one of two groups. One group (EPI n = 48) received combined general and epidural anesthesia and postoperative epidural analgesia for 48 hours. The other group (GA n = 51) received general anesthesia followed by postoperative intravenous analgesia. Anesthetic goals were to maintain hemodynamic stability (± 20% of preoperative values), and a stroke volume > 1 mL/kg-1. A Holter monitor was attached to each patient the day before surgery. Leads II, V2, and V5 were monitored. Myocardial ischemia was defined as ST segment depression > 1 mm measured at 80 milliseconds beyond the J point or an elevation of 2 mm 60 milliseconds beyond the J point which lasted > 60 seconds. An event that lasted > 60 seconds but returned to the baseline for > 60 seconds and then recurred, was counted as two separate events. The Holter tapes were reviewed by a cardiologist blind to the patient's group. There were no demographic differences between the two groups. Myocardial ischemia was common; it occurred in 55% of patients. In hospital, preoperative ischemia was uncommon (GA = 3, EPI = 8). Intraoperative ischemia was common (GA = 18, EPI = 25). Mesenteric traction produced the largest number of ischemic (GA = 11, EPI = 11) events. Postoperative ischemia was most common on the day of surgery. Termination of epidural analgesia produced a burst of ischemia (60 events in 9 patients). Combined general and epidural anesthesia and postoperative epidural analgesia do not reduce the incidence of myocardial ischemia or morbidity compared with general anesthesia and postoperative intravenous analgesia. Fifty patients undergoing elective abdominal aortic surgery were randomized to receive either combined epidural and general anesthesia and postoperative epidural analgesia (CEGA) or general anesthesia and postoperative intravenous morphine infusion.[132] Prospective data was collected in order to compare the two groups. This included intraoperative cardiovascular changes and postoperative complications. The use of intraoperative vasopressors was significantly higher in the CEGA group ($P < 0.01$) but the use of intravenous glyceryl trinitrate was significantly lower ($P < 0.01$). There was no significant difference between groups in regard to blood loss, volume replacement or in the number of patients requiring postoperative ventilation. Two patients in the CEGA group died postoperatively compared to one in the general anesthesia group. There was no significant difference between groups in the total number or type of postoperative complications. Combining epidural anesthesia with general anesthesia altered intraoperative cardiovascular management but did not affect postoperative outcome.

Salvi et al.[133] assessed the feasibility of high thoracic epidural anesthesia combined with sevoflurane for off-pump coronary artery bypass surgery and evaluated the postoperative pain control, side effects, and perioperative hemodynamics. One hundred six consecutive patients received thoracic epidural combined with sevoflurane. Insertion of the epidural catheter was successful in all but two patients; one bloody tap occurred and the dura was never punctured, although one patient presented with postoperative paraplegia. An emergency spinal cord NMR excluded signs of medullary compression caused by epidural or spinal hematoma.

VAS for pain during the first 24 hour period were < 2 in all patients. Mean time to extubation was 4.6 ± 2.9 hours. The average ICU stay was 1.5 ± 0.8 days. Incidences of perioperative myocardial infarction, myocardial ischemia, and atrial fibrillation were 2.8%, 7.5%, and 10.6%, respectively. Two patients died; one from multiorgan failure and the other from myocardial infarction. Heart rate, MAP, CI, and SVR were not affected by thoracic epidural alone. MAP and CI decreased ($P < 0.05$) when general anesthesia was induced and remained stable thereafter. Neither heart rate nor SVR changed from baseline during operation. Thoracic epidural as an adjunct to general anesthesia is a feasible technique in off-pump coronary artery bypass surgery. It induces intense postoperative analgesia and does not compromise central hemodynamics.

Pastor et al.134 evaluated the risk of neurologic complications caused by an epidural hematoma in a series of patients who had coronary artery bypass graft surgery with cardiopulmonary bypass under combined general and thoracic epidural anesthesia in 714 patients who had coronary artery bypass grafting surgery over a 7 year period. An epidural catheter was inserted at T1-T3 as soon as the patient was in the operating room and local anesthetic was administered as a bolus and then as a continuous infusion throughout the operation and postoperatively. A set of safety guidelines was routinely followed. A protocol for postoperative neurologic evaluation was used to rule out any signs of spinal compression. Preoperatively, a battery of coagulation tests was systematically performed including activated partial thromboplastin time (APTT), platelet count, and prothrombin time. Antiplatelet drugs (aspirin) were stopped at least 7 days before surgery. No patient required parenteral opiates postoperatively. Seventy five percent of the patients were extubated in the operating room. No clinical epidural hematomas were detected. In this study, some of the benefits previously reported during cardiac surgery under thoracic epidural anesthesia, such as excellent analgesia and early extubation, were confirmed. In addition, the series adds further evidence that adherence to a set of standard safety measures, in this setting, averts the occurrence of symptomatic epidural hematomas. Canto et al.[135] evaluated the risk of neurologic complications resulting from epidural hematoma in 305 patients who had surgery for repair or replacement of heart valves under combined general and thoracic epidural analgesia. An epidural catheter was inserted at T1-3 as soon as the patient was in the operating room, and local anesthetic was administered as a bolus, then as a continuous infusion throughout the operation and postoperatively. A protocol for postoperative neurologic evaluation was used to rule out clinical signs of spinal lesions. A set of safety guidelines was routinely followed. Preoperatively a battery of coagulation tests was systematically carried out: APTT, platelet count, and prothrombin time. Oral anticoagulants (warfarin) were stopped >60 hours before surgery, and antiplatelet drugs (aspirin) were stopped 7 days before. No patient required parenteral opiates postoperatively. Of the patients, 65% were extubated in the operating room. There were no neurologic complications resulting from epidural hematoma. Thoracic epidural analgesia can provide effective postoperative analgesia and assist in early tracheal extubation in cardiac valve surgery. In this series, there were no neurologic deficits detected. When certain safety measures are taken, routine thoracic epidural analgesia is feasible and helpful in cardiac valve surgery.

After cardiac surgery adequate postoperative analgesia is necessary. Lena et al.[136] assessed analgesia using intrathecal morphine and clonidine. In a double-blind randomized study, 45 patients having coronary artery bypass graft surgery were allocated randomly to receive i.v. PCA morphine (bolus, 1 mg; lock-out interval, 7 minutes) (control group), either alone or combined with intrathecal morphine 4 μg kg-1 or with both intrathecal morphine 4 μg kg-1 and clonidine 1 μg kg-1. Intrathecal injections were performed before the induction of general anesthesia. Pain was measured after surgery using a VAS. Intravenous PCA morphine consumption during the 24 hours after operation was recorded. Morphine dosage [median (25th-75th percentiles)] was less in the first 24 hours in the patients who were given intrathecal morphine + clonidine [7 (0-37) mg] than in other patients [40.5 (15-61.5) mg in the intrathecal morphine group and 37 (30.5-51) mg in the i.v. morphine group]. VAS scores were lower after intrathecal morphine + clonidine compared with the control group. Time to extubation was less after intrathecal morphine + clonidine compared with the i.v. morphine group [225 (195-330) vs. 330 (300-360) minutes, $P<0.05$]. Intrathecal morphine and clonidine provide effective analgesia after coronary artery bypass graft surgery and allow earlier extubation.

Lee et al.[137] in a double-blind, randomized, controlled trial examined the effect of high-dose intrathecal bupivacaine in combination with general anesthesia on atrial beta adrenergic receptor function, the stress response, and hemodynamics during coronary artery bypass graft surgery. Thirty eight patients were randomized to either control (n = 19) or intrathecal bupivacaine groups (n = 19). Patients in the intrathecal bupivacaine group received 37.5 mg intrathecal hyperbaric bupivacaine before induction of general anesthesia. Control patients received an injection of local anesthetic into the skin and subcutaneous tissues (sham spinal). Comparisons were made between groups with respect to atrial receptor desensitization and down-regulation, in addition to circulating catecholamines and hemodynamics. In patients with cardiopulmonary bypass (CPB) times in excess of 1 hour, the intrathecal bupivacaine group had significantly less atrial beta receptor dysfunction, as measured by maximal isproteronol, 50% maximal isoproterenol, sodium fluoride-stimulated activity, and zinterol stimulation assays of adenylyl cyclase activity ($P \leq 0.02$) and beta-adrenergic receptor density ($P = 0.02$). Serum epinephrine, norepinephrine, and cortisol concentrations were significantly lower in the intrathecal bupivacaine group, independent of CPB times ($P < 0.0001$, $P < 0.001$, and $P < 0.05$, respectively). Intrathecal bupivacaine patients had a higher CI index and a lower pulmonary vascular resistance index in the post-CPB time period ($P < 0.01$ and $P < 0.05$, respectively). In the pre-CPB period, MAP and systemic vascular resistance index were significantly lower in the intrathecal bupivacaine group. High dose intrathecal bupivacaine, when combined with general anesthesia, resulted in less beta-receptor dysfunction and a lower stress response during coronary artery bypass graft surgery.

Whether regional anesthesia is preferable to general anesthesia for patients with congestive heart failure undergoing noncardiac surgery remains controversial. Cohen et al.[138] made a study to determine whether anesthetic technique affects postoperative cardiac outcome in patients with congestive heart failure; they hypothesized that cardiac outcomes would be superior with regional anesthesia compared with general anesthesia. One hundred and six patients with prior or persistent congestive heart failure, undergoing femoral to distal artery bypass surgery, were randomized to general anesthesia or regional anesthesia (epidural or spinal). The primary end point was death or adverse cardiac events (myocardial infarction, unstable angina, or congestive heart failure). There was no statistically significant difference between groups in incidence of combined cardiac events, death, myocardial infarction, death or myocardial infarction combined, unstable angina, or congestive heart failure.

