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Research Article

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Differentiated Approach to the Method of Fixing the Epidural Catheter

O.N. Yamschikov[1, 2], A.P. Marchenko[1, 2], S.A. Emelyanov[1, 2], A.I. Levina[1, 2], K.A. Pavlova[1, 2], N.A. Marchenko[1] ✉

Department of Hospital Surgery with Traumatology Course
[1] G.R. Derzhavin Tambov State University, Medical Institute
Internatsionalnaya Str. 33, Tambov, Russian Federation 392000
[2] City Clinical Hospital of Kotovsk
Pionerskaya Str. 24, Kotovsk, Tambov Region, Russian Federation 393190

✉ **Contacts:** Naila A. Marchenko, Student of the Medical Institute, G.R. Derzhavin Tambov State University. Email: marchenkonaily@gmail.com

AIM OF STUDY To study the individual structural features of the surface of the lumbar region of the back of patients who underwent catheterization of the epidural space at the lumbar level, and, depending on these features, to determine a group of patients with the possibility of convenient and reliable fixation of the epidural catheter (EC) to the skin with fixing devices and a group of patients who require such fixation will be inconvenient and unreliable and for whom it is better to use subcutaneous tunneling for reliable fixation of the EC, and based on this, determine the absolute and relative indications for this method of fixation.

MATERIAL AND METHODS A study of the surface of the lumbar region of the back was carried out in 600 patients who were on the operating table in a sitting position, while performing neuraxial blockades in the intervertebral spaces L2–L3 and L3–L4. As a result, 4 forms of the back surface were identified: "V" shape, "M" shape, "Л" shape and "—" flat shape of the back surface.

RESULTS The overwhelming majority of the studied patients had absolutely convenient (34.2%) and relatively convenient (53.5%) places for EC fixation in the area of epidural access. Significantly fewer patients (2%) had a completely uncomfortable site for EC fixation to the skin using fixation devices, which can be considered an absolute indication for EC fixation by subcutaneous tunneling.

CONCLUSION 1. The absolute indication for fixing an epidural catheter using the subcutaneous tunneling method is the presence of an absolutely uncomfortable fixation site in the area of epidural access in the patient in the form of a combination of a recess greater than 7 mm and a distance from the points of maximum elevation in the specified zone to the right and left of the midline less than the size of the dense adhesive plate of the fixing device (for the Epi-Fix device this is 55 mm).

2. A relative indication for fixing an epidural catheter using the subcutaneous tunneling method is the presence of a relatively inconvenient fixation site in the epidural access area for the patient, regardless of the size of the depression or elevation of the surface shape at the epidural access site and the distance from the points of maximum elevation to the right and left of the larger midline than the size of the dense adhesive plate of the fixing device.

Keywords: epidural catheter, epidural analgesia, methods of fixing the epidural catheter, shape of the back surface, tunneling of epidural catheter
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Affiliations

Oleg N. Yamshchikov	Doctor of Medical Sciences, Professor of the Department of Hospital Surgery with a Course of Traumatology of the Medical Institute, G.R. Derzhavin Tambov State University, Chief Physician of City Clinical Hospital of Kotovsk; https//orcid.org/0000-0001-6825-7599, yamschikov.oleg@yandex.ru; 30%, scientific supervision, approval of the manuscript for publication
Aleksandr P. Marchenko	Candidate of Medical Sciences, Associate Professor of the Department of Hospital Surgery with a Course of Traumatology at the Medical Institute, G.R. Derzhavin Tambov State University, Head of the Department of Anesthesiology and Resuscitation, City Clinical Hospital of Kotovsk; https//orcid.org/0000-0002-9387-3374, sashamarchen@mail.ru; 25%, writing the article, selecting and examining patients in accordance with the study design
Sergey A. Emelyanov	Candidate of Medical Sciences, Associate Professor of the Department of Hospital Surgery with a Course of Traumatology at the Medical Institute, G.R. Derzhavin Tambov State University, Deputy Chief Physician for the Medical Unit of City Clinical Hospital of Kotovsk; https//orcid.org/0000-0002-5550-4199, cep_a@mail.ru; 25%, review of critical article content

