Anesth Pain Med. 2020 February; 10(1):e99745. doi: 10.5812/aapm.99745.

Published online 2020 February 19. **Review Article**

Regional Catheters for Postoperative Pain Control: Review and Observational Data

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Received 2019 November 27; **Revised** 2020 January 22; **Accepted** 2020 January 29.

Abstract

Context: Perioperative analgesia is an essential but frequently underrated component of medical care. The purpose of this work is to describe the actual situation of surgical patients focusing on effective pain control by discarding prejudice against 'aggressive' measures.
Evidence Acquisition: This is a narrative review about continuous regional pain therapy with catheters in the postoperative period. Included are the most-relevant literature as well as own experiences.
Results: As evidenced by an abundance of studies, continuous regional/neuraxial blocks are the most effective approach for relief of severe postoperative pain. Catheters have to be placed in adequate anatomical positions and meticulously maintained as long as they remain in situ. Peripheral catheters in interscalene, femoral, and sciatic positions are effective in patients with surgery of upper and lower limbs. Epidural catheters are effective in abdominal and thoracic surgery, birth pain, and artery occlusive disease, whereas paravertebral analgesia may be beneficial in patients with unilateral approach of the truncus. However, failure rates are high, especially for epidural catheter analgesia. Unfortunately, many reports lack a comprehensive description of catheter application, management, failure rates and complications and thus cannot be compared with each other.
Conclusions: Effective control of postoperative pain is possible by the application of regional/neuraxial catheters, measures requiring dedication, skill, effort, and funds. Standard operating procedures contribute to minimizing complications and adverse side effects. Nevertheless, these methods are still not widely accepted by therapists, although more than 50% of postoperative patients suffer from 'moderate, severe or worst' pain.

Keywords: Major Surgery, Postoperative Pain, Regional Analgesia, Neuraxial, Catheters, Peripheral Catheters, Efficacy, Failure Rate

1. Context

Against the backdrop of more than 320 million surgical procedures per year worldwide (1), perioperative pain control should be a high-priority issue within health care providers. However, in contrast to the belief of many therapists, postoperative pain is still markedly 'undermanaged' (2, 3). The rationale of this review was to increase therapists', particularly anesthesiologists' and surgeons', consciousness of the ongoing unfortunate situation of post-surgical patients with moderate to severe/unbearable pain, including concrete proposals for solution. Physicians should be repeatedly reminded of the famous saying of Galen of Pergamon, "divinum est sedare dolorem" (it is divine to ease pain).

2. Evidence Acquisition

The aim of this review was to discuss reasons and potential solutions for a condition, which is highly unpleasant for patients and unflattering for therapists. The focus was on surgical procedures creating severe postoperative pain, with the emphasis on the outstanding potential of continuous regional blocks with catheters.

We selected an adequate, balanced number of published studies, but excluded particular operations, such as foot, hand or hip surgery, as the majority of these patients can be sufficiently treated systemically or with local infiltration (4, 5).

3. Results

The subject of whether the method of postoperative pain control influences outcome parameters, such as major complications or length of hospital stay, is an ongoing debate (6). However, the discussion frequently misses patients' central concern: their suffering and discomfort. As matters now stand, the 2016 statement of Rawal remains unchanged, "Postoperative pain has been poorly managed for decades. Recent surveys from USA and Europe do not show any major improvement" (7).

3.1. Current Situation of Postoperative Pain Control

In his 2010 review, Sinatra (8) complained about the unsatisfactory situation of patients with severe postoperative pain, and concerns are still shared by others (7, 9, 10). The team of Gan published several surveys describing the situation of postoperative patients in the United States. In the years 2003, 2014, and 2017, inadequately treated postoperative pain was almost similar with an incidence of 86%, 75% (74% after discharge), and > 80%, respectively (3, 11, 12). This indicates that during a period of 14 years, postoperative pain control did not change for the better.