In a double-blind randomized study Mason et al.[139] compared a group of 15 patients undergoing thoracotomy who received a spinal injection of sufentanyl 20 µg combined with morphine 200 µg after induction of general anesthesia with a control group of the same size. Post operative pain was rated on VAS and a VRS at rest and with a VAS on coughing. In the recovery room, patients received titrated i.v. morphine until the VAS score was <30, and were followed by PCA for 72 hours. The intrathecal sufentanyl and morphine group had a lower intra operative requirement for i.v. sufentanyl and needed less i.v. morphine for titration in the recovery room. Intravenous PCA morphine consumption and pain scores were lower in the active group than in the control group during the first 24 hours. There were no differences after this time. Spirometric data were similar in the two groups. It was concluded that the combination of intrathecal sufentanyl and morphine produces analgesia of rapid onset and with duration of 24 hours. Liu et al.[140] compared the analgesic effect of lumbar intrathecal 0.5 mg morphine (Group M, n = 10), 50 µg sufentanyl (Group S, n = 10), and their combination (Group S-M, n = 10) given before general anesthesia and PCA with i.v. morphine (group C, n = 19) in a randomized, double-blinded study performed in patients undergoing thoracotomy. Pain VAS and morphine consumption were assessed for 24 hours. In group S-M the number of patients initially titrated with i.v. morphine was less than in group C (30 vs. 84%, $P < 0.05$). Morphine requirement was higher in group C (71 ± 30 mg) than in groups S (46 ± 34 mg, $P < 0.05$), M (38 ± 31 mg, $P < 0.05$) and S-M (23 ± 16 mg, $P < 0.01$). VAS scores were significantly decreased during the first 0-11 postoperative hours at rest and during the first 0-8 postoperative hours on coughing in groups M and S-M rather than in group C. The incidence of side effects was infrequent except for urinary retention. Preoperative intrathecal morphine or combined sufentanyl and morphine could be given as a booster to achieve rapidly effective analgesia in the immediate postoperative period. As compared with i.v. PCA, intrathecal morphine or combined sufentanyl and morphine provided superior postoperative pain relief both at rest (11 hours) and on coughing (8 hours) than did i.v. PCA morphine alone. Intravenous morphine requirement was decreased during the first postoperative day after posterolateral thoracotomy.

Kowalewski et al.[141] reported their experience with general anesthesia supplemented with subarachnoid bupivacaine and morphine for coronary artery bypass surgery (CABG) in 18 patients. Fifteen patients were male, mean age was 62 years. Anesthesia was induced with alfentanil 97 ± 22 µg/kg-1 and midazolam 0.04 ± 0.02 mg/kg-1 supplemented with a muscle relaxant, and maintained with isoflurane (0.25-0.5%) in oxygen throughout surgery. Spinal anesthesia was then performed at a lumber level using hyperbaric bupivacaine (23-30 mg) and/or lidocaine (150 mg) with morphine (0.5-1 mg). Pooled data showed the following hemodynamic results ($P < 0.05$). Induction of general anesthesia produced a decrease in MAP. Addition of spinal anesthesia produced a decrease in heart rate. Heart rate and MAP did not change with sternotomy. Phenylephrine support of arterial blood pressure was used at some time during operation in 17 patients. Supplementation of general anesthesia was minimal. Patients received 2.7 ± 0.7 coronary grafts. Operating room time was 3.9 ± 0.6 hours. Postoperative analgesic requirements were minimal, and in half of the patients tracheal extubation occurred on the day of surgery. Complications included one myocardial infarction, one resternotomy, a metabolic encephalopathy in a dialysis dependent patient, and one case of herpes labialis. No patient recalled intraoperative events. Combined general anesthesia with spinal anesthesia may be an effective technique for CABG surgery. The records of 10 patients who had well preserved respiratory and ventricular function and had received 50 µg of sufentanyl and 0.5 mg of morphine intrathecally before induction of anesthesia for cardiopulmonary bypass surgery were reviewed.[142] Anesthesia was maintained with isoflurane and no patient received i.v. narcotics intraoperatively. Postoperative analgesic requirements were low, with 7 of 10 patients requiring no supplemental analgesic during the first 12 hours. Early extubation (within 8 hours of arrival in the ICU) was possible in 8 patients; two patients remained intubated for reasons unrelated to the anesthetic technique. No patient required naloxone, reintubation, or treatment for respiratory depression. Combined intrathecal sufentanyl and morphine provided conditions that allowed successful early extubation in 8 of 10 of these selected cardiac surgery patients.

CSEGA for laparoscopic operations

Although endoscopic totally extraperitoneal inguinal hernioplasty confers superior early outcomes compared to those of open repair, the requirement of general anesthesia has been held as an argument against the application of totally extraperitoneal inguinal hernioplasty by opponents of laparoscopic surgery. To date, the literature on totally extraperitoneal inguinal hernioplasty performed under spinal anesthesia remains scarce. Lau and coworkers143 reports their experience performing totally extraperitoneal inguinal hernioplasty under spinal anesthesia in selected patients who were medically unfit for general anesthesia. Six male patients underwent attempted totally extraperitoneal inguinal hernioplasty under spinal anesthesia. Selection criteria for the procedure included reducibility of the inguinal hernia and concomitant medical conditions precluding general aesthesia, such as impaired lung function. All patients were conscious and able to communicate verbally during the operation. Totally extraperitoneal inguinal hernioplasty was successfully completed in four patients, with a mean operative time of 33 minutes. All four patients were asymptomatic and experienced no pain throughout the procedure. Conversion to open repair was required in two patients because of uncooperative movement in one, and inadequate neural blockade by spinal anesthesia in the other. Intraoperative cardio respiratory parameters were stable in all patients. Postoperative urinary retention occurred in one patient. Successful performance of totally extraperitoneal inguinal hernioplasty under spinal anesthesia requires the combined efforts of an experienced anesthesiologist, a skilled surgeon, and a cooperative patient. The initial experience of totally extraperitoneal inguinal hernioplasty under spinal anesthesia appeared promising. Totally extraperitoneal inguinal hernioplasty under subarachnoid anesthesia may have a role in selected patients who are medically unfit for general anesthesia but are otherwise suitable for this type of surgery. Abdominal wall lift laparoscopic surgery is often used for patients during pregnancy because it is physiologically superior to CO_2 pneumoperitoneum laparoscopic surgery. Operation for adnexal cysts is performed in the first trimester. Yamada et al.144 reported on seven cases of ovarian cysts during pregnancy, resected using gasless laparoscopic method with a whole abdominal wall lift under CSE anesthesia. CSE anesthesia had several advantages in these cases; 1. In the first trimester general anesthesia should be avoided. They could manage these cases without general anesthesia nor sedative medications. 2. During pregnancy it is difficult to estimate the level of sensory blockade by spinal anesthesia. Epidural top-up helped to easily control the level of sensory blockade. 3. Differential diagnosis of pain related to uterine contraction and postoperative pain is difficult. Post operative analgesia was established by epidural PCA, thus anti uterine contraction medicines were prophylactically administered in only one of seven cases. There was no particular trouble during the anesthesia and all the operative procedures were performed uneventfully. Based on this limited experience, CSE anesthesia may be a safe and appropriate anesthetic technique for laparoscopic ovarian cystectomy with abdominal wall lift during pregnancy.

Laparoscopic surgery has become popular in recent years, but few studies have addressed analgesia for this type of surgery. Kong et al.[145] conducted a prospective double-blind randomized trial on 36 cases of laparoscopic colorectal surgery to determine the influence of intrathecal morphine on postoperative pain relief. All patients received a subarachnoid block with local anesthetic in addition to general anesthesia. One group also received intrathecal morphine. A PCA device was prescribed for pain control postoperatively and the VAS was used for pain assessment. The group who received intrathecal morphine used significantly less morphine. There were no adverse cardiovascular effects of the combined anesthetic technique. Nausea and vomiting remained the main side effect of intrathecal morphine but this was easily treated with anti-emetics.

A randomized controlled trial compared recovery characteristics after selective spinal anesthesia or propofol general anesthesia for short-duration outpatient laparoscopic surgery.[146] Forty women were randomized to receive either selective spinal anesthesia (1% lidocaine 10 mg, sufentanyl 10 µg and sterile water 1.8 mL) or general anesthesia (propofol and N_2O 50% in oxygen). Compared with the general anesthesia group, times to leaving the operating room, performing a straight leg raise, performing deep knee-bends and achieving an Aldrete score >9 and the time in phase II recovery were significantly shorter ($P < 0.05$) in the selective spinal anesthesia group.