Anastasia I. Levina	Resident in Anesthesiology and Resuscitation of the Department of Hospital Surgery with a Course of Traumatology at the Medical Institute, G.R. Derzhavin Tambov State University; https//orcid.org/0000-0003-3901-4031, anastasiakoncakova@gmail.com; 10%, article writing, literature analysis
Ksenia A. Pavlova	Resident in Anesthesiology and Resuscitation of the Department of Hospital Surgery with a Course of Traumatology at the Medical Institute, G.R. Derzhavin Tambov State University; https//orcid.org/0000-0003-1931-0706, ksenia.nickolaewa@yandex.ru; 5%, collection of clinical material in accordance with the study design
Naila A. Marchenko	Student of the Medical Institute, G.R. Derzhavin Tambov State University; http://orcid.org/0000-0002-6612-794X, marchenkonaily@gmail.com; 5%, collection of clinical material

BMI – body mass index
CPPS – chronic postoperative pain syndrome
EA – epidural analgesia
EC – epidural catheter

INTRODUCTION

Epidural analgesia (EA) has become widespread and continues to occupy a worthy place in modern anesthesiology practice. And EA is still considered the "gold standard" of postoperative pain relief. Almost all research papers compare the effectiveness of new pain relief methods with the effectiveness of EA. In terms of the level of analgesic effect and comfort for patients, EA is preferable to other methods of pain relief. For prolonged postoperative pain relief, as well as for the treatment of chronic postoperative pain syndrome (CPPS), a long-term presence of a catheter in the epidural space is required. We increasingly hear that EA is no longer the "gold standard" of postoperative pain relief due to the fact that "it requires the participation of an anesthesiologist, is associated with a significant percentage of failures, and the use of installed catheters is quite labor-intensive" [1]. This conclusion belongs to *N. Rawal* (2016).

Many works are devoted to the description of the positive effects of epidural anesthesia and EA, such as a decrease in the frequency of phantom pain syndrome in comparison with patients operated on under general anesthesia, before other types of postoperative analgesia [2], a preventive effect on chronic phantom pain syndrome during hysterectomy [3], cesarean section [4], thoracotomy [5], a decrease in the severity of the stress response and immune disorders [6], limitation of systemic inflammatory reaction processes during highly traumatic operations [7], and the special effectiveness of the blockade during operations on the lower extremities due to their only segmental innervation [8]. The list of these works is endless. And *N. Rawal himself* admits that "epidural analgesia and peripheral blocks are very effective in terms of postoperative pain relief" [1]. Yes, epidural catheterization and peripheral blockades require well-trained anesthesiologists, and it is also necessary to operate the installed catheters in such a way as to prevent dislocation and infectious complications. This is a fairly labor-intensive process. The failure rate of epidural anesthesia and EA, according to *N. Rawal,* is 47%, and with peripheral blockades, even with the use of ultrasound navigation, it reaches 77%. The frequency of EC migration is high when fixing with adhesive tapes, which, according to *I.M. Bishton et al*., reaches 36% [9], and according to *M. Clark et al.* – up to 75% [10]. One of the reasons for the failure of epidural block and the ineffectiveness of EA is the displacement of a correctly installed catheter. If the EC is fixed to the skin with special fixing devices, then displacement is noted in 2.5% of cases [11]. *M. Tripathi* and *M. Pandey* in their study described the displacement of the EC during tunneling in 10% of cases [12]. The positive properties of tunneling the EC are that the internal part of the catheter is extended by the length of the subcutaneous tunnel and, thus, the entry gate for infection is located further from the epidural space, the location of the EC in the subcutaneous tunnel itself is a fixing component, the attachment of the catheter to the

skin is carried out lateral to the medial line, and this place is always a flat surface [13].

