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SCIENTIFIC ARTICLE

Teaching practices of thoracic epidural catheterizations in different grade of anesthesia residents[☆]



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KEYWORDS

Residency training;
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Abstract

Background and objectives: In this study, we aimed to clarify the importance of residency grade and other factors which influence the success of thoracic epidural catheterization in thoracotomy patients.

Methods: After the ethical committee approval, data were recorded retrospectively from the charts of 415 patients. All patients had given written informed consent. The thoracic epidural catheterization attempts were divided into two groups as second–third year (Group I) and fourth year (Group II) according to residency grade. We retrospectively collected demographic data, characteristics of thoracic epidural catheterization attempts, and all difficulties and complications during thoracic epidural catheterization.

Results: Overall success rate of thoracic epidural catheterization was similar between the groups. Levels of catheter placement, number and duration of thoracic epidural catheterization attempts were not different between the groups ($p > 0.05$). Change of needle insertion level was statistically higher in Group II ($p = 0.008$), whereas paresthesia was significantly higher in Group I ($p = 0.007$). Dural puncture and postdural puncture headache rates were higher in Group I. Higher body mass index and level of the insertion site were significant factors for thoracic epidural catheterization failure and postoperative complication rate and those were independence from residents' experience ($p < 0.001, 0.005$).

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PALAVRAS-CHAVE

Treinamento em
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Complicações

Conclusion: Body mass index and level of insertion site were significant on thoracic epidural catheterization failure and postoperative complication rate. We think that residents' grade is not a significant factor in terms overall success rate of thoracic epidural catheterization, but it is important for outcome of these procedures.

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Ensino da prática de cateterismo epidural torácico em diferentes anos de residência em anestesia
Resumo

Justificativa e objetivos: Neste estudo o objetivo foi esclarecer a importância do ano de residência e outros fatores que influenciam o sucesso do cateterismo epidural torácico (CET) em pacientes submetidos à toracotomia.

Métodos: Após a aprovação do Comitê de Ética, os dados foram retrospectivamente analisados a partir dos prontuários de 415 pacientes. Todos os pacientes assinaram os termos de consentimento informado. As tentativas de CET foram divididas em dois grupos: segundo-terceiro ano (Grupo I) e quarto ano (Grupo II), de acordo com o ano de residência. Dados demográficos, características das tentativas de CET e todas as dificuldades e complicações durante o CET foram registrados retrospectivamente.

Resultados: A taxa de sucesso global de CET foi semelhante entre os grupos. Os níveis de colocação do cateter, o número e a duração das tentativas não foram diferentes entre os grupos ($p > 0,05$). A alteração do nível de inserção da agulha foi estatisticamente maior no Grupo II ($p = 0,008$), enquanto que a parestesia foi significativamente maior no Grupo I ($p = 0,007$). As taxas de cefaléia durante e após punção dural foram maiores no Grupo I. Um índice de massa corporal (IMC) maior e o nível do local de inserção foram fatores significativos para o fracasso do CET e para as taxas de complicações no pós-operatório, mas independentes da experiência dos residentes ($p < 0,001, 0,005$).

Conclusão: O IMC e o nível do local de inserção foram significativos para o fracasso do CET e para as taxas de complicações no pós-operatório. Pensamos que o ano de residência não é um fator significativo em termos de taxa de sucesso global para o CET, mas é importante para o resultado desses procedimentos.

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Introduction

As a method of choice for analgesic management of thoracic and upper abdominal surgery, thoracic epidural catheterization (TEC) is one of the most difficult procedures in anesthesia practice.¹ Although TEC is a gold standard for thoracotomy pain, it is related to specific complications and contraindications which may limit its' usage.¹⁻⁴ The establishment of balance between anesthesia residency training and safety of patients is ongoing dilemma in anesthesia interventions, especially in TEC.^{5,6} The TEC may also become complicated due to anatomical difficulty and variations. Residency grade and previous experience might be important factors in achieving successful TEC attempt, whereas no exact criteria have been mentioned as regards to timing for initiation of TEC training.⁷⁻⁹ In general, anesthesia residents have sufficient experience on spinal anesthesia and lumbar epidural catheterization before the TEC training, but learning curve of TEC attempts is uncertain.⁸⁻¹¹

Whether residents educated lumbar epidural before TEC or not was not an important factor for experience.¹² TEC is also secure and easy to teach with a very low incidence of serious complications.¹² To the best of our knowledge, the articles evaluating regional anesthesia training of anesthesia residents, in particular focusing on TEC, have been limited. In this study, we aimed to clarify the importance of residency grade and other factors which influence the success of TEC in thoracotomy patients.

