Original Article

Predicting clinical entry point for thoracic epidural catheter insertion during paramedian approach: A prospective observational study

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Abstract

Background and Aims: Thoracic epidural insertion has high failure rates in the mid-thoracic region due to steep angulation of oblique bending of spinous processes. The preferred skin puncture point for epidural needle insertion in the paramedian sagittal plane with respect to the superior/inferior tip of spinous process or inter-spinous cleft in the mid-thoracic region (T5-8) is not standard. The primary objective of this prospective observational study was to find the skin puncture point which had the best success rate for a successful epidural catheterization. Secondary objectives were to study the number of attempts and passes required to locate epidural space, incidence of failed epidural, and its relationship with patient characteristics and demographics.
Material and Methods: After informed consent, 155 patients planned for general anesthesia with epidural analgesia in the mid-thoracic region were included in the trial. Patient demographics, the details of epidural attempts with respect to anatomical landmarks, distance from the midline, and number of passes in each attempt were noted. Epidural catheterization was considered successful after demonstrating dermatomal band of sensory blockade.
Results: The success rate at different skin puncture sites was not statistically significant ($P = 0.58$). We found a failure rate of 12.9%. Failed epidural catheterization was significantly high in the age group >56 years ($n = 62$ and $P = 0.007$).
Conclusion: In our study, none of the skin puncture points had a significant association with successful epidural insertion in mid-thoracic segments using a para-median approach.

Keywords: Clinical entry point, para-median, Thoracic epidural

Introduction

Thoracic epidural analgesia (TEA) is considered a gold standard for optimal analgesia for major thoracic and abdominal surgery and is a component of enhanced recovery after surgery program.[1,2] Epidural insertion for analgesia has evolved as a safe procedure over years with advances in equipment, technique, and safe use of drugs, for example, local anesthetics.[3] Although newer imaging modalities can ease the epidural placement, epidural insertion is commonly performed by the blind method using surface landmarks as a guide to decide the level of insertion and loss of resistance to either air or saline to locate the entry in the epidural space.[4]

The complications of thoracic epidural include unsuccessful catheter placement, dural puncture, radicular pain, epidural infection, and neurological dysfunctions.[5] Even though it is a commonly performed procedure, it has a significant failure rate in thoracic region (34% for overall failure to 13% for technical failure) due to oblique bending of spinous processes in thoracic area.[6]

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Experts have described the entry point for a successful thoracic epidural identification by paramedian approach as "1 cm lateral to superior tip of spinous process of the chosen space."[7] Conversely some have recommended entry point as "1 cm lateral to the inferior tip of the spinous process."[8] Hence this non-interventional observational study was conducted to determine the exact point for successful epidural space identification in clinical practice at a high-volume cancer center where 8–10 epidural catheterizations are performed daily.

Material and Methods

Following approval from ethics board (IEC 24/08/2020) and registration with Clinical Trial Registry of India (CTRI/2020/09/027745), 155 patients were included in this study after obtaining an informed consent. TEA is a part of the standard practice of care for patients undergoing major and supra major surgeries in our institute. All patients scheduled for upper abdominal and thoracic surgery requiring epidural catheter insertion in the mid-thoracic region (T5-T8) were screened for inclusion and exclusion criteria. Patients with obvious spine deformity and previous spine surgeries were excluded.

After attaching standard monitors in the operating or procedure room and on completion of surgical safety checklist, patients were placed in lateral position for epidural catheter insertion. Para median approach was used in all patients, as routinely practiced. The exact level of epidural catheter insertion (between T5 and T8 level) was decided by the supervising consultant anesthesiologist based on the surgical incision site and best felt spine landmarks.

Each fresh skin puncture was considered as an attempt and any redirection of needle in the same attempt was considered as a pass. For each attempt to locate the epidural space, an independent observer recorded the used anatomical landmark of chosen space (superior or inferior tip of spinous process or interspinous cleft) and the paramedian distance of puncture point. The paramedian distance was noted using the markings on the Tuohy's needle as within 1 cm, 1–2 cm or beyond 2 cm. Number of passes required to locate the epidural space were also noted for each attempt. The reasons of failure of each attempt (e.g. dural tap, bone contact, vascular puncture) were noted. Once the catheter was placed, the distance of puncture point from midline until 1 decimal point was noted using a ruler.