As can be seen, special fixing devices provide reliable fastening of the EC with a low percentage of displacement even in relation to tunneled catheters. Fixation with such devices allows not to replace it for 5 days. Many devices have a transparent film through which it is possible to visually control the condition of the catheter and skin. Unfortunately, one fixing device cannot always be used during the entire period of epidural anesthesia. There were frequent situations when multiple attempts were made to puncture the epidural space from several punctures in one intervertebral space, as a result of which a significant amount of wound hemorrhagic discharge accumulated under the device after 24 hours, which subsequently impaired the adhesive properties of the sticker and, accordingly, the ability of the device to hold the EC. We often encounter postoperative cognitive disorders, in which patients exhibit motor restlessness, and this can also lead to detachment of the device, migration of the EC, its loss and termination of EA. Replacing the fixing device is a labor-intensive procedure. To replace a device such as *the Lockit,* it is necessary to completely disassemble the entire catheter fixing structure down to the antibacterial filter. As a result, replacing the device may become a factor leading to catheter dislocation. The midline cannot be considered an ideal place for fixing the EC due to anatomical and physiological features, since this is the projection site of the spinous processes, which are hard bone formations that, when the patient is lying on their back, will create pressure on the skin between the spinous processes, the fixing device, and the surface on which the patient is located. Fixation will be reliable if the device is located on a flat surface, because the pressure on the device will be distributed evenly [13]. Also, along the midline of the chest and back, especially in the interscapular region, the number of sebaceous glands reaches 400 to 900 per square centimeter. These zones are usually called seborrheic [14]. Large sebaceous glands of the first order with maximum sebum production can be found on the back [15]. This feature does not contribute to the reliable fixation of the adhesive device on the skin.

There is no absolutely reliable method of fixing the EC and there is no ideal fixing device. Any sticker, under a certain force and under factors that can disrupt adhesion, can lose its fixing properties. To simplify all of the above, everything that is glued to the skin can come off. The catheter inserted into the epidural space is fixed by the yellow ligament, interosseous, supraspinous ligaments and dermis. When tunneling under the skin, such fixing components as another bend of the catheter at an angle of 90° and subcutaneous placement of the catheter are added. The shape of the back surface in the midline area is anatomically very variable, which also creates inconveniences in fixing the EC with certain anatomical variants.

In this regard, we conducted our own study, which was devoted to studying the shape of the back surface in the midline area in patients who underwent neuraxial blockades at the lumbar level.

MATERIAL AND RESEARCH METHODS

The clinical study was conducted at the traumatology department of the Kotovsk City Clinical Hospital in 2021-2022. 600 patients who were on the operating table before neuraxial blockades during surgical interventions for fractures of the lower extremities were examined. The patients were on the operating table in a sitting position with a bent back. Neuraxial blockades were performed at the lumbar level in the intervals *L2 - L3* and *L3 - L4*. The surface shape study was carried out at the same levels. There were 248 women and 352 men among the patients. The maximum age was 95 years, the minimum was 20 years. Four forms of the back surface were identified:

1. “*V*” shape of the back surface (Fig. 1);
2. “*M*” shape of the back surface (Fig. 2);
3. “L” shape of the back surface (Fig. 3);
4. “—” even shape of the back surface (Fig. 4).

Fig. 1. “V” shape of the back surface

Fig. 2. “M” shape of the back surface

Fig. 3. “L” shape of the back surface

Fig. 4. “—” smooth shape of the back surface

Among the examined patients, there were 75 (12.5%) with the "*V*" shape of the lumbar region of the back, 49 (8%) with the "*M*" shape, 271 (45%) with the "L" shape and 205 (34%) with the "-" smooth shape of the back surface. In our study, it was noted that the frequency of occurrence of various variants of the lumbar region of the back surface in patients depends on the body mass index (BMI) (Table 1).

As can be seen from the table, in patients with body weight deficiency, the "V" shape of the back surface predominates (80%), in normal body weight, the "-" shape (flat surface) predominates (40.7%), in excess body weight, the "L" shape predominates (49.3%) and the "-" flat shape (33%), and in obesity, the "L" shape is more common (68%). Also, in patients with body weight deficiency, the "M" shape does not occur and the "L" shape and "-" flat shape are very rare, 10% each. In patients with obesity, the "V" shape is rare, 1.4%. In patients with normal body weight, the "V" shape is found in almost equal proportions, 21.1%, and the "L" shape, 29.7% of cases.