Several guidelines with questionable effect have been implemented. Meissner et al. in their 2018 multinational consensus report (13) noted, "despite the introduction of evidence-based recommendations for postoperative pain management, the consensus is that pain control remains suboptimal", a statement we perceive as euphemistic.

3.2. Alternatives for Sufficient Postoperative Pain Therapy

For treating severe pain, opiates are effective, although they have considerable adverse effects, such as sedation, post-operative nausea and vomiting (PONV), urinary retention, pruritus, and constipation (14, 15). However, regional analgesia (RA) using mainly local anesthetics lacks these side effects. In their current review, i.e. 'state of the art opioid-sparing strategies for post-operative pain in adult surgical patients', Gabriel and co-workers emphasized both the excellent analgesic potential of RA and its 'opiate-sparing' effects (16).

Table 1 shows observational data of a large German hospital (17, 18) with a variety of regional catheters, demonstrating that the majority of relevant postoperative pain conditions are treatable in this way.

It is difficult to judge the efficacy of individual pain treatment strategies and compare them with others. This is mainly due to the lack of crucial information, such as techniques of catheter insertion and postoperative maintenance, qualification and responsibilities of respective therapists, and if mandatory standards have been applied. Although from years back, the 2012 statement of Hermanides et al. (19) regarding neuraxial analgesia is still highly relevant, "estimates of the incidence of failed epidurals are hampered by the lack of uniform outcome measures". As a consequence, published success/failure rates have to be considered with the utmost caution. The issue is well exemplified by the 2018 Cochrane review of Salicath et al. (20), comparing epidural analgesia (EDA) with patient-controlled intravenous analgesia after major abdominal surgery in adults. As was concluded, "any improvement needs to be interpreted with the understanding that the use of EDA is also associated with an increased chance of failure to successfully institute analgesia, and an increased likelihood of episodes of hypotension requiring intervention and pruritus". However, according to our understanding, neither failure rate nor postoperative pruritus was attributable to EDA itself. The EDA efficiency depends on therapists' skill, as well as positioning and fixation of the catheter, whereas pruritus is a well-known effect of epidural opiates. With adequate organization, hypotensive episodes are not also considered relevant clinical problems.

In view of the fact that there is no coherent, generally accepted definition of failure regarding RA, we agree with the unambiguous criteria for 'effective' catheter-related analgesia of von Bormann et al. (17):

1. No need for routinely administered additional systemic analgesics;

2. No relevant side effects and no complications;

3. VAS score (0 - 10) continuously $\leq$ 3 during movement; patients are satisfied;

4. Length of the in situ period of the respective catheter as scheduled.

3.3. Specific Procedures-Peripheral Catheters

3.3.1. Femoral and Sciatic Block

Major knee surgeries, such as total knee arthroplasty, cause extreme pain, normally lasting 2 to 3 postoperative days. Ongoing pain control is crucial to enable mobilization starting immediately after surgery. The 2014 Cochrane review by Chan et al. (21) suggested superior effects of femoral catheter for pain control after total knee replacement, especially when combined with sciatic block or periarticular infiltration.

Femoral catheter insertion is simple; therapists can orientate themselves to clear landmarks, particularly the femoral artery. Ultrasound is not necessary and stimulation of the needle is adequate. However, the method has been increasingly challenged and adductor canal block (ACB) is becoming an attractive alternative.

Table 1. Regional Catheters for Perioperative Pain Control in Elective Surgical Patients. Publication Granted by the Authors (17)

Procedure	Specifics	Indication	Schedule (Planned)	Done (%)
Epidural catheter	Lumbar	Delivery (obstetrics)	70 %	45
		Artery occlusive disease of the lower limb	ALL	96
	Thoracic	Major abdominal and thoracic surgery	ALL	97.4
Femoral catheter		Major knee surgery	ALL	100
Sciatic dorsal catheter	With FC only	Major knee surgery	10%	98
Sciatic ventral single injection	With FC only	Major knee surgery	90%	100
Brachial catheter	Interscalene approach	Major shoulder surgery	ALL	99.3