Laparoscopic repair of inguinal hernia is traditionally performed under general anesthesia mainly because of the adverse effects that carbon dioxide pneumoperitoneum has on awake patients. Since a mandatory use of general anesthesia for all hernia repairs is questionable, the feasibility of laparoscopic extraperitoneal herniorraphy using spinal anesthesia combined with nitrous oxide insufflation was investigated.[147] Over a 4 month period, 35 consecutive total extraperitoneal inguinal hernia procedures were performed (24 unilateral, 11 bilateral) using spinal anesthesia and nitrous oxide extraperitoneal gas. Data on operative findings, self-reported operative and postoperative pain and discomfort, procedure related hemodynamics, and complications were collected prospectively. All 35 procedures were completed laparoscopically without the need to convert to general anesthesia. Mean operative time was 39 ± 7 minutes for unilateral hernia and 65 ± 10 minutes for bilateral hernia. Incidental peritoneal tears occurred in 22 patients (63%) resulting in nitrous oxide pneumoperitoneum, which was well tolerated. The patients remained hemodynamically stable throughout the procedure, and operative conditions and visibility were excellent. Laparoscopic total extraperitoneal hernia repair can be safely and comfortably performed using spinal anesthesia with extraperitoneal nitrous oxide insufflation gas. This method provides a good alternative to general anesthesia.

Chilvers et al.[148] performed a double-blind, controlled trial to determine the optimal dose of intrathecal fentanyl in small dose hypobaric lidocaine spinal anesthesia for outpatient laparoscopy. Sixty four gynecological patients were randomized into three groups, receiving 0, 10, or 25 µg fentanyl added to 20 mg lidocaine and sterile water (total 3 mL). Administration was with 27-gauge Whitacre needles and patients sat upright until the block was > T8. One patient in the 0 µg fentanyl group required general anesthesia 40 minutes after the start of surgery, leaving 21 patients per group. Three patients in each of the 0 µg and 10 µg fentanyl groups had mild discomfort with trocar insertion, or return of some sensation and felt discomfort with sutures toward the end of surgery. Shoulder-tip pain was less frequent in the 25 µg than 0 µg fentanyl group, 28% vs. 67% ($P < 0.0166$). Intraoperative supplementation with alfentanil (± propofol) was needed less often in the 25 µg than 0 µg fentanyl group, 43% vs. 76% ($P = 0.028$). Recovery of sensation took longer in the 25 µg than in the 0 µg and 10 µg fentanyl groups, 101 ± 21 vs. 84 µg 20 and 87 ± 18 min ($P < 0.05$), although motor recovery and discharge times were the same. Postoperative analgesia was needed earlier in the 0 µg than in the 25 µg fentanyl group, median 54 (13-120) vs. 87 (65-132) minutes ($P < 0.05$). Pruritus was the only side effect that occurred more often in the 10 µg and 25 µg groups than in the 0 µg fentanyl group, 62% and 67% vs. 14% ($P < 0.0166$). One patient required an epidural blood patch for postdural puncture headache. Based on these results, it was concluded that 25 µg intrathecal fentanyl is required when 20 mg lidocaine is used for hypobaric spinal anesthesia to ensure reliable, durable anesthesia, reduce shoulder-tip pain, and minimize the need for intraoperative supplementation. This dose provides longer postoperative analgesia and does not increase side effects apart from pruritus. Spinal anesthesia with small dose hypobaric lidocaine-fentanyl was found to be a satisfactory technique for outpatient laparoscopy, although postdural puncture headache can occur in some patients.

CSEGA: Statistics

A national survey in France including 35,439 patients who had received spinal anesthesia showed that the incidences of cardiac arrest and mortality associated with spinal anesthesia were 2.5 and 0.8 per 10,000 anesthetics, respectively. Irita et al.149 investigated these values using data obtained from annual surveys conducted by the Japanese Society of Anesthesiologist. Since 1994, the Japanese Society of Anesthesiologist has conducted annual surveys concerning critical incidents in the operating theater by sending confidential questionnaires to their certified training hospitals, then collecting and analyzing the responses. Irita and coworkers investigated critical incidents associated with regional anesthesia using data from annual surveys between 1999 and 2002. The questionnaire was identical in each survey conducted during these years. The total number of anesthetics available for this analysis was 3,855,384, of which spinal anesthesia, CSE anesthesia and epidural anesthesia were performed in 409,338, 146,282, and

69,001 patients, respectively. In patients receiving regional anesthesia, 628 critical incidents including 108 cardiac arrests, and 45 subsequent deaths were reported. The causes of critical incidents were classified as follows: totally attributable to anesthetic management, due mainly to intraoperative pathological events, preoperative complications, and surgical management. It consists of coronary ischemia including coronary vasospasm not suspected preoperatively, arrhythmias including severe bradycardia, pulmonary thromboembolism, and other conditions. Mortality was determined by postoperative day 7. Statistical analysis was performed by chi-square test and Mann-Whitney test. A P value less than 0.05 was considered significant. The incidences of cardiac arrest and mortality due to all etiologies were 1.69 and 0.76 with spinal anesthesia, 1.78 and 0.68 with CSE anesthesia, and 1.88 and 0.58/10,000 anesthetics with epidural anesthesia, respectively. The incidences of cardiac arrest and mortality due to anesthetic management were 0.54 and 0.02 with spinal anesthesia, 0.55 and 0.00 with CSE anesthesia, and 0.72 and 0.14/10,000 anesthetics with epidural anesthesia, respectively. These values did not significantly differ among regional anesthesia. Death attributable to anesthetic management was reported in 2 patients: both patients were classified as ASA III E, and developed cardiac arrest; one due to inadvertent high spinal anesthesia with spinal anesthesia, and the other due to local anesthetic intoxication with epidural anesthesia. Anesthetic management and intraoperative pathological events comprised 33 and 43% of cardiac arrests, respectively. The distribution of causes of death was as follows: anesthetic management, 5%; intraoperative pathological events, 34%; preoperative complications, 35%; surgical management, 26%. Among the causes of anesthetic management-induced critical incidents, inadvertent high spinal anesthesia was the leading cause of cardiac arrest in spinal and CSE anesthesia: 90% of arrests occurred in patients with ASA I-II; 88% in patients below 65 years of age; 45 and 25% in patients undergoing hip or lower extremities surgery, and Cesarean section, respectively. Among the causes of intraoperative pathological event induced critical incidents, pulmonary thromboembolism was the leading cause of cardiac arrest in spinal and combined spinal-epidural anesthesia: 59% of arrests occurred in patients with ASA I-II; 81% in patients above 66 years of age; 91% in patients undergoing hip or lower extremity surgery. The incidence of cardiac arrest and mortality associated with spinal anesthesia in Japan was shown to be in the same order as in France by analyzing a larger population. In patients with good ASA physical status, critical incidents occurred more often under regional anesthesia than under general anesthesia. Inadvertent high spinal anesthesia should be carefully avoided. We should also pay much attention to subclinical deep vein thrombosis in patients who were scheduled for hip or lower extremity surgery, and tourniquet or bone cement associated pulmonary embolism in these patients. A retrospective analysis was performed on 19,259 deliveries that occurred in one institution in three years.150 Anesthesia records and quality assurance data sheets were reviewed for the characteristics and failure rates of neuraxial blocks performed for labor analgesia and anesthesia. The neuraxial labor analgesia rate was 75% and the overall failure rate was 12%. After adequate analgesia from initial placement, 6.8% of patients had subsequent inadequate analgesia during labor that required epidural catheter replacement. Ultimately 98.8% of all patients received adequate analgesia even though 1.5% of patients had multiple replacements. Six percent of epidural catheters had initial intravenous placement but 46% were made functional by simple manipulations without higher subsequent failure. Unintended dural puncture occurred in 1.2% of labor neuraxial analgesia. The incidences of overall failure, intravenous epidural catheter, wet tap, inadequate epidural analgesia and catheter replacement were lower in patients receiving CSE vs. epidural analgesia. For Cesarean section, 7.1% of pre-existing labor epidural catheters failed and 4.3% of patients required conversion to general anesthesia. Spinal anesthesia for Cesarean section had a lower failure rate of 2.7%, with 1.2% of the patients requiring general anesthesia. The overall use of general anesthesia decreased from 8% to 4.3% over the three year period. Furthermore, regional anesthesia was used in 93.5% of Cesarean deliveries with no anesthetic related mortalities. Other prospective survey of anesthesia for Cesarean section was performed for the year 1997.[151] Two hundred and fifty maternity hospitals were sent questionnaires from which 129 responses were obtained. The data provided information on anesthesia for 60,455 Cesarean sections. Overall 78% of sections were performed with regional anesthesia: 47% single shot spinal; 22% epidural; 9% CSE; 22% general anesthesia. For elective Cesarean sections (39% of all sections) regional anesthesia was used for 87% of cases: 68% single shot spinal; 3% epidural; 15% CSE; 13% general anesthesia. For emergency procedures regional anesthesia was used for 72% of cases: 34% single shot spinal; 34% epidural; 4% CSE; 28% general anesthesia. There was a wide range of regional anesthesia use among the units, varying from an overall rate of 95% at one extreme to 41% at the other. Similarly, there was a wide range of conversion of regional anesthesia to general anesthesia, varying from 0% to 88%. Overall, 10.6% of the general anesthetics were the result of regional to general anesthesia conversion.