The level of the spinous processes elevation above the skin surface of the studied area of more than 7 mm and the level of the depression of more than 7 mm were taken by us as the critical value at which deformation of the fixing device occurs, preventing its reliable adhesion to the skin. Based on this indicator, we distributed patients in whom a depression or elevation above the skin surface was detected (Table 2).

Table 1

Variants of the surface shape of the lumbar region of the back in patients depending on body mass index

	Body mass inde, kg/ m^2	In total, *n* (%)	Back shape, *n* (%)			
			«*V*»	"*M*"	"*L*"	«—»
Underweight	No more than 18.4	10 (100%)	8 (80%)	0 (0%)	1 (10%)	1 (10%)
Normal body weight	from 18.5 to 24.9	246 (100%)	52 (21.1%)	21 (8.5%)	73 (29.7%)	100 (40.7%)
Overweight	from 25.0 to 29.9	203 (100%)	13 (6.4%)	23 (11.3%)	100 (49.3%)	67 (33%)
Obesity	from 30	141 (100%)	2 (1.4%)	5 (3.5%)	97 (68.8%)	37 (26.3%)

Table 2

Distribution of patients into groups depending on the size of the depression or elevation of the spinous processes at the lumbar level

Form surfaces of the back	Total	Quantity, *n*	
		Level of elevation or depression no more than 7 mm	Level of elevation or depression more than 7 mm
" *V* " shape	75	65	10
" *M* " shape	49	46	3
" L " shape	271	210	61
"–" flat surface	205	–	–

We also examined the distance between the points of maximum elevation located laterally from the midline on the right and left in patients with the "L" shape of the back surface. This distance is important when fixing with special fixing devices, in which the size of the dense adhesive plate is 55 mm for the *Epi-Fix device* and 40 mm for the *Perifix device*. Accordingly, if the depression is greater than 7 mm, and the distance from the points of maximum elevation on the surface of the lumbar region to the right and left of the midline is less than the size of the dense adhesive plate of the device, then fixation of the EC along the midline will be considered absolutely inconvenient. In our study, 12 patients were identified who had this combination.

RESULTS AND DISCUSSION

Depending on the shape of the surface and the size of the depression or elevation at the site of epidural access, the fixation site can be absolutely convenient, relatively convenient, relatively inconvenient, and absolutely inconvenient. There were 205 patients (34%) in whom we defined the fixation site of the epidural graft as absolutely convenient, 210 (53.5%) as relatively convenient, 62 (10.3%) as relatively inconvenient, and 12 (2%) as absolutely inconvenient. Results research presented in Table 3.

When choosing the method of fixing the EC, the anesthesiologist-resuscitator takes into account the expected duration of prolonged epidural analgesia. There are no clear criteria for deciding on the issue of performing tunnel fixation of the EC. We believe that if prolonged EA is planned for more than 3 days, it is better to perform subcutaneous tunnel fixation of the EC.

Also, when choosing the method of fixing the EC, it is necessary to take into account the anatomical features of the back surface in the area of epidural access. The more uneven the shape of the back surface in the area of epidural access, the greater the likelihood of disruption of the adhesion of the fixing device to the surface of the patient's skin. This, in turn, can lead to dislocation of the EC up to the loss of the catheter and termination of epidural anesthesia.

Table 3

Convenience of fixing the epidural catheter depending on the shape of the back surface at the lumbar level

Convenient fixation	Surface of the back				Total
	"*V*" shape	"*M*" shape	"L" shape	"–" form	
Absolutely convenient	0	0	0	205	205 (34.2%)
Relatively comfortable: the level of elevation or depression is no more than 7 mm and the distance between the points of maximum elevation on the surface of the lumbar region to the right and left of the midline is more than 55 mm	65	46	210	0	321 (53.5%)
Relatively uncomfortable: the level of elevation or depression is more than 7 mm and the distance between the points of maximum elevation on the surface of the lumbar region to the right and left of the midline is more than 55 mm	10	3	49	0	62 (10.3%)
Absolutely uncomfortable: the level of elevation or depression is more than 7 mm and the distance between the points of maximum elevation on the surface of the lumbar region to the right and left of the midline is less than 55 mm			12		12 (2%)

Also, a violation of the tightness of the fixing device and dislocation of the catheter can contribute to infection of the tissues surrounding the catheter and lead to infectious neurological complications.