Abbreviation: FC, femoral catheter

3.3.1.1. Motoric Function and Adductor Canal Block

There is concern among surgeons and physiotherapists that continuous femoral nerve block (FNB) may hamper motoric function, thereby leading to delayed ambulation and increasing risk of falls (22). As a consequence, ACB has been promoted in order to provide adequate analgesia with less quadriceps weakness compared to femoral block (23, 24). However, Schwenk and Gandhi (25) focused on conclusions drawn from dynamometer data and emphasized that differences in motoric function between ACB and FNB were significant only during the first 8 postoperative hours, whereas fall accidents mostly occurred on the second postoperative day. Memtsoudis et al. (26) selected 191,570 total knee arthroplasty patients from the national (US) Premier Perspective Database. The overall inpatient fall (IF)-incidence was 1.6% without any association between IF and peripheral nerve blocks. To evaluate the assumption that ACB is only an indirect femoral block (27), Chuan et al. (28) conducted a multinational, multicenter, double-blinded randomized trial. They found no differences in immediate postoperative functional mobility, analgesia, and opioid consumption provided by FNB and ACB catheters for total knee arthroplasty surgery.

Currently, experts' opinion regarding FNB and ACB appears to be undecided, with the use of the respective technique obviously based on individual therapists' preferences.

3.3.1.2. Efficacy and Complications

Accurate and systematically collected failure rates of FNB or ACB have not yet been investigated. Popping et al. (29) in their observational study included 1,374 patients with femoral/sciatic block. They reported a failure rate of 3.96% and moderate infections without late sequelae in 35 patients (2.4%).

However, there have been reports about some few serious complications including compartment syndrome, periprosthetic fracture, and vascular injury (30). Widmer et al. (31) investigated 1,802 patients with femoral block, reporting an incidence of 1.94% sensory abnormalities in the distribution of the femoral nerve without lasting damage.

3.3.2. Brachial Block with Interscalene Catheter

The shoulder is another anatomic area with high sensitivity to pain (32). Common surgical procedures such as endoscopic removal of exostosis require passive movement of the joint immediately after surgery to avoid 'frozen shoulder'. The shoulder has to be pain-free for this maneuver, which can be best achieved with a brachial plexus block via interscalene catheter. In cases with intermittent immobilization, bolus applications before physiotherapy may be preferable to continuous infusion.

3.3.2.1. Efficacy and Complications

Ullah et al. in their Cochrane review found better pain relief for continuous interscalene brachial block compared to parenteral analgesia (33). Failure rates can be low (0.4%) (34) or extremely high (18.8%) (35). Potential complications after interscalene catheter insertion are hoarseness, neurologic sequelae, dyspnea, and nerve injury; the reported incidence ranges from 0.8% long-term neurologic deficits to 31% hoarseness (36, 37). Inserting a sufficiently working interscalene pain catheter is a sophisticated technique requiring adequate training (32).

3.3.3. Peripheral Nerve Blocks for Postoperative Analgesia: Type of Application

Ilfeld and Gabriel (38) recently raised the issue of type of application for perineural catheters, asking "should we take the 'continuous' out of 'continuous peripheral nerve blocks'?", a concern that may lead to an ongoing debate regarding resources and efforts for RA. Organizing and monitoring bolus applications is, without question, less effortful compared to continuous application.

3.3.4. Neuraxial Blocks-Paravertebral Catheters

One of the first publications on paravertebral block (PVB) including a 2 year follow-up period was the 1998 report of Coveney and colleagues (39) in patients with breast cancer surgery. Since then, PVB has been used for pain control in different surgical settings, mainly after thoracic surgery (40). Norum and Breivik (41) do not consider PVB equivalent to EDA in thoracic surgery. Among others, they emphasize that optimally conducted EDA has not yet been compared with PVB.