Methods

After Ataturk Chest Disease and Thoracic Surgery Training and Research Hospital Ethical Committee approval, data were recorded from the charts of 415 patients who underwent thoracic surgery. Written informed consent associated with surgery and all interventions were provided from patients. According to residency grade, the TEC attempts

Table 1 Demographic data and American Society of Anesthesiology (ASA) physical status of patients in terms of residency grade.

Variables	Group 1 (n = 203) (mean ± SD)	Group 2 (n = 212) (mean ± SD)	p
Age (year)	49.2 ± 15.7	52.6 ± 14.5	0.020 ^a
Gender			0.436
Male	157 (77.3%)	157 (74.1%)	
Female	46 (22.7%)	55 (25.9%)	
BMI (kg/m ²)	25.4 ± 4.0	25.3 ± 4.3	0.899
Distribution by BMI (kg/m ²)			0.546
18.5	7 (3.4%)	7 (3.3%)	
18.5–25	92 (45.3%)	103 (48.6%)	
25–30	76 (37.4%)	66 (31.1%)	
>30 kg	28 (13.8%)	36 (17.0%)	
ASA			0.560
I	3 (1.5%)	1 (0.5%)	
II	106 (52.2%)	113 (53.3%)	
III	94 (46.3%)	98 (46.2%)	

Group I, 2nd–3rd year residents; Group II, 4th year residents; BMI, body mass index; ASA, American Society of Anesthesiology. Demographic data were presented as mean ± SD and distribution of BMI, gender, and ASA were presented as numerical values and percentage.

^a p < 0.05, comparison between groups.

were divided into two groups as second–third year (Group I) and fourth year residency grade (Group II).

All interventions, including TEC, which performed by the residents have been achieved under the supervision of staff anesthesiologists. The failed process was defined as 3 sequential unsuccessful attempts or interventions lasting more than 15 min, Touhy needle related dural puncture, and persistent bleeding from catheter or needle. In case of TEC failure, the staff anesthesiologist performed thoracic paravertebral block at the end of surgery, and postoperative analgesia was provided with multimodal analgesia techniques.

We retrospectively collected demographic data, American Society of Anesthesiology (ASA) physical status, the level and any change of the insertion level, duration and number

of TEC attempts, and all difficulties during TEC. We also reviewed pain charts for the satisfaction of pain management, TEC related postoperative complications which were included kinking, obstruction and dislodgement of the thoracic epidural catheter, hypotension, post dural puncture headache (PDPH), hyperemia at the catheter insertion site, and ipsilateral shoulder pain.

Statistical analysis was performed using SPSS 11.5 for Windows. Descriptive statistic was expressed as mean ± standard deviation, and categorical variables were expressed as case number and percentage. Student-t test was performed to compare mean values in groups. Pearson's chi-square, Fisher's exact test, chi-square or likelihood ratio were performed to evaluate the categorical variables. The effect of residents' experience, patients'

Table 2 Characteristics of thoracic epidural catheterization (TEC).

Variables	Group I (n = 203)	Group II (n = 212)	p
Touhy needle insertion level			0.257
Thoracic 4–5	55 (27.1%)	53 (25.0%)	
Thoracic 5–6	50 (24.6%)	42 (19.8%)	
Thoracic 6–7	42 (20.7%)	61 (28.8%)	
Thoracic 7–8	56 (27.6%)	56 (26.4%)	
Number of attempts			0.320
1	93 (45.8%)	91 (42.9%)	
2	48 (23.6%)	42 (19.8%)	
3	62 (30.5%)	79 (37.3%)	
^a Duration of TEC attempts (min)			0.715
0–5	101 (49.8%)	99 (46.7%)	
5–10	66 (32.5%)	77 (36.3%)	
10–15	36 (17.7%)	36 (17.0%)	

Group I, 2nd–3rd year residents; Group II, 4th year residents.

^a Time between needle insertion and removal after catheter placement. Data were presented as percentage.

Table 3 Patients' satisfaction and difficulties related to thoracic epidural catheterization.

Variables	Group I (n = 203)	Group II (n = 212)	p
Number of insertion level change	46 (23.0%)	72 (35.0%)	0.008 ^a
Bleeding ^b	16 (8.0%)	15 (7.3%)	0.785
Dural puncture	3 (1.5%)	1 (0.5%)	0.366
Difficulty of catheter advance	4 (2.0%)	7 (3.4%)	0.386
Paresthesia	7 (3.5%)	–	0.007 ^a
Complications during TEC	25 (12.5%)	20 (9.7%)	0.370
TEC failure rate	18 (8.9%)	19 (9.0%)	0.973
Patients' satisfaction			0.857
Excellent	103 (50.7%)	102 (48.1%)	
Good	61 (30.0%)	66 (31.1%)	
Moderate	36 (17.8%)	42 (19.8%)	
Bad	3 (0.15%)	2 (0.1%)	

TEC, thoracic epidural catheterization; Data were presented as patients' number and percentage. Group I, 2nd–3rd year residents; Group II, 4th year residents.