Hergert et al.[152] reported on postoperative pain treatment using epidural analgesia in 1,822 patients, following continuous epidural anesthesia combined with general anesthesia for operations in various specialized areas (general or visceral surgery, vascular and thoracic surgery, gynecology, urology and orthopedics). A total of 1,727 of these postoperative epidurals were included in a detailed evaluation. The postoperative epidural analgesia consisted of a continuous application of 0.25% bupivacaine or 0.2% ropivacaine. These local anesthetics were administered epidurally in an hourly perfusion rate of 7.5 mL. It was found a good pain relief through continuous epidural administering of the local anesthetics in 1,292 patients (74.8%). Moderate pain relief was achieved in 392 patients (22.7%). Sufentanyl had to be epidurally administered in addition to local anesthetics in 262 patients (15.2%) in the wake up room. The sufentanyl doses lay between 5 and a maximum 10 µg per hour. An additional epidural application of morphine bolus in a dose of 3 mg every 8-12 hours was necessary in 384 patients (22.2%) in the surgical wake up stations. In 392 patients (22.7%), the additional systemic administering of antipyretic analgesics such as metamizol or paracetamol or spasmolytica was sufficient. In 43 cases (2.5%), sufficient pain relief could not be achieved with epidural analgesia even with additive applications of systemic functioning pharmaceuticals, so that the postoperative pain therapy had to be completely switched to a PCA. The time of the epidural catheter was 2 to 5 days. It was shortest with the gynecological patients and longest with patients from general, visceral, thoracic and vascular surgery areas. An important factor for a sufficient epidural analgesia is the exact epidural positioning of the catheter tip in the area of the spinal cord segments, which are affected by the operation. The following side effects resulting from the epidural analgesia were found: blood pressure loss of more than 20% of the starting value (21%), temporary bladder voiding disorders (8%), temporary sensory disorders of the lower extremities (6.5%), seldom nausea (2.4%) and PDPH (1.2%). The most important prerequisites for successful postoperative epidural analgesia and thus for increased patient satisfaction are correct selection of the insertion height in relation to the planned operation, constantly available medical pain service, the inclusion of trained care personnel and unequivocal written instructions.

Rodgers et al.[153] made a systematic review of all trials with randomization to intraoperative neuraxial blockade or not in order to obtain reliable estimates of the effects of neuraxial blockade with epidural or spinal anesthesia on postoperative morbidity and mortality. One hundred and forty one trials including 9,559 patients for which data were available before 1 January 1997 were eligible irrespective of their primary aims, concomitant use of general anesthesia, publication status, or language. Trials were identified by extensive search methods, and substantial amounts of data were obtained or confirmed by correspondence with realists. All cause mortality, deep vein thrombosis, pulmonary embolism, myocardial infarction, transfusion requirements, pneumonia, other infections, respiratory depression, and renal failure. Overall mortality was reduced by about a third in patients allocated to neuraxial blockade (103 deaths/4871 patients vs. 144/4688 patients, odds ratio=0.70, 95% confidence interval 0.54 to 0.90, P=0. 006). Neuraxial blockade reduced the odds of deep vein thrombosis by 44%, pulmonary embolism by 55%, transfusion requirements by 50%, pneumonia by 39%, and respiratory depression by 59% (all P<0.001). There were also reductions in myocardial infarction and renal failure. Although there was limited power to assess subgroup effects, the proportional reductions in mortality did not clearly differ by surgical group, type of blockade (epidural or spinal), or in those trials in which neuraxial blockade was combined with general anesthesia compared with trials in which neuraxial blockade was used alone. Neuraxial blockade reduces postoperative mortality and other serious complications. The size of some of these benefits remains uncertain, and further research is required to determine whether these effects are due solely to benefits of neuraxial blockade or partly to avoidance of general anesthesia. Nevertheless, these findings support more widespread use of neuraxial blockade.

CSE anesthesia offers theoretical advantages especially for lower abdominal and limb surgery, because it produces the rapid onset of anesthesia and the proper muscle relaxation, with the option to extend the blockade with an epidural catheter. Niinai et al.[154] analyzed questionnaires on CSE anesthesia obtained form 148 hospitals in Japan. It was revealed that most anesthesiologists in Japan preferred general anesthesia with epidural block for lower abdominal surgery to CSE anesthesia. For lower limb surgery longer than two hours, CSE anesthesia was employed in 57 hospitals (39%). CSE anesthesia was mainly used for orthopedics, obstetrics and gynecology and urology. Double needle double interspace method was commonly used rather than needle through needle method. In general, CSE anesthesia was not a widely performed anesthetic technic in Japan. CSE should contribute to reduction of the incidence of PONV caused by general anesthetics, and produce pre-emptive analgesia. A survey of all German hospitals providing obstetric anesthesia in 1997 (n = 1061), recovery rate 82% comprising 115,000 Cesarean sections, revealed that most Cesarean sections are performed under general anesthesia. For elective Cesarean section, the average was 63%, and 82% for urgent (non-emergency) sections. Succinylcholine is the standard neuromuscular blocker for intubation. Of the regional techniques, epidural continuous anesthesia is preferred for elective Cesarean section (59%) over subarachnoid (10%) and CSE. In urgent Cesarean section, spinal blocks are used more often (56%) than epidural anesthesia (42%) and CSE.[155]

A survey of anesthesia practice was conducted among French residents in anesthesia at the end of their training.[156] This study was performed mainly to evaluate the residents' experience in peripheral nerve blocks. Two short clinical cases were proposed to all French residents during a telephone interview immediately before their certification. The first described the case of a young asthmatic patient admitted for an elbow fracture. The second described an elderly woman with severe aortic stenosis admitted for a supracondylar fracture of the femur. A questionnaire had been prepared and was filled in during the interview. Each resident was asked to answer according to the actual choice he or she would have made. For both cases, when general anesthesia was chosen first, the next question was to discuss which regional anesthesia would be used if general anesthesia had to be discarded. In that way, the practical knowledge about most common peripheral nerve blocks learned during residency was investigated. Of 77 residents registered as being at the end of their residency, 8 were on either sabbatical or maternity leave. Regional anesthesia was the first choice in 78% and 57% of cases for the first and second clinical cases, respectively. The regional anesthetic techniques chosen were axillary block (66%), interscalene block (31%), and intravenous regional anesthesia (3%) for case 1 and combined lumbar plexus and sciatic block (36%), epidural anesthesia (30%), single shot spinal anesthesia (18%), and continuous spinal anesthesia (16%) for case 2. Throughout the residency of the group, 32 ± 2 axillary blocks, 12 ± 2 interscalene blocks (axillary vs. interscalene, P < .0001), 21 ± 3 femoral blocks, and 10 ± 2 sciatic blocks (femoral vs. sciatic, P < .0001) had been performed (mean ± SEM). They had also performed 2.5 ± 0.5 continuous spinal anesthesia and 17 ± 3 intravenous regional anesthesia respectively. Upper extremity blocks were more often used during residency than lower extremity blocks (44 ± 3 vs. 31 ± 4, P < .01). A peripheral nerve stimulator was routinely used by 83% of residents. French residents in anesthesiology at time of certification are better trained for peripheral nerve blocks of the upper extremity than for those of the lower extremity. Axillary plexus and femoral nerve block are the most widely used blocks, probably reflecting the techniques the most mastered among teachers. Finally, the extensive use of a peripheral nerve stimulator by residents is probably the result of the widespread use of this device by teachers in France.

CSEGA and the immune system

Intrathecal administration of morphine has been shown to suppress natural killer (NK) cell activity. Yokota et al.[157] tested the hypothesis that combined administration of morphine and noradrenaline would further modify NK cell activity in patients undergoing hysterectomy. Thirty female patients were randomly divided into three groups of ten patients each. Groups MN and M received intrathecal morphine (0.5 mg) dissolved in 5 mL of physiological saline with and without 5 μg noradrenaline, respectively. Group C received saline alone. After the intrathecal administration, general anesthesia was induced. Blood samples were withdrawn before and two hours after surgery and on postoperative days 1, 2, and 7 to determine the NK cell activity, the ratio of T-helper/inducer cells (CD4) to T-suppressor/cytotoxic cells (CD8), the levels of interleukin-6 (IL-6) and interleukin-8 (IL-8), and the plasma concentrations of catecholamines and cortisol. NK cell activity decreased on postoperative day 1 in groups MN (12.0 ± 2.7%) and M (25.4 ± 9.6%) compared with their respective baseline levels. In group MN, NK cell activity remained lower (23.7 ± 8.0%) on postoperative day 2 than the baseline value before surgery. Intrathecal administration of morphine causes a decrease in NK cell activity, and its combined use with noradrenaline prolongs the suppression of NK cell activity. The perioperative period is characterized by a state of immunosuppression, which was shown in animal studies to underlie the promotion of tumor metastasis by surgery. As this immunosuppression is partly ascribed to the neuroendocrine stress response, Bar-Yosef et al.[158] hypothesized that spinal blockade, known to attenuate this response, may reduce the tumor promoting effect of surgery. Fischer-344 rats were subjected to a laparotomy during general halothane anesthesia alone or combined with either systemic morphine (10 mg/kg) or spinal block using bupivacaine (50 µg) with morphine (10 µg). Control groups were either anesthetized or undisturbed. Blood was drawn 5 hour after surgery to assess number and activity of natural killer cells, or rats were inoculated intravenously with MADB106 adenocarcinoma cells, which metastasize only to the lungs. Metastatic development was assessed by quantifying lung retention of tumor cells 24 hours after inoculation or by counting pulmonary metastases three weeks later. Laparotomy conducted during general anesthesia alone increased lung tumor retention up to 17 fold. The addition of spinal block reduced this effect by 70%. The number of metastases increased from 16.7 ± 10.5 (mean ± SD) in the control group to 37.2 ± 24.4 after surgery and was reduced to 10.5 ± 4.7 during spinal block. Systemic morphine also reduced the effects of surgery, but to a lesser degree. NK cell activity was suppressed to a similar extent by surgery and by anesthesia alone. The addition of spinal blockade to general halothane anesthesia markedly attenuates the promotion of metastasis by surgery.

