Original Article

Use of ultrasound to estimate the prevalence of occult spinal dysraphism in children undergoing urogenital and anorectal surgeries: A cross-sectional study

Ann Sumin Toms, Ekta Rai[1], Novin Chacko John[2], Jyoti Panwar[3]

Asst. Professor, [1]Professor and Head, [2]Senior Registrar, Department of Anaesthesiology, [3]Professor, Department of Radiology, CMC Vellore, Tamil Nadu, India

Abstract

Background and Aim: The use of ultrasound has immensely increased the safety toward regional blocks and central venous access and has been considered as the standard of care for securing central access. The aim of this study is to estimate the prevalence of occult spinal dysraphism using ultrasound in children less than 2 years of age undergoing elective urogenital or anorectal surgery.

Material and Methods: The lumbosacral region of 159 American Society of Anesthesiologists (ASA) category I/II patients, posted for elective urogenital and anorectal surgery was scanned with ultrasound, prior to giving caudal block.

Results: The prevalence of occult spina bifida was 3% in our study. There was no statistically significant association of cutaneous marker with abnormal scan.

Conclusion: Prevalence of occult spina bifida was ten-times higher in our study than in the general population. Perioperative ultrasound screening of the lower spinal anatomy by anesthesiologist done prior to performing neuraxial block is worthwhile in ruling out occult spinal anomalies in high-risk children of occult spinal dysraphism.

Keywords: Caudal block, filum terminale, sacral hiatus, spinal dysraphism, ultrasound

Introduction

Genitourinary and anorectal surgeries are among the most performed pediatric surgeries. Complete perioperative care includes safe administration of analgesia and regional blocks play a very important role in intraoperative and postoperative analgesia. The identification of occult spinal dysraphism is an essential task of the anesthesiologist to ensure safe regional block in these children.[1,2] As ultrasound delineates the entire needle track along with the regional anatomy, success rates have improved close to 100%.[3] Among the various regional blocks performed in children, caudal epidural block is the most common. Traditionally, the caudal block is performed by palpating the surface landmarks and the feel of entry of the needle entering into the caudal epidural space, but the route traversed by the needle is blind. The use of ultrasound has been advantageous in that the route traversed by the needle is always in view and it confirms the presence of the needle tip in the caudal epidural space.[1]

Abnormal skin markers in the sacrum like hyperpigmentation, dimpling, and dermal sinus are few reasons to avoid caudal epidural block in order to prevent inadvertent dural puncture.[2] This is because the skin marker could point to a

Address for correspondence: Dr. Ekta Rai,
Professor and Head, Department of Anaesthesiology, Christian Medical College, Vellore, Tamil Nadu, India.
E-mail: drektarai@yahoo.com

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clinical condition called occult spinal dysraphism,[3] which is defined as the absence or incomplete fusion of midline neural, mesenchymal, and cutaneous structures, with or without herniation of the underlying normal or abnormal neural tissue.[4] This abnormality may be associated with urogenital and anorectal anomalies, which in turn are mesodermal derivatives. Our study is an attempt to estimate the prevalence of occult spinal dysraphism in patients under the age of 2 years planned for urogenital and anorectal surgeries.

Material and Methods

After obtaining the approval of the institutional review board and ethics committee (IRB Min. No. 9760(observe) Dated 18/11/2015), this cross-sectional prospective study was conducted in 159 patients who were posted for elective urogenital and anorectal procedures. All children less than 2 years of age with American Society of Anesthesiologists (ASA) physical status classification I and II and posted for elective urogenital and anorectal surgeries were included in the study. All those children whose parents/guardians refused consent, those with ASA physical status classification III, IV, and V, and children with obvious spinal anomalies like meningocele and myelomeningocele were excluded from the study.

Sample Size Calculation:[5]

P = 7% (Prevalence of occult spinal dysraphism in children below 2 years from a previous study) − Ultrasonography reveals a high prevalence of lower spinal dysraphism in children with urogenital anomalies.

