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To study and compare the reliability of four different techniques for identifying the correct needle placement in caudal epidural space-loss of resistance, whoosh test, swoosh test and nerve stimulation in paediatric age group

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ABSTRACT

Background: Precise knowledge of anatomical land marks of sacral hiatus and the proper identification of the epidural space is indispensable for successful caudal epidural anaesthesia. **Aim:** To test the reliability of loss of resistance, whoosh test, swoosh test and nerve stimulation in identifying the correct caudal needle placement in children. **Methods:** 40 children aged between 1-6 years with ASA-I and ASA-II undergoing infra umbilical surgical procedures studied. On completion of surgery under general anaesthesia, neuromuscular blockade was reversed and caudal given. Nerve stimulator needle was inserted with Loss of Resistance (LOR) as reference and gradually current increased until a motor response visible in the anal sphincter (S2-S3). Then, whoosh and swoosh test performed by another observer blinded and local anaesthetic given using Armitage formula. **Results:** LOR was appreciated in 34 (85%) patients. Elicitation of nerve stimulation test was positive in all 40 (100%) of patients. The mean current used was 7.47 ± 2.52 mA. The whoosh test (1ml of air) and swoosh test was positive in all 40 (100%) of the patients. In one patient sacral hiatus could not be identified. The most frequent difficulty noticed was multiple attempts in six out of 20 cases. **Conclusion:** LOR technique requires experience, thus not a good teaching tool for beginners. Nerve stimulator is an excellent objective tool however; limited availability and time constraints make its use impractical. Whoosh and swoosh are the preferred clinical techniques if ultrasound is unavailable.

Key words: Caudal, Loss of Resistance, Nerve Stimulator, Swoosh, Whoosh

INTRODUCTION

The secret to successful caudal epidural anaesthesia is the accurate placement of right dose of local anaesthetic drugs in the correct anatomical location. The successful caudal epidural anaesthesia depends upon the ability to locate anatomical land marks of sacral hiatus and the proper identification of the epidural space. In adults, the success rate may be as low as 75%[1] but overall success rate in children is in the order of 96%[2] as the anatomical landmarks tend to be more reliable[3]. However, even in skilled hands of consultants misplacement of the needle and complications are possible. Several researchers across the world have devised various methods to correctly identify the caudal epidural space in children. Considering the varied success of different techniques, we carried out the present study with an aim to improve the success rates of caudal block in children by correctly identifying the caudal epidural space especially in teaching hospitals

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where there is no ultrasound available. In our study, we compared the reliability of four different techniques- loss of resistance, whoosh, swoosh and nerve stimulation in identifying the correct caudal needle placement in paediatric patients.

METHODS

After approval of Institutional Research and Ethical Committee this study was carried out in 40 ASA-I and ASA- II children aged between 1–6 years undergoing infra umbilical surgical procedures at our institute. All children were pre-medicated with 0.5 mg/kg midazolam syrup per orally (maximum 10 mg), 30 min before induction of anaesthesia. Oxygen saturation, electrocardiography, systolic blood pressure and heart rate values were monitored preoperatively as well as intraoperatively. Before induction atropine 0.02 mg/kg given intravenously followed by thiopentone 5–6 mg/kg and tracheal intubation was facilitated by atracurium 0.5mg/kg. Anaesthesia was maintained with 66% nitrous oxide in oxygen and halothane 0.5–0.8%. In addition, fentanyl 2 mcg/kg was used for analgesia and muscle relaxation was maintained with atracurium 0.1 mg/kg. Ventilation was manually controlled using Jackson-Ree's breathing circuit. After completion of surgery, neuromuscular blockade was reversed with neostigmine 0.05 mg/kg and atropine 0.02mg/kg but patients were kept intubated and depth of anaesthesia was maintained with N_2O: O_2: Halothane. The children were placed in left lateral position a 40 mm insulated nerve stimulator needle was inserted through sacral hiatus till Loss of Resistance (LOR) felt. Then, needle was connected to nerve stimulator and electric stimulation was started with 1 mA current at 1 Hz frequency followed by gradual increase in the current to a maximum of 20 mA or until a motor response or twitch was visible in the anal sphincter (S2-S3). The nerve stimulator cable modification was done from NMJ mode to deliver current up to 20 mA. The electric stimulator was removed and whoosh test was performed with 1 ml of air after confirming negative aspiration for blood and CSF followed by injection of 1 ml of 0.2% ropivacaine given rapidly after confirming again for negative aspiration to rule out needle displacement. The auscultation was done over L_5-S_1 space and the observer was blind to both whoosh and swoosh test. The volume of local anaesthetic solution was given (one ml/kg calculated by using Armitage formula[4]) if any of the four technique was positive.