3.3.4.1. Efficacy and Complications

The incidence of complications after paravertebral puncture may be low. However, the severity of events such as pleural or vascular puncture, hypotension, bilateral epidural, and intrathecal spread is a matter of concern. Naja and Lonnqvist (42) studied the outcome characteristics of thoracic and lumbar PVBs in 620 adults. The general failure rate was 6.1%; most relevant complications were vascular and pleural puncture, epidural or intrathecal spread, and pneumothorax. Moreover, the use of a bilateral paravertebral technique resulted in doubling of vascular puncture (9% vs. 5%) and an eight-fold increase in pleural puncture and pneumothorax. Sufficient placement of paravertebral catheters requires profound knowledge of anatomy, skill in puncturing the paravertebral space, and experience in applying ultrasound. In their randomized study, Sundarathiti and co-authors (43) performed paravertebral catheters as stand-alone anesthesia in major breast surgery. The catheters, although 100% sufficient to perform surgery including extensive axillary lymph node removal, were not left in situ due to organizational issues. Nevertheless, the study showed that catheters under ultrasound guidance could be advanced 8 cm deep into the paravertebral space without complications, relevant technical difficulties, or kinking, confirming the potential of PVC for postoperative pain control.

3.3.5. Neuraxial Blocks-Epidural Catheters

Based on a large body of evidence, EDA with thoracic approach remains the first-line therapy to control pain after major abdominal and thoracic surgery (44-46), whereas lumbar catheters are suitable in obstetrics and for patients with artery occlusive disease of the lower limb. Concerns about outcome deterioration due to delayed bowel function return, hypotension, and urinary retention caused by EDA are not substantiated; EDA does not lead to an increased risk of any major complications or relevant side effects (47, 48).

3.3.5.1. Efficacy

Majority of studies, some of them with large sample sizes, have demonstrated significant benefits of EDA for patients' comfort and outcomes (17, 44, 49, 50), with the study of Monaco and co-workers (48) being an example. They investigated 459 consecutive patients with open thoraco-abdominal aortic aneurysm repair, with 409 (89%) patients receiving thoracic EDA (TEA). The patients with TEA, when compared to the other patients, experienced significantly less post-operative pain, as well as less complications, such as acute kidney injury, atrial fibrillation, and acute myocardial infarction. Moreover, there was no epidural hematoma/infection or paraplegia. The results remained statistically significant, even after propensity matching (43 vs. 43 patients). In our opinion, EDA is still the gold standard for controlling intense abdominal and thoracic pain.

3.3.5.2. Failure Rate

As a consequence of unclear or different criteria to assess the effectiveness of EDA, the reported failure rates vary over a wide range (Table 2). Primary reasons for failure are dislodgement/migration of the catheter, which was conclusively demonstrated by Motamed et al. (51) using postoperative computer tomography. Other relevant causes for insufficient therapeutic effects include delayed injections (19) and under-dosing of respective agents, as demonstrated by Panousis et al. (52) comparing intraoperative ropivacaine 0.2% and 0.5% with placebo. Once again, we emphasize that the dose of local anesthetics determines their effects, whereas concentration and volume affect onset of action and spread, respectively (53). To avoid relevant motoric and sympatholytic effects, the smallest possible volume with adequate concentration should be applied. Therefore, the tip of the catheter has to be in the center of pain perception, which is for major abdominal and thoracic surgery between Th 6 and Th 10. An interesting approach to reduce failure rates has been reported by Larsson and Gordh (54). They tested the effectivity of epidural catheters directly after insertion and before surgery and managed to reduce failure rates significantly. Delays did not exceed 10 - 15 minutes (Table 2). Failure of EDA catheters can be significantly reduced by improving perioperative organization, as it has been nicely demonstrated by Gleicher and co-workers (55). They decreased the failure rate of thoracic epidural catheters (112 vs. 142 patients) from 16.0% to 5.6% after implementing a separate block room. We also need to point out that a separate block room also reduces the delay of operating theatre turnover, as regional catheter insertions, particularly epidurals, can be performed simultaneously to a running OR. Our own

data indicate a time saving of 12 - 25 minutes per major procedure. Installing and operating a block room should be easily manageable for large departments. However, for smaller units, additional efforts and extra holding of specialized personnel may be a matter of concern. Finally, regardless of organizational issues, our own experiences indicate that proper fixing of catheters, such as epidural or central venous lines, is paramount to ensure that catheters remain in position and also to avoid catheter-related infections.