^a $p < 0.05$, comparison between groups.

^b Bleeding through epidural catheter or Touhy needle.

age, body mass index (BMI), and level of insertion site on complication during TEC, procedure failure, and TEC related postoperative complications were analyzed by using Univariate Logistic Regression analyses. The effect of all probable risk factors on complication during TEC, procedure failure, and TEC related postoperative complications were analyzed by Multivariate Logistic Regression analysis. Odd ratio (OR) and 95% confidence interval (CI) were calculated for each variables. Statistically significant differences were accepted as $p < 0.05$.

Results

Average age of patients was slightly higher in Group II ($p < 0.020$). There was no significant difference in

terms of gender, BMI, and ASA physical status ($p > 0.05$) (Table 1).

Differences in the Touhy needle insertion level, number and duration of TEC attempts were not significant between the groups ($p > 0.05$) (Table 2). The number of needle insertion level change was statistically higher in Group II ($p = 0.008$). Paresthesia frequency was significantly higher in Group I ($p = 0.007$). There were no statistically difference in terms of bleeding through epidural catheter, difficulty of the catheter advance, and failure rate ($p > 0.05$). Patients' satisfactions were not different between the groups ($p > 0.05$) (Table 3). Distribution of postoperative complications rate was not statistically different between the groups ($p > 0.05$).

The BMI and level of the insertion site were significant factors on TEC failure and postoperative complication rate, and there were independent from residents' experience. Postoperative complication rate was 3.196 times higher in

Table 4 The correlation between residency grade, body mass index (BMI), and the level of needle insertion and thoracic epidural catheterization (TEC) related complications and procedure failure rate.

	Complications during TEC		Procedure failure		Postoperative Complications	
	OR (95% CI)	p	OR (95% CI)	p	OR (95% CI)	p
<i>Experience</i>						
4th year	1.000	–	1.000	–	1.000	–
2nd–3rd year	1.329 (0.712–2.478)	0.953	1.022 (0.499–2.095)	0.953	0.947 (0.464–1.933)	0.882
<i>BMI (kg/m²)</i>						
<18.5	1.000		1.000		1.000	
18.5–25	1.630 (0.338–7.861)	0.543	1.535 (0.172–13.718)	0.701	0.857 (0.100–7.318)	0.888
25–30	1.770 (0.904–3.465)	0.096	2.985 (1.172–7.150)	0.021 ^a	0.905 (0.373–2.194)	0.825
>30	0.686 (0.223–2.111)	0.511	5.673 (2.186–14.728)	<0.001 ^a	3.196 (1.372–7.447)	0.007 ^a
<i>Insertion level</i>						
T7–8	1.000		1.000		1.000	
T4–5	2.099 (0.891–4.943)	0.090	2.025 (0.559–7.334)	0.282	0.660 (0.209–2.088)	0.480
T5–6	1.528 (0.604–3.867)	0.371	3.420 (1.008–11.601)	0.049 ^a	2.904 (1.190–7.088)	0.019 ^a
T6–7	0.977 (0.362–2.639)	0.963	5.204 (1.647–16.449)	0.005 ^a	0.704 (0.237–2.094)	0.528

OR, odds ratio; CI, confidence interval; TEC, thoracic epidural catheterization; BMI, body mass index.

^a $p < 0.05$, comparison between groups.

obese patients according to normal weight patients (95% CI: 1.372–7.447; $p=0.007$).

Postoperative complication rate was also higher in T5–6 group when compared the T7–8 group (OR, 2.904; 95% CI: 1.190–7.088; $p=0.019$) (Table 4). The TEC failure rate was significantly higher in overweight patient (OR, 2.985; 95% CI: 1.172–7.150), ($p=0.021$) and obese patients (OR, 5.673; 95% CI: 2.186–14.728), ($p<0.001$) when compared to normal weight patients. Failure rate was also increased in T5–6 level (OR, 3.420; 95% CI: 1.008–11.601; $p=0.049$) and T6–7 (OR, 5.204; 95% CI: 1.647–16.449; $p=0.005$), according to T7–8 level (Table 4). There was no correlation between complication during TEC and residents experience, patients' age, BMI, and level of insertion site ($p>0.05$) (Table 4).

Conclusion

In present study, retrospective analysis of 415 TEC attempts showed that BMI and level of insertion site were considerable factors for procedure failure and postoperative complication rate. Although absence of serious neurological complications, paresthesia was more frequent in 2nd–3rd residents. Dural puncture and PDPH rates were also higher in this group.