Each type of anesthesia has varying influence on the amount of catecholamine secretion during surgery. Epidural or spinal anesthesia can markedly suppress the increase of many of the stress hormones. Poon et al.[159] evaluated metabolism change during surgery under anesthesia in order to see whether general anesthesia combined with intraspinal anesthetic and narcotic is a better way to suppress such stress response. Seventeen patients ASA I, with normal biochemical screening scheduled for radical gastrectomy were studied. All patients were premedicated with diazepam and glycopyrrolate and an indwelling catheter was inserted into a radial artery under local anesthesia for monitoring blood pressure and obtaining blood samples for glucose and hormonal assays. A central venous line was set up via the right internal jugular vein for the administration of free of sugar fluid. In the study group, a 32-gauge intraspinal catheter was placed via lumbar interspaces. Spinal blockade up to T4 by titrating 0.25% bupivacaine. Then anesthesia in both groups was induced with thiopental 5 mg/kg, followed by succinylcholine 1.5 mg/kg for intubation. Anesthesia was maintained with isoflurane, N_2O, O_2 and pancuronium. Blood samples for measurement cortisol, catecholamine and sugar were taken after induction and 30 minutes after surgical incision. Thirty minutes after skin incision all patients were subjected to glucose tolerance test, accomplished by giving 50% dextrose at 0.33 g/kg in 3 minutes. Arterial blood samples were then obtained at 1, 3, 5, 7, 10, 20, 30, 45 and 60 minutes intervals for plasma glucose determination. No difference was evident in cortisol values, baseline, before and after surgical incision ($P > 0.05$) either intragroup or intergroup. Catecholamine and glucose were significantly higher in control group after surgical incision ($P < 0.05$, intragroup and intergroup). Following a glucose load the decay of plasma glucose was similar in both groups but glycemic level was higher in the control group. Better control of stress response by general anesthesia combined with subarachnoid block was disclosed in this study.

Stress can be defined as a "reaction by living beings to any relevant impairment". The effect of anesthesia on endocrine function is closely related to the actual stress concept based on the works by Cannon and Selye. Cannon described the role of catecholamines in stress and characterized the fight-flight reaction. Selye emphasized the role of the adrenocortical reaction defining the "general adaptation syndrome", which evolves in three stages ("alarm reaction", "stage of resistance", "stage of exhaustion"). Later, Henry postulated the dual stress concept. The sympathetic-adrenomedullary system is activated during the fight-flight reaction, thus representing an active role of the organism. The pituitary-adrenocortical system is activated during loss of control, submission and depression, especially in a social context. Main valid parameters of this endocrine stress response are adrenaline, noradrenaline, ADH, ACTH and cortisol. In the perioperative period, both pathways are "stressed". The most important factors are patient, operation, and anesthesia. Anesthesia can influence the stress response by afferent blockade (local anesthesia), central modulation (general anesthesia) or peripheral interactions with the endocrine system (etomidate). Up to now, a total peripheral blockade of the nociceptive system is impossible, due to surgical technique (destruction of nerve fibers) and release of mediator substances. With regard to reduction of endocrine stress response, inhalation anesthesia with volatile anesthetics and N_2O may be less effective than neuroleptic, spinal or epidural anesthesia. Immediately after extubation, rapid increases of endocrine parameters are observed. In addition to central modulation of pain and stress, both halothane and enflurane inhibit catecholamine release from the adrenal medulla. Neuroleptic anesthesia and TIVA are very potent and sufficient to control the increases in endocrine parameters even during major surgery, due to their central effects. Spinal and epidural anesthesia alone as well as in combination with general anesthesia can reduce the endocrine stress response more than necessary. This is due to the sympathetic blockade, combined with an afferent blockade of central cord fibers which modulate the pituitary-adrenocortical system. Only few data are available concerning the stress response during infiltration anesthesia or nerve block, but additional sedation seems to be beneficial. Peripheral interactions with the endocrine system like blockade of the adrenal cortex by etomidate is dangerous and has caused a high mortality in ICU patients if the substance was admitted for a longer period. Assessment of endocrine stress response in anesthesia and surgery is controversial.[160]

CSEGA and special diseases

A series of diverse scenarios in special clinical situation where CSEGA, epidural or spinal anesthesia were used is described in the following paragraphs in order to discuss its use.

A 36-year-old patient with a history of previous back surgery, asthma, latex allergy and achondroplasia presented for urgent Cesarean delivery at 31 weeks gestation for worsening nonimmune fetal hydrops.[161] The fetus was diagnosed with trisomy 21 and achondroplasia. Because of the urgent clinical situation, the patient was given a spinal anesthetic, which required supplemental i.v. sedation after delivery of the fetus. Molyneux[162] described the peripartum anesthetic management of a 36-year-old woman who was a manifesting carrier of Duchenne muscular dystrophy. Duchenne muscular dystrophy is an X-linked recessive disorder affecting young males associated with severe complications during anesthesia if depolarizing neuromuscular blocking drugs and volatile agents are used. A manifesting carrier is a heterozygous female who demonstrates the disease in a milder form than in males. This probably occurs because of skewed X-inactivation. Molyneux planned to establish regional anesthesia should an operation be necessary during labour or delivery and to use propofol TIVA anesthesia and rocuronium if general anesthesia became unavoidable. At 37 weeks, the woman went into spontaneous labour, but fetal distress necessitated Cesarean section for which CSE anesthesia was used. Machado-Joseph disease is a form of progressive spino-cerebellar ataxia with both bulbar and peripheral neurological manifestations. General anesthesia may be problematic because of the risk of pulmonary aspiration and hypoxia. Teo et al.[163] described their experience with the successful use of CSE anesthesia in a patient with Machado-Joseph disease. A 38-year-old woman with Machado-Joseph disease complicated by significant bulbar and peripheral neuropathy presented for an elective vaginal hysterectomy. She had no other medical history of note. A subarachnoid block was performed by CSE anesthesia at the L2-3 lumbar intervertebral space with hyperbaric bupivacaine 12 mg, morphine 100 µg, and fentanyl 10 µg. Surgery proceeded uneventfully, with excellent postoperative analgesia. There was full recovery of preinduction neurologic function by the sixth postoperative hour. Central neuraxial anesthesia is an option for patients with Machado-Joseph disease presenting for lower abdominal and lower extremity operations. CSE anesthesia confers hemodynamic stability yet allows for augmentation of intraoperative anesthesia and postoperative analgesia.

A 24-year-old woman was admitted because of pressing hydramnion. She was treated by ritodrine hydrochloride leading to rhabdomyolysis, and she was diagnosed as having myotonic dystrophy.[164] She underwent Cesarean section because of urgent premature birth. The surgery was performed with spinal anesthesia using tetracaine. A 1-year-old boy, the son of the previous case, underwent orchiopexy.[164] He showed respiratory distress at birth and needed respiratory support for 140 days. The surgery was performed under general anesthesia combined with caudal anesthesia. Anesthesia was induced with N_2O-O_2-sevoflurane. He was intubated without muscle relaxants. Since he recovered consciousness soon after the surgery, he was extubated and returned to the ward. A 30-year-old woman, the sister of case 1, underwent tonsillectomy.[164] At the age of 27 she underwent salpingectomy under general anesthesia with N_2O-O_2-halothane, after which she was diagnosed as myotonic dystrophy. She was anesthetized with propofol and fentanyl. Because severity of the myotonic dystrophy varies among the patients, the strategy for anesthesia should be planned on each patient. Generally speaking, regional anesthesia including spinal and epidural anesthesia is preferable.

Kartagener's syndrome is a rare disorder characterized by the triad of situs inversus, including dextrocardia, bronchiectasis and paranasal sinusitis. Mathew et al.[165] reported on the anesthetic management of a patient with Kartagener's syndrome and postrenal transplant immunosuppression, presenting for repair of uterovaginal prolapse. CSE anesthesia was administered to this patient. Namiki et al.[166] described a case of Freeman-Sheldon syndrome that presented some problems for anesthetic management. A 2-yr-old girl required orthopedic surgery for the bilateral lower extremities. Anesthesia was induced via a mask with oxygen (2 Lt/min), nitrous oxide (4 Lt/min) and sevoflurane (approximately 5%). Tracheal intubation by direct laryngoscopy was successfully achieved. Combined caudal epidural block was, however, avoided because spina bifida occulta was suspected. Spina bifida occulta was revealed postoperatively by X-ray. For anesthetic management of a patient with Freeman-Sheldon syndrome, the spine should be evaluated preoperatively when performing epidural/spinal anesthesia.