3.3.5.3. Complications

Typical adverse side effects of EDA are hypotension, urine retention, and pruritus, the latter mainly caused by neuraxial opiates (15). With a thoracic catheter in the center of pain perception, deterioration of motoric function or bowel function is not an issue (17, 44, 67). Complications after epidural puncture are rare but may have dramatic effects including paraplegia (68). However, the currently available literature suggests that the benefits of EDA outweigh its risks and side effects (44, 46, 49, 50, 69, 70). Thoracic epidurals are inserted in close vicinity to the spinal cord; the procedure has to be performed by experienced professionals (71).

A 0.06% rate of severe complications, exclusively in patients with lumbar epidural catheters suffering from severe artery occlusive disease has been reported by von Bormann et al. (17). This is slightly above the rate of symptomatic spinal mass lesion (0.034%) described by Popping et al. (29).

3.4. Synopsis

Regional analgesia with catheters is highly effective when performed properly. It is not in any competition with alternative methods. However, new methods such as modified local infiltration techniques and percutaneous nerve stimulation (72, 73) have to be proven superior before replacing established procedures.

3.4.1. Agents

In contrast to many others, we do not recommend adding adrenaline to local anesthetics, although there are no sufficient data to support this strategy. We are, however, in agreement with Wiles and Nathanson (74), challenging the assumed benefits. Mauch et al. (75) observed t-wave, blood pressure, and heart rate alterations after adrenaline-containing LA, but could not distinguish whether the catheter was actually intravascular or whether the observed effect was the result of resorption. Nevertheless, we have to admit that the majority of anesthesiologists still oppose our strategy and hence the discussion is still open.

3.4.2. Organization

In cases of inadequate effect, catheters should be reinserted as suggested by Pan et al. (66). Patients in the general ward should be regularly visited twice a day by members of the pain service, and in cases of particular need. A 24-hour emergency service must be ensured. Moreover, a separate block room should be implemented wherever possible.

3.4.3. Standard Operating Procedures (SOP), Patients with Anticoagulants

Standardizing procedures is key to guarantee patients' safety and efficacy of procedures. SOPs should be mandatory; they are not ordered 'top-down' but have to be developed by the people involved, such as anesthesiologists, surgeons, oncologists, pharmacists, and purchase department, with the general manager or clinic director finally bringing it into effect.

As an example for the necessity of standards as an essential safety measure, Table 3 shows our own SOP for patients with compromised coagulation, including the most common anticoagulants. However, utmost caution has to be exercised for all regional catheter insertions. We strongly recommend that every facility should create and update its own SOPs adapted to the situation of the respective department/hospital.

3.4.4. Patients with Immunosuppression

Deterioration of the immunologic system is not per se a contraindication against any kind of pain catheters, assuming that the indication (pain status) is solid and the procedure is performed as described: sterile and atraumatic.

3.4.5. Expenses/Manpower

Expenses for RA are high, mainly due to safety and organizational measures, leading to extensive use of specialized medical personnel. The costs for RA exceeds those for patient controlled analgesia significantly, whereas systemic treatment (injection on demand) is by far the cheapest, yet the least effective alternative (Table 4). The delay of turnover time of operating rooms (OR) can indeed be a significant cost factor. However, it is also the source of conflicts between anesthesiologists and surgeons, a problem best managed with a 'block room' that serves several ORs.

