Scientific Research Publishing

Open Journal of Anesthesiology, 2024, 14, 131-135
https://www.scirp.org/journal/ojanes
ISSN Online: 2164-5558
ISSN Print: 2164-5531

A Structured Method of Teaching Epidural Block Reduces the Incidence of Accidental Dural Puncture in Inexperienced Trainees

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How to cite this paper: Scorzoni, M., Gonnella, G., Capogna, E., Campione, M., Draisci, G., Velardo, M. and Capogna, G. (2024) A Structured Method of Teaching Epidural Block Reduces the Incidence of Accidental Dural Puncture in Inexperienced Trainees. *Open Journal of Anesthesiology*, **14**, 131-135.
https://doi.org/10.4236/ojanes.2024.144011

Received: March 28, 2024
Accepted: April 21, 2024
Published: April 24, 2024

Abstract

Background: The rate of accidental dural puncture is particularly high during the period of training, especially in novices. The structured epidural teaching model (SETM) includes three standardized video lessons, the construction of a 3D epidural module by trainees and practical training by using an epidural simulator with and without the CompuFlo™ Epidural instrument. In this study we report the retrospective analysis of the accidental dural puncture rate of inexperienced trainees during their 6 months clinical practice rotation in obstetrics before and after the introduction of the SETM in our Institution. *Method*: We evaluated the incidence of accidental dural puncture before the introduction of the SETM methodology and afterwards by analyzing our departmental database from February 2019 to January 2023. All epidural blocks were executed by trainees who had never previously performed an epidural block and were about to begin their obstetrics rotation. *Results*: We analyzed 7415 epidurals: 3703 were performed before the introduction of the SETM methodology (control group) and 3712 afterwards (study group). The incidence of accidental dural puncture was 0.37% for the control group and 0.13% for the study group ($p < 0.05$). The probability of making an accidental dural puncture was 64% (OR: 0.36) lower for trainees who had the training than for those who did not. *Conclusions:* After the introduction of the structured teaching method, we observed a significant reduction of accidental dural puncture during the training period. We hope that our observation will encourage a constructive discussion among experts about the need to use standardized and validated tools as a valuable aid in teaching epidural anesthesia.

Keywords

Anesthesia, Epidural, Obstetrical, Teaching

1. Introduction

It has been reported that trainees require approximately 50 attempts to achieve epidural competence [1], but it is not clear how many epidurals are needed for a trainee to reach a reasonably low rate for accidental dural puncture. It is commonly believed, and it is a common observation, that the rate of accidental dural puncture is particularly high during the period of training, especially in novices.

The incidence of accidental dural puncture has been reported to be as high as 3% in novice trainees and to decrease once trainees progress past the "novice" training stage [2].

It is therefore essential to practice a teaching method that may reduce and prevent, as much as possible, accidental dural puncture when the epidural block is given by novices during their first few months of hands-on patient learning, in order to expose patients to this complication as little as possible.

A structured epidural teaching model (SETM) has now been fully updated and described in detail [3]. It includes three standardized video lessons, the construction of a 3D epidural module by trainees and practical training by using an epidural simulator with and without the CompuFlo®Epidural instrument.

In one previous study [4] we demonstrated that using this Structured Epidural Teaching Method (SETM) may improve the learning curve (CUSUM) for lumbar epidural block in entirely inexperienced anesthesia trainees, the percentage of trainees who reached the competence being significantly greater in the group who underwent the SETM.

In this study we report the retrospective analysis of the accidental dural puncture rate of inexperienced trainees during their 6 months clinical practice rotation in the labor and delivery suites before and after the introduction of the SETM in our Institution.

2. Methods

We analyzed the incidence of accidental dural puncture before the introduction of the SETM methodology (Appendix) and afterwards by analyzing our departmental database from February 2019 to January 2023.

All epidural blocks were executed by trainees who had never previously performed an epidural block and were about to begin their obstetrics rotation.

For the purpose of this study we retrospectively reviewed the departmental database and the database of our clinical protocol registered at Clinical.Trial.Gov (ID n. NCT04749186) and approved by the Ethics Committee of Fondazione Policlinico Gemelli IRCCS, Rome (approval n 0017199/21).

A logistic regression model was applied to investigate a possible dependency

relationship between the probability of accidental dural puncture and the group.