Internal migration of the EC is dangerous due to such complications as injury to the vessels of the epidural space with the formation of an epidural hematoma. To prevent EC prolapse, it is proposed to insert the catheter deeper into the epidural space. A number of authors have studied the ideal depth of EC placement. In particular, there is an opinion that for catheters with side holes, the ideal depth of placement is 5 cm [16]. The authors of this study noted inadequate analgesia in 24 patients out of 100, in whom the catheter was inserted by 3 cm. However, it should be taken into account that deep insertion of the catheter increases the risk of nodulation, accidental intravascular penetration, and unilateral block. Therefore, this strategy is less preferable than more reliable fixation of the catheter using tunneling. The positive properties of conducting EC in the subcutaneous canal are the lengthening of the internal part of the EC by 70-80 mm (the further from the epidural space the EC exit onto the skin is located, the lower the risk of neurological infectious complications) and the exit of the EC onto the skin surface lateral to the medial line by 70-80 mm, and in this area the surface shape is always smooth. The presence of the EC in the subcutaneous canal itself is a fixing component in addition to its fixation by the yellow ligament. Also, a stronger fixation of the EC is facilitated by the appearance of another bend at an angle of 90° (in total, there are three such bends: the first in the epidural space, the second at the exit onto the skin at the site of epidural access, and the third at the exit onto the skin from the subcutaneous canal). Tunneled catheters are also easier to use: it is easier to replace the protective fixing sticker, since there is no risk of EC dislocation, whereas there is such a risk when replacing a special fixing device in the area of epidural access [13].

Based on the conducted research, it was established that:

1. The overwhelming majority of patients studied had absolutely convenient (34.2%) and relatively convenient (53.5%) places for fixing the epidural catheter in the area of epidural access, which will facilitate its reliable fixation when using special fixing devices.

2. A smaller number of patients (10.3%) had a relatively inconvenient location of EC fixation in the area of epidural access, which can be considered a relative indication for EC tunneling.

3. A significantly smaller number of patients (2%) had an absolutely inconvenient place for fixation of the EC in the area of epidural access, which can be considered an absolute indication for tunneling of the EC.

From all of the above, it can be concluded that the ideal method of fixing an epidural catheter should provide high-quality long-term analgesia , the ability to control the condition of the catheter and maintain sterility at the site of its installation. The fixing properties of special fixing devices and adhesive stickers should be maintained not only in dry skin conditions, but also when sweat, sebum, blood and edematous interstitial fluid get under the device. Significant deformation of the back surface prevents the correct and reliable functioning of the fixing device, therefore, when choosing a method for fixing an epidural catheter, the doctor must rely on a combination of factors, one of which is the shape of the back surface of the area where catheterization of the epidural space is performed and it is planned to fix the epidural catheter.

CONCLUSIONS

Based on the results of the study of the surface shape of the lumbar region of the back, we determined absolute and relative indications for tunneling an epidural catheter:

1. An absolute indication for fixing an epidural catheter using subcutaneous tunneling is the presence of an absolutely inconvenient fixation site in the area of epidural access in the patient - a combination of a depression greater than 7 mm and the presence of a distance between the points of maximum elevation in the specified area to the right and left of the midline less than the size of the dense adhesive plate of the fixing device (for the *"Epi-Fix" device* this is 55 mm).

2. A relative indication for fixation of an epidural catheter by subcutaneous tunneling is the presence of a relatively inconvenient fixation site in the area of epidural access in the patient, regardless of the size of the depression or elevation of the surface shape at the site of epidural access, the presence of a distance between the points of maximum elevation to the right and left of the midline greater than the size of the dense adhesive plate of the fixation device.