We believe that costs as a limiting factor may be often a 'lame excuse', especially in large departments where manpower and expenses can easily be acquired by organiza-

Table 2. Published Failure Rates of Epidural Pain-Catheters

Author, Year of Publication	Surgical Approach (Number of Patients)	C-Position (Failure Rate)	Reasons for Failure/Success
High Failure Rate			
Burstal, 1994 (56)	Abdominal (1,062)	Lumbar, thoracic (23%)	Premature removal, no analgesic effect
Ready, 1999 (57)	Abdominal, thoracic (2,140)	Thoracic (32%); Lumbar (27%)	Migration, ineffective
McLeod, 2001 (58)	Upper abdominal, thoracic (640)	Thoracic (13%)	Dislodgement, malposition, occlusion
Motamed, 2006 (51)	Upper abdominal (125)	Thoracic (24.8%)	Dislodgement, verified by computer tomogram
Pratt, 2008 (59)	Pancreaticoduodenectomy (158)	Thoracic (31%)	Dislodgement, early abortion
Königsrainer, 2009 (60)	Thoraco-abdominal (300)	Thoracic (41.4%)	Dislodgement
Sakowska, 2009 (61)	Pancreaticoduodenectomy (51)	Thoracic (25%)	Unplanned removal
Choi, 2010 (62)	Pancreaticoduodenectomy (18)	Thoracic (36%)	Unplanned removal
von Bormann, 2013 (17) **[1989-1992]**[a]	Upper abdominal, thoracic (1,880); Lower abdominal/limb, thigh amputation (620)	Thoracic (19.3%); Lumbar (16.9%)	Catheter migration, malposition, early abortion
Patel, 2014 (63)	Pancreaticoduodenectomy (73)	Thoracic (42.5%)	No effect (site of catheter insertion?)
Wranicz, 2014 (64)	Upper abdominal, thoracic (317)	Thoracic (34.4 - 41%)	Dislodgement, malposition, occlusion
Wongyingsinn, 2016 (65)	Upper abdominal, thoracic (364)	Lumbar/Thoracic (48.6%)	Dislodgement, ineffective, wrong anatomic position
Gleicher, 2017 (55)	Upper abdominal (112)	Thoracic (16%)	Organizational issues
Low Failure Rate			
Pan, 2004 (66)	Obstetrics (19,259)	Lumbar (1.2%)	Immediate re-insertion in case of inefficacy
Popping, 2008 (29) **[1998 - 2006]**[a]	Thoracic and major abdominal (10,198)	Thoracic (7%)	Standards
Larsson, 2010 (54)	Upper abdominal surgery (100)	Thoracic (2%)	Testing and re-inserting the catheter before surgery
von Bormann, 2013 (17) **[1993 - 2010]**[a]	Upper abdominal and thoracic (8,828), lower abdominal/limb, thigh amputation (2,755)	Thoracic (3.7%); Lumbar (3.1%)	Mandatory standards, catheter sewing, re-insertion, block room
Gleicher, 2017 (55)	Upper abdominal (142)	Thoracic (5.6%)	Block room

[a] Investigation period.

tional measures, such as optimizing the schedule of operating rooms.

3.4.6. Lacking Expertise

The application of pain catheters requires skill, confidence and expertise, and is only acquirable for the novice by adequate training including multiple applications under supervision. Failure rates are obviously dependent on permanency of anesthetic staff as it has been emphasized by Heinink et al. (77).

3.4.7. Limitations

Every narrative review includes the risk of bias. We inserted a balanced number of pro and con literature referring to every discussed issue. In addition, the authors possess above average knowledge and experience in invasive pain treatment.

4. Conclusions

The following recommendations can only work in a well-organized and well-equipped facility with sufficient resources and uncompromised cooperation.

1. Postoperative pain therapy is not a 'sideline'. Regional catheters should be offered whenever indicated, given that adequate expertise and manpower exist.