A post hoc power analysis was conducted to verify the power of the test (z test—Logistic Regression). By setting a significance level $\alpha = 0.05$, based on the results obtained (OR: 0.36), the number of epidurals analyzed was sufficient to ensure that the power of the test was greater than 90%.

3. Results

We analyzed 7415 epidurals performed at the Department of Obstetric Anesthesia of the Policlinico Gemelli, Roma, in the years 2019-23. 3703 were performed before the introduction of the SETM methodology (control group) and 3712 afterwards (study group).

During the retrospective observation period there were no significant changes in either the clinical activity performed, the type of patients treated, or the staff involved, except for the introduction in the years 2022/23 of the training with the SETM method.

The incidence of accidental dural puncture was 0.37% for the control group and 0.13% for the study group (overall incidence: 0.25%).

A statistically significant ($p < 0.05$) dependency relationship was inferred; the probability of making an accidental dural puncture was 64% (OR: 0.36) lower for trainees who had the SETM training than for those who did not.

4. Discussion

Even today, the typical teaching of epidural catheter placement in obstetric anesthesia often consists of a mix of theoretical didactic training and practical experience, in which student and master tackle the task together in the clinical setting, on the patient, which is used as a learning model.

The method of teaching is not usually standardized, is hardly formalized and institutionalized, and is extremely variable among different Institutes.

A recent analysis of the trainee curricula in six different countries reported that implementation of new educational methods is variable, incomplete, and lacking in data related to patient outcomes [5].

We have now introduced the SETM into our routine teaching practice which uses audiovisual systems, anatomical model building, practice with the simulator and with an instrument that visualizes the pressure curves that the epidural needle elicits within the tissues that are traversed by the epidural needle (CompuFlo®). After the introduction of such a structured teaching method we observed a significant reduction of accidental dural puncture during the training period, which has been halved.

We believe that as practical and interactive an approach as possible before proceeding to the hands on the patient may be of benefit for both the trainee and the patient.

We are certainly aware of the retrospective nature of this report and of the well-known limitations of this kind of studies.

In addition, the results of this study are applicable to novice trainees only, since we did not study the more expert trainees or the staff.

However, we hope that our observation will encourage a constructive discussion among experts about the need to use standardized and validated tools as a valuable aid in teaching epidural anesthesia.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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Appendix

The Structured Epidural Teaching Method (SETM) [3] includes three modules:

Module 1

The first module aims to change the trainee's knowledge from a two-dimensional to a 3-dimensional vision of the epidural region anatomy by using a standardized video recording. In this videoclip lumbar anatomy is explained by using vertebral models. During and after watching the video, trainees must set up an epidural region plastic model with various plastic materials representing the ligaments. After the construction of the epidural model, more detailed information and comparison with the information contained in the anatomy texts and the micro and macroscopic anatomy of the anatomical structure involved in the lumbar epidural block is provided. An instructor is present to assist the trainee in setting up the model and answer questions.

Module 2

The second module consists of a video to familiarize the trainees with the materials and explain the basic principle of the epidural technique. After the video the trainees perform a practical exercise to appreciate the increase and the loss of the resistance with a Tuohy needle, a syringe, and a silicone cube. Discussion and clarification with the participants on the general principles ends this section.

Module 3

The third module uses an epidural simulator as a task trainer through which the Tuohy needle is passed with and without the help of the CompuFlo®. The aim is to let trainees appreciate and know how to recognize the differences in resistance offered by the fabrics encountered by having objective feedback.

Using the CompuFlo® [6], the entry of the needle into the ligamentum flavum is indicated by a great increase in pressure on the visual display with a simultaneous increase of the pitch of the audible tone, while the entry of the needle into the epidural space results in a brisk drop in pressure and a distinct fall in the tone of the audio output. A drop in pressure sustained for more than 5 seconds is consistent with entry into the epidural space. Comprehensive information on the use of the CompuFlo Epidural® has been reported in previous studies [3] [7] [8].

Typical curves, comparable with that obtained in the humans [7], may be obtained, and graphs illustrating the procedure were recorded and eventually examined by each trainee performing the block, to discuss the correlation between the trainee's tactile sensations, the acoustic advice, and the visual display of the pressure waveforms.

This third module also includes the projection of an eye movement modeling example (EMME) which is a video which depicts an epidural block demonstration performed by experts, with their eye movements (previously recorded by eye tracking) superimposed on the task [9].