REFERENCES

1. Rawal N. Current issues in postoperative pain management. *Eur. J. Anaesthesiol.* 2016;33(3):160–171. https://doi.org/10.1097/EJA.0000000000000366
2. Ovechkin AM. *Pathogenetic basis for the use of prolonged perioperative epidural analgesia for the prevention of phantom pain syndrome after lower limb amputation. Cand. Med. Sci. Diss. Synopsis* . Moscow; 1995. (In Russ.)
3. Brandsborg B, Nikolajsen L, Hansen C, Kehlet H, Jensen TS. Risk factors for chronic pain after hysterectomy: a national questionnaire and database study. *Anesthesiology* . 2007;106:1003–1012. PMID: 17457133 https://doi.org/10.1097/01.anes.0000265161.39932.e8
4. Nikolajsen L, Sorensen HC, Jensen T, Kehlet H. Chronic pain after Caesarean section. *Acta Anaesthesiol Scand* . 2004;48:111–116. PMID: 14674981 https://doi.org/10.1111/j.1399-6576.2004.00271.x
5. Senturk M, Ozcan PE, Talu GK, Kiyan E, Camci E, Ozyalcin S, et al. The effects of three different analgesia techniques on longterm postthoracotomy pain. *Anesth. Analg* . 2002;94(1):11–15. PMID: 11772793 https://doi.org/10.1213/00000539-200201000-00003
6. Yokoyama M, Itano Y, Katayama H, Morimatsu H, Takeda Y, Takahashi T, et al. The effects of continuous epidural anesthesia and analgesia on stress response and immune function in patients undergoing radical esophagectomy. *Anesth Analg* . 2005;101(5):1521–1527. PMID: 16244024 https://doi.org/10.1213/01.ANE.0000184287.15086.1E
7. Lyuboshevskiy PA, Artamonova NI, Zabusov AV, Denisenko IL. Hemostatic disorders in major abdominal surgery: the role of regional anesthesia. *Regional anesthesia and treatment of acute pain.* 2009;2(3):20–26. (in Russ.)
8. Ovechkin AM. Postoperative Analgesia in Obstetrics and Gynecology: Foreign Guidelines and Our Reality. *Regional Anesthesia and Acute Pain Management* . 2014;8(2):5–16. (in Russ.)
9. Bishton IM, Martin PH, Vernon JM, Liu WH. Factor influencing epidural catheter migration. *Anaesthesia* . 1992;47(7);610–612. PMID: 1626676 https://doi.org/10.1046/j.1365-2044.2000.01547-2.x
10. Clark MH, O'Hare K, Gorringe J, Oh T. The effect of the Lockit epidural catheter clamp on epidural migration: a controlled trial. *Anaesthesia* . 2001;56(9):865–870. PMID: 11531673 https://doi.org/10.1046/j.1365-2044.2001.02089.x.11
11. Ovechkin AM, Karpov IA, Lyuosev SV. *Migration of the epidural catheter as one of the main causes of inadequate epidural analgesia: the nature of the problem and ways to solve it* . (Russ.) Available at: https://medgate.ru /article/103/116703/ [Accessed May 15, 2024].
12. Tripathi M, Pandey M. Epidural catheter fixation: subcutaneous tunneling with a loop to prevent displacement. *Anaesthesia* . 2000;55(11):1113–1116. PMID: 11069341 https://doi.org/10.1046/j.1365-2044.2000.01547-2.x
13. Protsenko DN, Yamshikov ON, Marchenko AP, Emelyanov SA, Cherkaeva AV, Ignatov MA. Tunneling an Epidural Catheter: Pro and Contra. *Transbaikalian Medical Bulletin* . 2021;4:152–166. (in Russ.) https://doi.org/10.52485/1998617320214152
14. Araviyskaya ER, Krasnoselsky TV, Sokolovskiy EV. *Construction of sal'nykh zhelez* . (In Russ.) Available at: https://medeffect.ru/derma/akne0001.shtml [Accessed May 15, 2024]
15. Kalantaevskaya KA. *Morphology and Physiology of Human Skin.* 2nd ed., rev. and add. Kiev: Zdorov'ya Publ.; 1972. (in Russ.)
16. Beilin Y, Bernstein HH, Zucker-Pinchoff B. The optimal distance that a multiorifice epidural catheter should be threaded into the epidural space. *Anesth. Analg* . 1995;81(2):301–304. PMID: 7618719 https://doi.org/10.1097/00000539-199508000-00016

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