Test dose with adrenaline and local anesthetic was given to rule out intrathecal or intravascular placement of catheter. The attempt was only marked as successful after confirmation of anesthetic band in the postoperative period. Failure would indicate the catheter not being in the epidural space. The reason for abandoning in case of an abandoned procedure was noted. The final result of each epidural attempt was recorded as abandoned, successful or failure. Miscellaneous factors like demographics, BMI, and the quality of anatomical landmarks used to locate a desired level of interspace based on clinical ability to palpate were also recorded.

For primary end point the success was compared with various end points using Chi-square test for univariate analysis and binary logistic regression test for multivariate data analysis. For secondary outcomes, the Chi-square test was used for all the categorical variables. Age groups were categorized as young (18–35), middle aged (36–55) and older adults (above 55).[9] The entire data were analyzed using statistical package for the social sciences (SPSS) software version 22. *P* value less than 0.05 was considered statistically significant.

Results

In four months, from September to December 2020, 267 patients were posted for major thoracic and upper gastrointestinal surgeries. Of these, 155 patients were recruited as shown in Graph 1. Demographic details have been enlisted in Table 1.

Among the recruited patients, successful epidural placement was achieved in the first attempt in 76 patients. The first attempt success

Table 1: Socio-demographic and surgical details

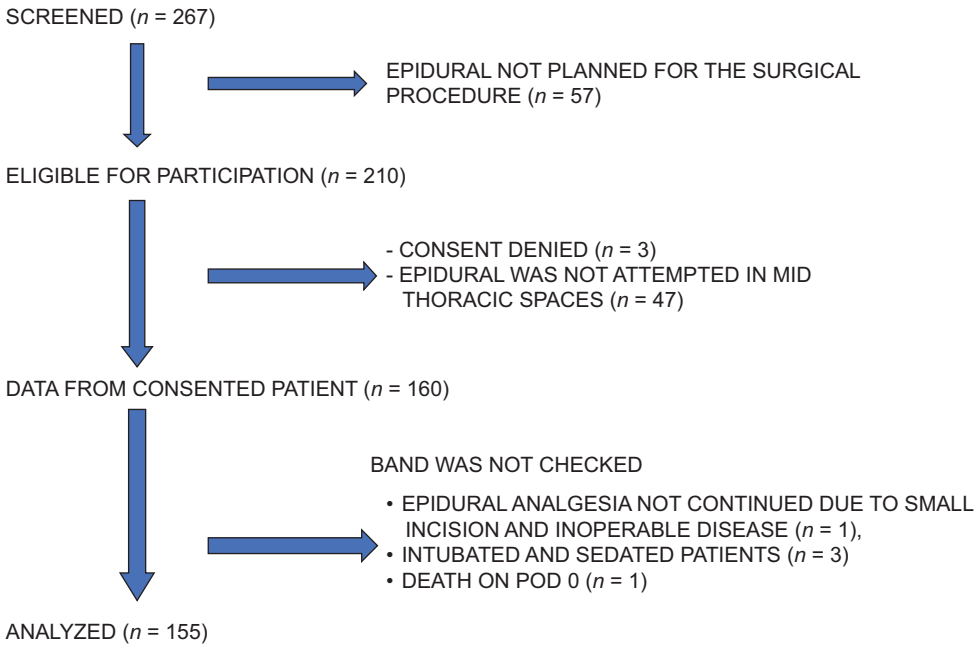
	N	Percentage %
Age (in years)		
Median	51	
Range	18–78	
Gender		
Male	95	61
Female	60	39
ASA Status		
I	78	50
II	66	43
III	11	07
Diagnosis (Malignancy)		
Hepatobiliary	48	31
Esophageal	22	14
Periampullary and gastroduodenal	54	35
Lung mass	27	17
Mediastinal mass	03	02
Renal mass	01	01
Procedures		
Hepatobiliary surgeries	48	31
Pancreatic and gastroduodenal	52	33
Lung reduction	26	17
Esophageal resection	20	13
Exploratory thoracotomy	04	03
Exploratory laparotomy	05	03