A 66-year-old male with colon cancer was scheduled for left hemicolectomy.167 He had a past history of respiratory failure due to COPD. Anesthesia method chosen was general anesthesia with sevoflurane combined with epidural anesthesia. Respiration was managed with assisted ventilation using laryngeal mask airway and muscle relaxation was obtained with suxamethonium chloride given intermittently. After the operation, he did not seem to have COPD because of the relation between arterial PCO_2 and bicarbonate in the perioperative period. Therefore, after obtaining informed consent from this patient, the relation between arterial and spinal fluid acid-base balance under acetazolamide administration was determined. He was more sensitive to central respiratory response because his respiration increased following the decrease of spinal fluid bicarbonate. He was further examined and diagnosed as Eaton-Lambert syndrome by evoked electromyography and by Ca2+ channel antibody. A 27-year-old female with Klippel-Trenaunay Syndrome presented for reconstructive surgery of the deep venous system of the right leg.[168] Contrast enhanced dynamic computed tomography was performed to exclude the presence of arteriovenous malformation of the lumbosacral spine. A CSE technique supplemented with light general anesthesia was performed. The patient's condition was stable throughout the three hours of surgery and postoperative analgesia was maintained successfully for three days. Cherng et al.[169] reported a case of myotonic dystrophy in a 34-year-old woman who presented for total abdominal hysterectomy. The goal of anesthetic management is to prevent the known triggers of myotonic crisis, such as hypothermia, shivering, and hyperkalemia; and to avoid depolarizing muscle relaxants and anticholinesterase agents. In this patient, they used CSE block for intraoperative anesthesia and postoperative analgesia. The advantages of the combined technique offers rapid onset and good muscle relaxation from subarachnoid block, with the ability to supplement analgesia through the epidural catheter both during and after surgery. In addition, the potential complications associated with general anesthesia, including respiratory insufficiency, aspiration pneumonia, cardiac arrhythmia, and heart failure can be avoided. The other measures were directed toward the prevention of shivering, a common problem encountered with general or regional anesthesia. After the operation, optimal analgesia was obtained by infusing 0.125% bupivacaine via the epidural catheter. No obvious side effects occurred. Sethna and Berde[170] reported on postoperative pain management of two adolescents after upper abdominal procedures, one with Hurler-Scheie syndrome and a second with Duchenne muscular dystrophy, and both had progressive spinal scoliosis with poor pulmonary function. A combined technique of subarachnoid and general anesthesia was used during surgery. Postoperative administration of small intermittent doses of subarachnoid morphine produced profound analgesia, which eliminated the need for systemic opioids, restored preoperative arterial oxygenation within 48 hours after the operation, and expedited postoperative recovery.

CSEGA: Complications

The following paragraphs contain reported CSEGA complications that need to be related and discussed. Steffek et al.[171] described a case of total spinal anesthesia, which occurred after a 3 mL 2% lidocaine test dose was administered through an epidural catheter in a 79-year-old patient scheduled for gastrectomy under combined general and epidural anesthesia. The surgery was postponed, and the patient required admission to the ICU. Spinal MRI from the total spinal cord did not reveal any pathology. During the next 24 hours the patient recovered and after 11 days was successfully operated under general anesthesia. No late complications followed. It was presumed that during placement, the epidural catheter had migrated to the spinal canal as a result of technical difficulties. A test dose of local anesthetic does not fully prevent complications.

Bradycardia and asystole can occur unexpectedly during neuraxial anesthesia. Risk factors may include low baseline heart rate, first-degree heart block, ASA I, beta-blockers, male gender, and high sensory level. Anesthesia information management systems automatically record large numbers of physiologic variables that are combined with data input from the anesthesiologist to form the anesthesia record. Such large databases can be scanned for episodes of bradycardia. Lesser et al.[172] selected spinal and epidural anesthetics that did not also involve general anesthesia among 57,240 automated anesthesia records that were scanned. Obstetrical patients and patients younger than age 12 year were excluded. The electronic records selected were then scanned for episodes of moderate (heart rate < 50 and ≥ 40 beats/minute) or severe (heart rate < 40 beats/minute) bradycardia. A total of 6,663 cases (11.6%) met the inclusion criteria. Among the 677 cases of bradycardia (10.2%) were 46 cases of severe bradycardia (0.7%). In the final multivariate logistic regression analysis, baseline heart rate less than 60 beats/min ($P \leq 0.0001$) and male gender ($P \leq 0.05$) contributed significantly to risk for a severe bradycardia episode (odds ratio [OR]), 14.1 and 95% confidence interval [CI], 6.9-28.0, and OR, 2.1 and 95% CI, 1-4.3, respectively). For the 631 episodes of moderate bradycardia (9.5%), the final multivariate model included baseline heart rate less than 60 beats/min (OR, 16.2; 95% CI, 12.4-22.0), age younger than 37 year (OR, 1.4; 95% CI, 1.1-1.7), male gender (OR, 1.4; 95% CI, 1.2-1.8), nonemergency status (OR, 1.7; 95% CI, 1.2-2.4), beta-blockers (OR, 1.6; 95% CI, 1.1-2.3), and case duration (OR, 2.0; 95% CI, 1.6-2.4) as significant risk factors. Time of occurrence of a bradycardia event was distributed widely across the entire duration of a case. Moderate or severe bradycardia may occur at any time during neuraxial anesthesia, regardless of the duration of anesthesia. Low baseline heart rate increases the risk for bradycardia.

A 31-year-old woman with a long history of back pain without neurological symptoms underwent a Cesarean section during the 36th week of pregnancy with CSE anesthesia.[173] Indication was the increasingly severe back pain. She delivered a normal healthy boy. On the third day after surgery she developed a discrete sensory cauda equina syndrome on the left side. The interpretation of the magnetic resonance imaging (MRI) was a tumor in the thecal sac extending from the middle of the vertebral body of L1 to the superior vertebral plate of L3. A few days later she underwent a laminectomy under general anesthesia with resection of an intradural mass adherent to the cauda equina. Pathological review of the surgical specimen revealed a myxopapillary ependymoma WHO grade I. The postoperative course was uncomplicated with preservation of bladder dysfunction but after 4 weeks the bladder function was normalized. Holdsworth et al.[174] compared the efficacy of three different pharmacologic regimens to relieve pain and distress in children with cancer undergoing bone marrow aspirations and lumbar punctures in a retrospective cohort study with crossovers for some patients. The pain and distress ratings of patients undergoing bone marrow aspirations (n = 73) and lumbar punctures (n = 105) were examined in a comparison of three different interventions: (1) a topical eutectic mixture of lidocaine and prilocaine (EMLA cream), (2) oral midazolam and EMLA cream, or (3) propofol/fentanyl general anesthesia. The choice of the intervention depended on patient/parent request. A validated faces pain scale was completed by the child or parent following each bone marrow aspiration or lumbar puncture. The faces pain scale includes ratings of the severity of pain (from 0 = none to 5 = severe) and ratings of how frightened (from 0 = not scared to 5 = scared) the child was prior to each procedure. Comparisons of the pain and distress ratings were made among all patients for their first procedure and also within individual patients who had received more than 1 of the 3 interventions. Independent comparisons between the first treatments received by each patient were analyzed using Kruskal-Wallis tests. Comparisons of different crossover treatments received by individual patients were analyzed using Wilcoxon tests. For all first procedures, mean ± SD pain and distress ratings during lumbar punctures were significantly lower when propofol/fentanyl was used (n = 43; 0.4 ± 1.0 and 1.4 ± 1.7) vs. either EMLA (n = 29; 2.4 ± 1.7 and 2.9 ± 1.9) or midazolam/EMLA (n = 33; 2.4 ± 1.8 and 2.7 ± 1.8), respectively. Pain and distress ratings during bone marrow aspirations were also significantly lower with propofol/fentanyl (n = 29; 0.5 ± 1.0 and 1.2 ± 1.7) vs. EMLA (n = 21; 3.5 ± 1.6 and 3.3 ± 1.8) or midazolam/EMLA (n = 23; 3.3 ± 1.5 and 3.0 ± 1.9), respectively. When data were analyzed within each patient, these differences were also present. Children receiving propofol/fentanyl general anesthesia experienced significantly less procedure related pain and distress than did those receiving either EMLA or oral midazolam/EMLA.

A 72-year-old woman underwent choledocholithotomy under general anesthesia combined with epidural block.175 She was complicated with hypertension, diabetes mellitus and angina pectoris, and was given ticlopidine hydrochloride. The medication was stopped 12 days before the operation. Her coagulation tests and platelet counts were within normal ranges. An epidural catheter was inserted at T9-10 interspace, and continuous epidural anesthesia was started for postoperative pain. Just after the operation, numbness and motor paralysis in both legs occurred. The continuous epidural anesthesia was stopped, and the symptom on right leg improved. However, after two days, MRI revealed epidural hematoma extending from T7 to L1, and the patient underwent laminectomy. After a month, her motor paralysis in the left leg started to improve gradually. It is possible that the term of discontinuation of ticlopidine was not enough. A 57-year-old male with prostatic cancer was scheduled for a radical prostatectomy under general anesthesia combined with epidural anesthesia.[176] An epidural catheter was introduced at the L1-2 interspace without any problem. The patient was placed in a hyperlordotic supine position with a bolster under his lower back for the seven and a half hour operation. Upon emergence from anesthesia, he complained of severe low back pain in addition to incisional pain. On the second postoperative day, the epidural catheter was removed. After residual analgesic effects had fully disappeared, he experienced muscular weakness in the left thigh and could not walk. Regional sensory loss and edema were also observed where pressure had been applied by the bolster, although spinal cord MRI was almost normal. It took him seven weeks to walk without the support of a brace after surgery. Hyperextension of the lumbar spine could increase the pressure on the inferior vena cava which is transmitted to the intraspinal vein, and could lead to the disci intervertebrales compression and the stress on the facet joint. Prolonged and/or excessive hyperlordosis during surgery should be avoided.