The children were awakened and the level of sensory blockade was assessed using pin prick method after 10–15 min. The children were shifted to the ward from recovery room after 4 segment regression of sensory level or after 2 hours, whichever was later. Postoperative analgesia, if required in recovery room, was administered in the form of paracetamol 15 mg/kg intravenously followed by oral syrup of ibuprofen 0.5 mg/kg (after establishment of feeding).

RESULTS

Forty percent of children in our study group belonged to 3-4 years of age and 82.5% of the patients in our study group were male children as shown in Figure 1. Herniotomy was the most commonly performed surgery in 62.5% cases. 52.5% of children had weight between 11–15 kg shown in Figure 2. The mean value of body weight was 12.42 kg. The mean volume of 0.2% ropivacaine given was 12.42 ± 2.72 ml. The peak sensory level attained was T_4 as shown in Figure 3.

The values of vital signs at the time of administering caudal block were taken as baseline. After extubation, it took around 15–20 minutes for the vitals to get stabilized and this time corresponds to the onset of caudal block as well. LOR was appreciated in 34 (85%) patients and in 6 patients (15%) LOR could not be appreciated. Five of these failures were seen in first 5 cases and all these required 3–4 attempts each to appreciate LOR. Elicitation of nerve stimulation test was positive in all 40 (100%) of patients. The mean current used was 7.47±2.52 mA. The whoosh test (1ml of air) was positive in all 40 (100%) of the patients. The swoosh test was also positive in all 40 (100%) of the patients. In one patient sacral hiatus could not be identified. Three patients had bloody tap so the procedure was abandoned and these patients were excluded from the study. The overall incidence of inability or failure in administering the caudal block was (10%) encountered in 4 out of 40 patients. The most frequent difficulty noticed was multiple attempts (max. 3 attempts) in six patients out of first 20 cases.

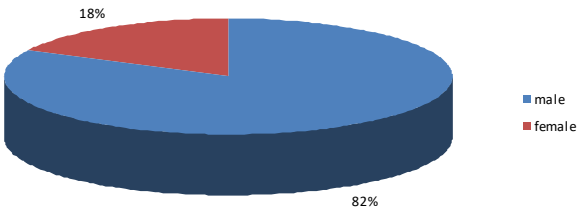

Figure 1: Gender distribution.

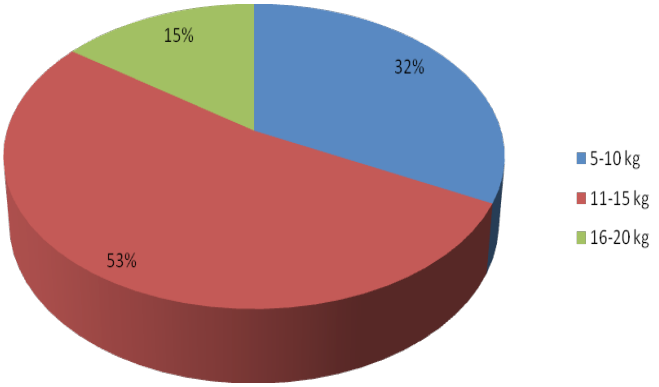

Figure 2: Weight distribution.

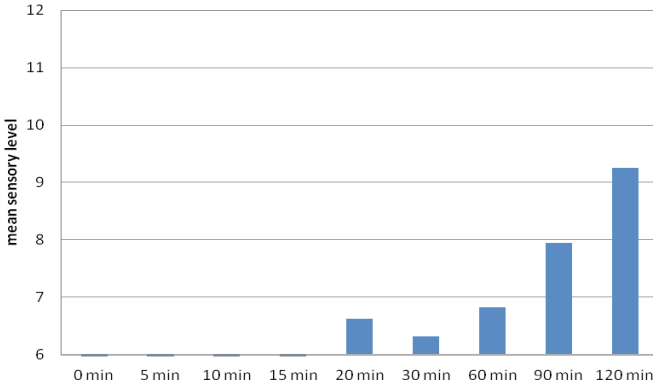

Figure 3: Mean sensory blockade levels.

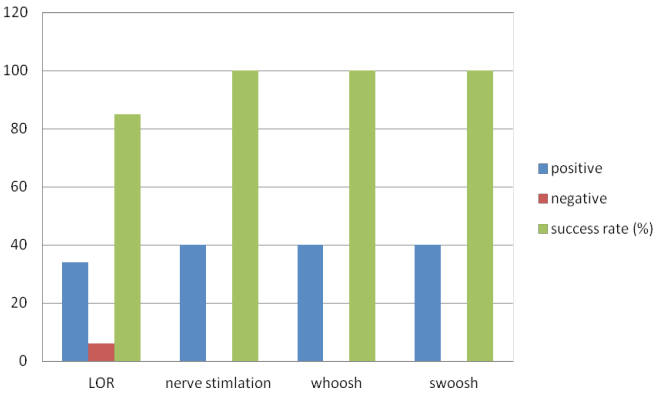

Figure 4: Outcome of different techniques used.