rate was 49% ($n = 76$). The analysis of entry point of the first attempt with respect to clinical landmark is summated in Table 2. The overall success rate for epidural catheter insertion in the mid-thoracic space was 84.5% ($n = 131$). Incidence of wrongly placed catheters (band negative epidurals in post-operative period) was 12.9% ($n = 20$). In 2.6% patients ($n = 4$), the epidural procedure was abandoned, and the total failure was 15.5%. Around 92% epidurals among first successful attempts ($n = 70$) were inserted using paramedian to the superior tip of the spinous process. For analyzing the correlation between entry point and success of epidural catheter placement, all the attempts were considered including the unsuccessful attempts. The total number of attempts was 248. The median value for attempts was 1 (IQR 1–2), and the mean value was 1.68 ± 0.93. The success rate was not statistically significant at any particular entry point using anatomical landmarks ($P = 0.708$, evaluated by Chi-square test). The distance from midline for maximum attempts was between 0.5 and 1 cm ($n = 183$). However, the success rate for attempts made at a distance of 0.5–1 cm from midline was not significantly more than the success rates for rest of the attempts, that is, attempts made within 1–2 cm or more than 2 cm from midline ($P = 0.35$).

We looked at age, sex, BMI, and quality of anatomical landmark on epidural outcome (Table 3). The failed procedures were significantly more $P = 0.007$ in older adults (above 56). Effect of quality of anatomical landmarks on epidural outcome was not statistically significant ($P = 0.42$, $P = 0.29$, $P = 0.84$ for spinous process, interspaces, and other bony landmarks, respectively).

Discussion

The overall success rate in our study was 84.5%, with a failure rate of 12.9% as assessed by a negative anesthetic



Graph 1: Patient recruitment chart

Table 2: Outcome of first attempt with respect to midline anatomical landmarks

Category	Outcome of First Attempt		
	Successful	Failed	*P*
Outcome with respect to midline anatomical landmarks			
Superior tip of spinous process	70	68	
Inferior tip of spinous process	5	9	0.485
Interspace	1	2	
Outcome with respect to distance from midline to entry point			
Distance from midline			
0.5–1 cm	71	69	
1–2 cm	5	9	0.347
>2 cm	0	1	

**Chi-square test applied, P<0.05 was considered significant*

Table 3: Effect of age, sex, BMI and quality of anatomical landmarks on epidural outcome

Category	Successful	Failed	Abandoned	*P**
Age (In years)				
Young adults (18–35 years)	16	1	1	0.007
Middle-aged adults (36–55 years)	68	4	3	
Older adults (Above 56 years)	47	15	0	
Sex				
Male	81	12	2	0.862
Female	50	8	2	
BMI				
Underweight (<18.5)	17	1	0	0.833
Normal (18.5–24.9)	73	13	2	
Overweight (25–29.9)	34	5	2	
Obese (30 and above)	07	1	0	
Ease of palpation Spinous process				
Well palpated	120	19	3	0.42
Poorly palpable	11	1	1	
Not palpable	0	0	0	
Interspace				
Well palpated	113	18	2	0.261
Poorly palpable	17	2	2	
Not palpable	1	0	0	
Other bony anatomical landmarks				
Well palpated	127	19	4	0.84
Poorly palpable	4	1	0	
Not palpable	0	0	0	

**Chi-square test applied, P<0.05 was considered significant*

band, and in 2.6% of patients, the procedure was abandoned. However, the first attempt success was 49%. The success rate for attempts was similar with respect to distance from midline (0.5–1 cm/1–2 cm/more than 2 cm from midline) and with respect to different anatomical landmarks (at the level of superior/inferior tip of spinous process/interspinous cleft).