CSE anesthesia involves the epidural administration of local anesthetic and opioid solutions adjacent to the prior dural puncture, potentially increasing their diffusion into the subarachnoid space. Beaubien et al.[177] designed a study to evaluate the influence of dural puncture on the adequacy and extent of analgesia, and drugs requirements of patient-controlled epidural analgesia (PCEA) in the postoperative period. In this prospective double-blind study, 40 patients undergoing major abdominal surgery under general anesthesia followed with PCEA were randomly assigned to either group I (preoperative insertion of an epidural catheter) or group II (preoperative dural puncture with a 25-gauge Quincke needle plus insertion of an epidural catheter). Postoperatively, a PCEA pump delivered an infusion of 0.1% bupivacaine + fentanyl 3 μg/mL, at 5 mL/h. Participants were allowed to self administer 5 mL boluses of the same solution with a 15 minute lock-out interval. Hourly epidural solution requirements were recorded for 40 hours. Sensory and motor block, and pain scores were also analyzed. There was no difference between groups with regard to epidural solution requirements, pain scores, spread of sensory blockade, or intensity of motor block. Dural puncture with a 25-gauge Quincke needle, performed as part of CSE anesthesia, does not influence the drug requirements when a combination of 0.1% bupivacaine and fentanyl is used for PCEA after major abdominal surgery.

Isolated, heated limb perfusion is used for the treatment of locally recurrent melanoma, intransit metastases, and acral lentiginous melanomas. Tissue warming during this procedure requires adequate perfusion within the isolated extremity. Hynson et al.[17]8 used spinal or epidural anesthesia to produce sympathetic blockade and vasodilation for lower extremity procedures. They also began using mild systemic hyperthermia to produce active thermoregulatory vasodilation. In the presence of heat stress, sympathetic blockade may actually decrease skin blood flow because active cutaneous vasodilation, which is associated with sweating, is dependent on intact sympathetic innervation. They therefore investigated whether the continued use of neuraxial blockade was justified. Twenty patients undergoing lower extremity perfusions were alternately assigned to receive either combined general and spinal anesthesia or general anesthesia alone. All were aggressively warmed using forced air and circulating water. There were no significant differences in tissue temperatures (measured at four sites in the isolated limb) between groups at any time before or after the start of perfusion. Similarly, pump flow (715 ± 211 mL/min vs. 965 ± 514 mL/min) and the time required to achieve an average tissue temperature of 39 °C (43 ± 16 vs. 34 ± 13 min) were not different between groups (spinal vs. no spinal). Sweating was observed in all but three patients at esophageal temperatures of 37.9 ± 0.6 °C. It was concluded that sympathetic blockade confers no added benefit for tissue warming during isolated limb perfusions in the presence of induced mild systemic hyperthermia. Sympathetic blockade prevents adrenergic vasoconstriction, but also inhibits active, neurally mediated cutaneous vasodilation (a normal thermoregulatory response to heat). In slightly hyperthermic patients, it was demonstrated that spinal anesthesia does not improve convective tissue warming during isolated, heated limb perfusion. Mild systemic hyperthermia may promote greater vasodilation than sympathetic blockade.

A 57-year-old man received gastrectomy under general anesthesia combined with epidural anesthesia.179 He showed no signs of dural puncture and catheter migration into the subarachnoid space. Cardiovascular status was stable with epidural injection of lidocaine, morphine during the operation. Although epidural morphine and buprenorphine infusions were continued for 1 to 6 postoperative days, respiratory depression and other side effects were not observed. However, severe headache in the upright position occurred after stopping these infusions and the removal of the catheter on the 7th postoperative day. The headache was thought to be caused by unintentional dural puncture. PDPH persisted over a period of 30 days and was treated with an epidural blood patch and stellate ganglion blocks since the other conservative therapy had been ineffective. It was considered that administration of continuous epidural opioids for postoperative analgesia helped to prevent PDPH until the 7th postoperative day. It was also concluded that prolonged PDPH after using a thick needle like a Touhy needle should be treated by an epidural blood patch. A 72-year-old woman with no past neurological history was scheduled for a rectum resection under general anesthesia combined with epidural anesthesia.[180] An epidural catheter was introduced at T11-12 interspace without any difficulties. During the operation, she had hypotensive episode needing dopamine, but waked up from anesthesia without any event. When she became alert, she complained muscle weakness and loss of sensation in both lower extremities. On the day after surgery, she became quadriplegic and completely insensitive under T4 level, but her MRI of the spine showed no abnormal findings. A month after the operation, her MRI showed diffuse spinal degeneration below C4 level and she had flaccid paralysis below T1 with complete sensory loss below T7 level. A 62-year-old man with no past neurological history was scheduled for gastrectomy under general anesthesia combined with epidural anesthesia.180 An epidural catheter was placed via T12-L1 without any difficulty. Operative course was uneventful and awakening from anesthesia was normal. He showed muscle weakness and hypesthesia of lower extremities two hours after the operation, and his continuous injection of epidural anesthesia was stopped. His paralysis became worse but MRI of his spine showed no abnormality on the day after the operation. He became complete flaccid paralytic and had complete sensory loss below T7 level. The MRI examination two weeks after the operation showed degeneration below middle thoracic spinal cord. His neurologic symptoms have not improved for two years. The etiology of neurologic deficits of these two cases is not obvious although the relation between epidural anesthesia and neurologic symptoms was most likely.

A 72-year-old female patient was scheduled for abdominal surgery with epidural block in combination with general anesthesia.[181] A 20-gauge epidural catheter was inserted through an 18-gauge Tuohy needle between T12 and L1 using the midline approach and the loss of resistance technique. A test dose of 13 mL bupivacaine 0.25% showed no effect and a bolus of 12 mL bupivacaine 0.25% was added 8 minutes later. Bilateral analgesia between S5 and C4 developed over the following 17 minutes but was not accompanied by any cardiovascular or respiratory depression. The patient became sleepy and was finally intubated after the administration of thiopentone 175 mg and pancuronium 6 mg. There were no objections to surgery, so the hemicolectomy was continued as planned. Intraoperatively the systolic blood pressure dropped twice, to a minimum of 105 mm Hg, coinciding with eventration of the intestine, but this was reversed immediately on administration of a vasoconstrictor. Extubation of the patient was possible 90 minutes later on the termination of surgery, when the level of anesthesia had reached T2. A spinal X-ray with radiopaque dye showed a typical intrathecal distribution. Most remarkable in this case is the stability of the cardiovascular function which is related to the 0.25% solution. Serious complications of an inadvertent dural puncture can be avoided or alleviated with this concentration if the epidural block is to be combined with general anesthesia.

Combined epidural general anesthesia might theoretically emphasize the cardiovascular effects of epidural block alone. Fanelli and coworkers[182] evaluated the incidence of both hypotension and bradycardia during integrated epidural-general anesthesia in a multicentric, observational study. The incidence of clinical hypotension (systolic arterial blood pressure decrease by 30% or more from baseline), and bradycardia (heart rate < 50 beats/minute) and other side effects have been evaluated in 1200 consecutive patients receiving epidural-general anesthesia. The time from induction of epidural anesthesia to induction of general anesthesia was considered as preoperative; while the time after general anesthesia induction was considered as intraoperative. Preoperatively hypotension developed in 85 patients (2.8%), and bradycardia in 54 patients (4.5%). Intraoperatively, hypotension was observed in 380 patients (31.6%), and bradycardia in 153 patients (12.7%). Hypotension and bradycardia were not influenced by the type of the surgical procedure, the type of maintenance of general anesthesia (inhalational vs. TIVA) and the level of epidural block (lumbar vs. thoracic); but they were more frequent in patients with ASA II and III-IV compared to patients with ASA I ($P < 0.05$). Prophylactic volume preload decreased the incidence of hypotension from 41.5% to 22.4% ($P < 0.0001$), while prophylactic atropine before epidural block did not affect the incidence of bradycardia. Patients receiving epidural clonidine showed an increased incidence of intraoperative bradycardia compared to those who did not receive it ($P < 0.0001$). Borghi et al.[183] evaluated the frequency of hypotension and bradycardia during integrated epidural-general anesthesia as compared with general anesthesia or epidural anesthesia alone in a prospective, randomized, open, multicenter study in 210 ASA I, II, and III patients undergoing elective total hip replacement. Occurrence of clinically relevant hypotension (systolic arterial blood pressure decrease >30% from baseline), or bradycardia (heart rate <45 per minute) requiring pharmacologic treatment were recorded, as well as routine cardiovascular parameters. Clinically relevant hypotension during induction of nerve block was reported in 13 patients receiving epidural block (18%) and 16 patients receiving epidural-general anesthesia (22%) ($P = 0.67$). Subsequently, 22 of the remaining 54 patients in the epidural-general anesthesia group (41%) developed hypotension after the induction of general anesthesia, as compared with 16 patients of the general anesthesia group (23%) ($P = 0.049$). No differences in heart rate or in frequency of bradycardia were observed in the three groups. The induction of general anesthesia in patients with an epidural block up to T10 increased the odds of developing clinically relevant hypotension as compared with those patients who received no epidural block, and was associated with a twofold increase of the odds of hypotension as compared with the use of epidural anesthesia alone. Neubauer and Seligson[184] evaluated and compared whether a difference exists between measurable factors such as heart rate, blood pressure, pulse, and anesthesia induction time in patients undergoing spinal vs. general anesthesia. A retrospective study of eighteen surgical cases on the leg from the knee and distally under spinal anesthesia were compared to identical or similar procedures performed with a patient under general anesthesia. Data for heart rate, blood pressure, oxygen saturation, and the time interval for anesthesia induction were studied. Heart rate and blood pressure values recorded from the intra-operative anesthesia record were compared with the recorded preoperative values obtained from the anesthesia record. Anesthesia induction time was obtained from the interval between the recorded time for beginning anesthesia and the surgery start time. Systolic blood pressure increased by an average of 12.3 mmHg in the general anesthesia group compared with a value of 12.9 for the spinal anesthesia group. Average intra operative systolic pressure decreased by 10.9 mmHg in the general anesthesia group vs. a decrease of 7.7 for spinal block. Pulse rate for general anesthesia decreased by 3.7 bpm vs. an increase of 3.2 in spinal anesthesia. Induction time for general anesthesia was 27.9 minutes compared to an average spinal anesthesia induction time of 29.8 minutes. The study found no significant differences in intra operative patient vital signs when comparing patients under general anesthesia to those under spinal anesthesia. Additionally, although the literature states that spinal anesthesia takes longer if the patient is not prepared prior to the operating room being ready, this study found no significant delay in operation start times for general anesthesia vs. spinal anesthesia. Fuzier et al.[185] evaluated regional anesthesia procedures for limb traumatic surgery performed in an emergency department.