Various reports have been published to determine the sufficient epidural catheter attempts for residency training, but number of attempts to achieve adequate experience is still unclear.^{5,8,9,12} According to the Accreditation Council for Graduate Medical Education, residents should perform 50 epidural catheterizations during training in anesthesiology.¹³ On the other hand, at least 20–25 epidural blocks are necessary to achieve consistency in residency training in anesthesiology.⁹ Recommended minimum number of lumbar epidural catheterization prior to TEC training in literatures is limited. In our department all residents perform at least 20 lumbar epidural catheter insertions before the TEC training. All attempts are performed under the supervision of staff anesthesiologist.

Midline or paramedian techniques may be preferred for TEC. Approximately fifty percent of anesthesiology programs teaches both midline and paramedian approaches in United States.¹² Midline approach had a higher success rate and required fewer attempts than the paramedian approach.⁹ In another study, researchers did not find any differences in success of the first attempt or number of attempts for either type of block, regardless of the approach.¹⁴ Advantages or disadvantages of midline or paramedian approach during TEC have been mentioned by the authors.^{12,15} We preferred midline approach and our residents were comfortable while using this approach and hanging-drop technique for TEC. Loss of resistant and hanging drop techniques are used to detect epidural space. Hanging drop technique was safe and comfortable on sitting position due to high negative pressure at thoracic level.¹⁶ We also performed all catheterizations in sitting position by using hanging-drop technique.

No exact criteria have been mentioned in the articles in terms of duration and number of TEC attempt to define the procedure failure. Two unsuccessful attempts or single attempt required more than 10 min was determined as procedure failure in a large number lumbar and low-thoracic

epidural catheterization study.¹⁷ In the present study, we defined the failure as 3 unsuccessful attempts or the procedure lasting for more than 15 min. Our criteria for procedure failure were more flexible than this study due to technical difficulties of mid-thoracic TEC.¹⁷

The BMI is one of the most important factors for epidural catheterization. Correct identification of the anatomical landmarks in TEC is the first step for successful catheterization without severe complications. Main challenges in performing regional anesthesia in obese patients are the appropriate landmark identification, the correct patient positioning, and the use of appropriate equipment.¹⁸ The lack of these issues may increase the failure rate in neuroaxial blockade. Our study indicated that the success rate of TEC was conversely correlated in overweight or obese individuals, and it was independent from residency grade. We think that subcutaneous fat tissue might affect negatively the identification of landmark in obese and overweight patients.

Mid-thoracic epidural catheter insertion is adequate to provide anesthesia and postoperative analgesia for thoracic surgery.¹⁴ Extreme upward angulations' of the Touhy needle makes insertion more difficult particularly in the mid and high thoracic regions.¹⁸ To the best of our knowledge no recommendation about success rate of TEC related to level of insertion site in mid-thoracic region in articles. We performed all TEC placements at mid thoracic levels, and we found significant differences with respect to level of insertion site. Compared to T7–8 level, failure rate was more frequent in upper mid-thoracic regions. It could reflect the difficulty of procedure at higher mid-thoracic region. Advanced researches may be helpful to identify the optimal level for insertion included this area.

The TEC related complications is in a wide range, but neurological injuries are the most crucial complication in anesthesia practice. Due to potential neurological sequel, the risk-benefit ratio of thoracic epidural analgesia is controversial.³ Our results showed that the rate of neurological complications was quite low. Paresthesia was observed only 7 patients included in 2nd–3rd year residents group. Dural puncture and PDPH were also higher in this group. Even if success rate of TEC is similar in groups, the high frequency of paresthesia and PDHD could explain the importance of experience and residency grade.

Until now, the associations between the number of TEC attempts and operator experience have been studied by the investigators, but no definitive information was provided. In one study, first-year residents successfully located the epidural space in 76% of cases.⁹ An another study either did not find a significant association between the level of training and first-level success.¹⁴ We found that the number of TEC attempts was higher in 4th year residents group. Considering safety and trauma during epidural attempts might be helpful to eliminate the complications. Less traumatic procedure may be related to operator's experience.¹⁹ We think that the number of attempts may not completely reflect the operator experience on TEC. In our study lower complications with the higher attempts rate in 4th year residents group could explain insignificance of the number of attempts in neuroaxial blockades.

In conclusion, TEA is one of the major components of thoracic and thoraco-abdominal anesthesia and postoperative pain management. In our study, BMI and level of insertion site were significant factors on procedure failure and postoperative complication rate. These factors were independent from residents' grade. Previous lumbar epidural and spinal block experience could be helpful for high success rate on TEC. The incidence of technical difficulties, procedure-related complications, and postoperative complications were quite low during TEC. Although success rate of TEC was similar in both groups, TEC related complications rate was higher in 2nd-3rd year group. It should be related to experience and residents' grade.

Conflicts of interest

The authors declare no conflicts of interest.

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