2. Patient information: Complete clarification about side effects of the respective method and its potential complications including bleeding, anaphylaxis, or nerve injury is paramount. Patients should be informed as soon as possible, ideally during the first contact with the treating department, and after the decision for the respective surgical procedure. In patients with epidural catheter, the rare possibility of injury, infection, or bleeding of the spinal cord and its consequences (paraplegia) must be explic-

Table 3. SOP Example Regarding Puncture/Catheter Application Near the Spinal Cord in Patients with Compromised Coagulation, Focusing on Time Intervals Prior To Puncture and Catheter Insertion or Removal

	Puncture	Removal	Reliable Biochemical Control Parameters
Unfractioned Heparin, Prophylaxis < 15.000 U/day	4 h	1 h	If therapy > 5 days: Thrombocyte count
Unfractioned Heparin: High dose therapy	4 - 6 h	1 h	PTT, (ACT), thrombocyte count
Low molecular Heparin: Prophylaxis	12 h	2 - 4 h	> 5 days: Thrombocytes
Low molecular Heparin: Therapy	24 h	2 - 4 h	Thrombocytes (anti Xa)
Fondaparinux (Arixtra®) (prophylaxis < 2.5 mg/die)	36 - 42 h	6 - 12 h	(anti Xa)
Vitamin-K-Antagonist, such as Warfarin, Cumarin	PT > 70%	PT > 50%	PT
Hirudin (Lepirudin, Desirudin)	8 - 10 h	2 - 4 h	aPTT, ECT
Argatroban (Argatra®)	4 h	2 h	aPTT, ECT, ACT
Acetylsalicylacid (Aspirin) 100 mg (ASS 100®)	None	None	PFA (Platelet function); CAVE: Combination with Heparin or antirheumatic agents
Clopidogrel	7 days	7 days	There are none
Ticlopidin (Tyclid®)	10 days	10 days	There are none
NSAR	None	None	There are none

Table 4. Expenses for 2-Day Alternative Pain Treatment

Causative Issue	Regional Catheter[a]	Systemic[a] (MO, Non-opiates)	PCA - MO (76)
Manpower	280.-	15.-	15.-
Material + Drugs	40.-	35.-	220.-
Total	320.-	50.-	235.-

Abbreviations: MO, morphine; PCA, patient controlled analgesia
[a]Own experience and educated guesses in more than 1,000 applications per year (averaging calculation)

itly mentioned. Patients must be aware of the need to notify medical staff immediately about back pain, strong headaches, or unexpected numbness. Patients should also be informed about the possibility of insufficient or fading analgesic effects.

3. Catheters should remain in 'one hand' during the entire treatment period.

4. Applying catheters in the intensive care unit or the operating room does not require sterile gowns as long as the procedure is performed under strict aseptic and atraumatic conditions.

5. Mixing epinephrine with local anesthetics is common, and most therapists do it. However, we oppose the trend and do not recommend it, as we are reluctant to mix highly active drugs when scientific evidence lacks for its benefits.

6. For epidural catheters, anatomic position and adequate fixation are essential. We strongly recommend suturing, which requires a wire armored catheter.

7. Pain catheters should be activated after insertion, usually before skin incision.

8. A working pain catheter in adequate position does not require the routine application of additional systemic analgesics.

9. As for all invasive procedures, the application of regional/neuraxial pain catheters has to follow established standards, ideally implemented in the form of mandatory written SOP.

A great number of patients are still suffering from moderate to severe pain, or even worst pain, after surgery. The consequent application of regional pain catheters can help to effectively counteract this problem.

Acknowledgments

The study was supported by the 'Wolf Schleinzer Foundation', Ulm, Germany.

Footnotes

Authors' Contribution: Benno von Bormann developed the original idea and the protocol, abstracted and analyzed data, wrote the manuscript, and is a guarantor. Sirilak Suksompong and Suparpit von Bormann contributed to the development of the protocol, abstracted data, and prepared the manuscript.

Conflict of Interests: All the authors declare no conflict of interest.

Funding/Support: Wolf Schleinzer Foundation, Ulm, Germany.

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