DISCUSSION

The success rate of LOR technique in our study group was 85% (34 patients) with failure in 6 patients in comparison to a study reporting the success rate of clinical judgement alone to be 47% in inexperienced hands of trainee anaesthetists and 62%[5] in consultant hands. The higher success rate in our study group could be attributed to well verse consultant anaesthetists performing the block and the use of short bevelled needles providing better appreciation of LOR. In a study conducted by Lewis *et al*[6]. 19 patients out of 26 patients showed positive whoosh test (2 ml) and the correct needle placement on epidurogram but in our study 100% sensitivity of whoosh test in detecting correct needle placement in caudal epidural space can be attributed to auscultation over the lower lumbar spine (L_5-S_1) and the smaller length of the vertebral column in children in comparison to the adults despite of the fact that we injected only 1ml of air. Although till date no study has been done to find out the safe volume or rate of air administration to avoid significant hemodynamic alteration in humans. Therefore we preferred using 1 ml of air for eliciting the 'whoosh' test to avoid the risk of VAE or any neurological damage. Talwar V *et al*[6] also used 1 ml of air or saline for eliciting whoosh and swoosh test observed that the sensitivity specificity and positive predictive value of whoosh test was 100%. Our findings having 100% sensitivity are in accordance with the adult studies which performed auscultation on lumbar spine. Orme RMLE and Berg SJ[7], reported swoosh technique as 90% sensitive, 100% specific and having positive predictive value of 100%. Smaller size patients, auscultation over L_5-S_1 which corresponded to the area immediately above the tip of the needle used for injection and use of narrower needle causing more turbulence probably would have contributed to higher rate (100%) of positivity in our study. We have auscultated the injection of 1 ml of local anaesthetic initially to avoid the risk of systemic toxicity in case of inadvertent intravascular injection.

In a study conducted by Singh M and Khan RM[8], 12 (80%) out of 15 patients showed positive motor movements in response to peripheral nerve stimulation and 2 patients (13.3%) reported only positive sensory sensations (tingling etc.) despite reaching 20 mA current stimulation; but all of them developed adequate analgesia. Since all of our patients were under general anaesthesia at the time of testing of all the four techniques no such complaints could be recorded. Mean value of the current in our study was 7.47± 2.52mA which is much lower than the one used by Singh M and Khan RM[11].

According to Talwar V *et al*[6] the sensitivity, specificity and positive predictive value of the 'whoosh' test and clinical predictors of caudal placement was found to be 100% whereas the modified 'swoosh' test had a sensitivity of 93%, specificity of 50% and a positive predictive value of 96%. Relatively larger size of the patients and higher level of auscultation in the subjects might have been responsible for the lower sensitivity of swoosh test in their study.

Dave NM and Garasia M[9] found the anal sphincter tone had the highest predictive value of 99.5% followed by heart rate response 98.48% and swoosh test 93.92%. Thus, the author concluded that heart rate response is an immediate predictor of successful needle placement and lax anal sphincter is best predictor of successful caudal epidural block. Though this study showed positivity of 93.92% on swoosh test other assessment parameters were subjective and the patients received block under general anaesthesia which could also have affected the results in this study. In our study, we used more objective pin prick method for assessing the effectiveness of the block. Moreover the block was administered just before the termination of general anaesthesia so the subjects were awake. And hence our assessment was definitely more objective.

A comprehensive review of literature reveals number of techniques for ascertaining the correct placement of needle in caudal epidural space; LOR, whoosh, swoosh, imaging, ultrasonograpy[10-13], fiberoptic guided insertion[14] nerve stimulator and bi-digital pressure[15]. In addition to technical issues, all the techniques have varying success and failure rates. But no clear benefits of these techniques have been shown against clinical assessment. Furthermore only a couple of studies have compared two different techniques and as such which of the techniques is better than the other techniques remains unanswered. More studies involving comparison of different techniques are seemingly warranted. Recently many studies are conducted using ultrasound to visualize caudal space and assess spread of local anaesthetics into that space. Ultrasound and fluoroscopy as a guide to needle placement have been known to reduce failure rate to minimal. But, availability, cost factor and time constraint tends to limit the use of these procedures.

Thus, we conclude that the LOR technique requires experience and so may not be a very good choice as a teaching aid for the beginners compared to other objective tests to identify correct needle placement in caudal epidural space. LOR, whoosh and swoosh all three tests are convenient and easy to use though limited availability, time and cost constraints may make the use of nerve stimulation practically difficult despite being an excellent objective teaching tool. The use of whoosh test in paediatric patients is still questionable because of safety concerns. Thus swoosh test is a safe, cost effective and less time consuming alternative to whoosh test and nerve stimulation test to correctly identify the caudal epidural space in paediatric patients.

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