A previous study compared epidural insertion in high (T1-T2) versus mid-thoracic (T5-T6) region.[10] They found that more attempts were required to secure epidural catheter in mid-thoracic group (1.92 ± 1.28) than high thoracic group (1.27 ± 0.45). Also, the mean time required to secure epidural catheter was significantly more in mid-thoracic group. The success of each attempt and failure rate were not mentioned. The study supported the fact that mid-thoracic epidural (T5-T6) was difficult to insert compared to high thoracic epidurals (T1-T2) due to more acute angulation of thoracic vertebra in the mid-thoracic spine.[10]

The thoracic epidural outcome is greatly affected by positioning and approach to the space. A prospective, randomized, comparative study found para-median approach easier and associated with lesser incidence of complications for lower thoracic epidural space. Also, paramedian approach was observed to have less epidural catheter tenting and more reliable cephalad catheter threading than midline approach.[11] In our study, all the cases were done in lateral decubitus with paramedian approach to locate epidural space.

Needle puncture point for thoracic epidurals by paramedian approach is specified along superior tip of spinous process.[7] McLeod in a review article quotes the skin puncture point as inferior tip of the spinous process.[8] Both recommendations are made for 1 cm paramedian distance. Results from our study suggests that there is neither a single clinical puncture point with respect to superior or inferior tip of spinous process nor a specific paramedian distance for successfully identifying epidural space in mid-thoracic segments using a paramedian approach.

Previous study on factors associated with difficult neuraxial block reported that ease of block and more first puncture success rate was obtained in patients with lower body weight and body mass index. Spine deformity poor identification of interspinous space was associated with multiple attempts due to failure.[12] Authors in the same study also found that the epidural was easier to perform in younger patients than older patients. In our study, we found significantly high failed epidurals in older adult patients (age >56 years). The chances of spine deformity and stiffness of ligaments increases with age and the compliance for proper positioning for epidural probably reduces with advance age.[12] This could explain the relatively high failure rates in the elderly patients.

The method used to locate the entry in epidural space in our study was "Loss of Resistance (LOR)" to air (N = 150) or saline (N = 5). Although easy to perform and commonly used method to locate epidural space, LOR to air or saline technique is associated with significant false positive rates.[13] Previous study has reported the failure rates of epidural procedure in thoracic region as 32%.[4] The details with respect to approach were not mentioned.[14] Technical failure rate stated by McLeod for TEA is 13%.[15] Apart from anatomical differences, this variable estimate of failure rate can also be attributed to non-uniformity in outcome measures used.[6] Most of the literature mention pain scores rather than confirmation of dermatomal anesthetic band. Modalities like ultrasound, epidural waveform analysis, fluoroscopy may be considered for successful epidural catheter placement.[6] Since specific modalities for confirmation were not used, in our study, we considered a positive demonstration of anesthetic band as the sign of functional epidural analgesia.

There are few limitations to this study. Due to limited literature about the same topic, an observational study was done. The clinical puncture point was selected by the performer. Therefore the results are clustered around certain puncture point. We had a success rate of only 49% in the first attempt. Ours being a teaching hospital, the operators had varied levels of experience. However, we do not feel this would affect the impact of this study, as outcome of all attempts were considered in the final analysis.

To improve the outcome with respect to successful placement, other modalities like ultrasound, fluoroscopy can be utilized. Clinical feasibility for fluoroscopy guided epidural block in midthoracic region has been studied.[16] The investigators found it as easy and safe procedure which needs further study on other alternative methods. However, procedure time, availability of C-arm, and performer's learning curve are few drawbacks with this method. The use of ultrasound and real time visualization of epidural needle can also improve the success. A trial conducted by David Auyong *et al.*[17] shows that ultrasound guided thoracic epidural placement reduces number of needle puncture sites and post-operative pain scores as compared to palpatory method. We have initiated a randomized trial evaluating the role of ultrasound in the midthoracic region.

Conclusion

We conclude that there is no single clinical skin puncture point with respect to superior or inferior tip of spinous process for successful epidural insertion in mid-thoracic segments using a paramedian approach.

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Conflicts of interest

There are no conflicts of interest.

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