CSEGA and emergency operations

Anesthetic procedures concerning traumatic emergencies have been studied from 1995 to 2000. A 32% increase in anesthesia practice was observed from 1995 (221) to 2000 (292) with a 52% increase in regional anesthesia. Since 1996, regional anesthesia represents more than 80% of the anesthetic procedures and 90% for the upper limb surgery (66% of the surgical procedures).

Axillary block (50%), interscalene brachial plexus block (15%) and combined sciatic and femoral nerve block (17%) were the main regional anesthesia procedures. Spinal anesthesia (9 cases) and intravenous loco regional anesthesia (12 cases) were rarely used. In this study, regional anesthesia is the most used technique when compared to general anesthesia for emergency procedure.

A 15-yr-old adolescent woman sustained an unstable spinal column injury with an incomplete neurological deficit following a high speed motor vehicle accident was scheduled for spinal decompression and stabilization through a left thoraco-abdominal approach. Balanced general anesthesia was undertaken. Prior to closure, a multi-orifice epidural catheter was surgically placed under direct vision 5 cm into the anterior epidural space. The catheter was then tunneled out through the psoas muscle and secured in place. Combined epidural-general anesthesia was then initiated for the duration of the case using 5 mL bupivacaine 0.25% after an initial test dose of 3 mL lidocaine 1.5% with epinephrine. An infusion of bupivacaine 0.10% and fentanyl 5 µg ml-1 at 8 mL/h-1 using patient PCEA provided excellent postoperative pain control for four days. She had an uncomplicated postoperative course. A surgically placed epidural catheter provided excellent, safe, perioperative anesthesia and analgesia in this patient with unstable spinal trauma.[186]

CSEGA and asthma

Kasaba et al.[187] prospectively investigated the incidence of asthmatic attacks in 94 patients (1.5%) who were diagnosed as definite asthma. They separated the patients into three groups: epidural anesthesia (n = 10) including CSE anesthesia (n = 7), combined epidural and general anesthesia (n = 23), and general anesthesia (n = 54). General anesthesia was induced with propofol or midazolam and maintained with N_2O and O_2 with sevoflurane in adults. Patients who underwent epidural anesthesia and CSE anesthesia showed no asthmatic attacks. The incidence of bronchospasm with combined epidural and general anesthesia was 2/23. The incidence of bronchospasm with general anesthesia was 4/54. Bronchoconstriction occurred after tracheal intubation in 5 patients except in one patient, in whom it occurred after induction of anesthesia with midazolam. All episodes of bronchospasm in the operative period were treated successfully. The frequency of bronchospasm did not depend on the severity of asthmatic symptoms or the chronic use of bronchodilators before operation. These findings suggest that tracheal intubation, not the choice of anesthetic, plays an important role in the pathogenesis of bronchospasm.

CSEGA and liver operation

Siniscalchi et al.188 compared the intraoperative effects of combined vs. general anesthesia during major liver surgery. In this prospective randomized study, 70 patients were divided into 2 groups of 35 subjects. Group A received general anesthesia (thiopentone, fentanyl, vecuronium, sevoflurane in a closed circuit) 15 minutes after placement of an epidural catheter (T9-10) and induction of epidural anesthesia (6 mL 2% ropivacaine). Continuous epidural infusion was initiated before surgical incision and continued with 0.2% ropivacaine (7 mL/hour) until the end of the operation. Group B received combined intraoperative anesthesia with fentanyl doses according to hemodynamic parameters and 0.1 mg/kg morphine 30-4 minutes before cutaneous suture. Hemodynamic values were measured at base line (T0), and then at 15, 30, 60, 120 and 180 minutes after induction of general anesthesia (T1, T2, T3, T4 and T5, respectively). On recovery, patients were assessed for pain at rest and on movement reported on a VAS; degree of motor blockade according to the Bromage scale; appearance of side effects and use of an analgesic. A statistically significant decrease in the MAP and heart rate was noted within each group at 15 minutes after induction of general anesthesia. Significant differences in MAP were found between the two groups at T1 to T5, whereas heart rate values were substantially similar. The mean intraoperative use of fentanyl was significantly higher in group B than in group A, as was that of vecuronium. Pain intensity on recovery in patients who received epidural anesthesia was lower both at rest and on movement; only the patients in group B required additional analgesics. No motor blockade was observed in either group. Nausea and vomiting were more frequent in group B; hypotension was more frequent in group A. The study confirms the safety of loco regional anesthesia in liver surgery, with good hemodynamic stability and absence of major side effects. The lower intraoperative use of opioids and muscle relaxants in patients who received epidural anesthesia confirms the neurovegetative protection this method provides. The data support the hypothesis that greater intraoperative use of opioids may be responsible for the higher incidence of side effects. Therefore, the intraoperative use of combined low-concentration anesthetic agents alone appears to offer a reasonable treatment option that provides adequate pain control at recovery from general anesthesia, with only minor side effects typically associated with local anesthetics (motor blockade) and opioids (nausea and vomiting). Given the complications associated with the technique, it should be performed by an expert anesthetist.

CSEGA and postoperative pain

Epidural blood flow was measured in seven patients undergoing elective abdominal surgery during combined lumbar epidural and general anesthesia.[189] After an initial dose of 20 mL plain bupivacaine 0.5%, a continuous epidural infusion of bupivacaine 0.5% (8 mL/hour) was given for 16 hours for postoperative pain relief. The epidural blood flow was measured by a local 133Xe clearance technique in which 15-35 MBq 133Xe diluted in 1 mL saline was injected through the epidural catheter on the day before surgery (no bupivacaine), 30 minutes after the initial dose of bupivacaine on the morning before surgery, and 8, 12, and 16 hours later during the continuous infusion. Initial blood flow was 6.0 ± 0.7 mL/min per 100 g tissue (mean ± SEM). After epidural bupivacaine, blood flow increased in all seven patients to 7.4 ± 0.7 m (P < than 0.02). Initial level of sensory analgesia was T4.5 ± 0.17 (mean ± SEM). Postoperatively, two patients maintained the initial level of sensory analgesia and low pain score throughout the 16 hour study. In these two patients epidural blood flow remained constant after the initial increase. Flow increased further to 10.3 ± 0.8 mL/min per 100 g tissue (P < than 0.03) in the other five patients as the level of sensory analgesia regressed postoperatively. These data suggest that changes in epidural blood flow during continuous epidural infusion of bupivacaine, and thus changes in rates of vascular absorption of bupivacaine from the epidural space, may be an important factor contributing to differences in rates of regression of sensory analgesia.

Conclusion

Epidural and spinal blocks are well accepted regional techniques, but they have several disadvantages. The CSE technique can reduce or eliminate the risks of these disadvantages. CSE block combines the rapidity, density, and reliability of the subarachnoid block with the flexibility of continuous epidural block to extend duration of analgesia. The CSE technique is used routinely at many institutions, particularly for major orthopedic surgery and in obstetrics. It has been used in tens of thousands of patients without any reports of major problems. Although at first sight the CSE technique appears to be more complicated than epidural or spinal block alone, intrathecal drug administration and siting of the epidural catheter are both enhanced by the combined, single-space, needle-through-needle method. Concerns about the epidural catheter entering the theca via the small puncture hole are now considered to be unfounded, but as with all epidural catheter techniques, vigilant monitoring of the patient during and after any injection is paramount. CSE anesthesia is an effective way to reduce the total drug dosage required for anesthesia or analgesia. The intrathecal injection achieves rapid onset with minimal doses of local anesthetics and opioids, and the block can be prolonged with low dose epidural maintenance administration. In addition, the sequential CSE method can be used to extend the dermatomal block with minimal additional drugs or even saline. Reduction in total drug dosage has made truly selective blockade possible. Many studies have confirmed that low dose CSE with local anesthetic and opioid, or low dose epidural block alone, will provide effective analgesia with minimal motor and proprioceptive block. Such neurologic selective blockade has made it possible for most patients to walk and bear down normally in labor or postoperatively. There remains concern about the risk of infection being increased when the CSE technique is used in place of epidural block alone. Despite a recent flurry of reports of meningitis with CSE procedures, there is no evidence the CSE block is more hazardous than epidural or subarachnoid block alone. Arguably, the single-space, needle-through-needle CSE technique will continue to improve with new needle designs and other advances to improve further the success rate and reduce complications, such as neurotrauma, PDPH, and infection. Over the past decade it has become clear that the CSE technique is a significant advance in regional blockade.[190]

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