Q = 93%, Type I (α error) $\alpha = 0.05$, Precision (d) = 4

$(Z\alpha)2PQ/d2$, $N = (1.96)2 \times 7 \times 93/(4)\ 4$; $N = 150$

Routine pre-anesthesia checkup, fasting orders, and premedication were followed in all patients. Anesthesia was decided based on the type and duration of the surgery, and type of anesthesia induction was based on the presence or absence of intravenous access. After induction of anesthesia and establishing standard ASA monitoring (pulse oximetry, three lead ECG and NIBP), airway was secured either with LMA or ETT based on need and $EtCO_2$ along with initiation of end-tidal inhalational agent monitoring. Subsequently, the child was positioned in the left lateral position and the child's lower back was then examined carefully for the presence of any cutaneous stigmata which was duly documented. The ultrasound machine used for the scan was GE venue 40 with linear probe, having a frequency of 7 Hz. The performer scanned the back starting from the upper thoracic region keeping the ultrasonography (USG) machine in the best possible ergonomic position. The spinal cord was visualized in the thoracic region and was followed down to its end point as the conus. This point was confirmed in transverse and longitudinal planes and marked on the skin. The first 20 scans were performed in the presence of a sonologist so that appropriate agreement in acquiring images could be made with regards to probe placement and measurements. The subsequent scans were done independently which was further cross-checked by sonologists. Further imaging of the lumbosacral anatomy was done systematically. The position at which the spinal cord ended was documented with reference to the vertebral level. The filum terminale (FT) was identified further below after the ending of the conus. The thickness of the filum was noted in both transverse and longitudinal planes. The presence of spinal cord pulsations was also documented. The dura was further followed down to the point where it ended. This was correspondingly marked on the skin surface, and its relation to the sacral or lumbar vertebrae was noted. The counting of vertebrae was done with the help of the guide pointer on the ultrasound screen from below upwards. The distance between the point marked on the skin where the dura ended and the sacral hiatus was noted.

The ultrasound scan was termed abnormal if the following findings were present: (1) low-lying spinal cord (ending below the lower border of 3rd lumbar vertebra), (2) thickened FT (more than 2 mm), (3) absent spinal cord pulsations, (4) low-lying dura (below the 3rd sacral vertebrae), and (5) presence of other abnormalities like filar cyst or dermal sinus tracts communicating with the dura. Patients with normal sonoanatomy underwent previously planned regional technique. The central neuraxial regional anesthetic technique was deferred in those who had abnormal sonoanatomy with alternate modes of analgesia being offered to them. The ones with an abnormal anatomy were further reconfirmed by an independent radiologist before being consulted by neurosurgery.

Statistical analysis

Categorical variables were summarized using counts and percentages. Quantitative variables were summarized using mean and standard deviation or median and range. Chi-squared test was used to compare the proportions between categorical variables. One-way analysis of variance (ANOVA) was used for the comparison between the groups. $P < 0.05$ was considered statistically significant. All the statistical analysis were done using Stata/IC 13.1.

Results

Of the 161 patients assessed for eligibility to be recruited for the study, parents of two patients refused to give consent. Therefore, data was collected from 159 patients and was analyzed.

Most children with urogenital anomalies were male, whereas females predominated among those with anorectal malformations. The majority of the patients (139 out of 159) recruited into the study were of ASA physical status class I. These baseline characteristics have been depicted in Tables 1 and 2. In the study population, 41 patients (25%) had a cutaneous marker over the lumbosacral region, with a skin dimple being the most common. Of these only one patient had an abnormal scan [Figure 1], thereby implying no significant association of cutaneous marker with an abnormal ultrasound scan ($P = 0.76$). One patient had low-lying conus suggestive of a tethered cord [Table 3].

Ultrasound data

The most common vertebral level at which the dura ended was at the upper border of S2 in 1–24 months age group, whereas in neonates it was at the lower border of S2. Nine patients had the dura ending at the upper border of S3 vertebra and we had one patient with low lying conus [Figure 2].

The thickness of the filum terminale ranged from 0.5 mm to 2.3 mm. Thickness of the filum terminale of more than 2 mm was taken as suspicious of cord tethering. All 159 patients had presence of spinal cord pulsations.

The prevalence of suspected occult spinal dysraphism at 3.1% (5/159) was found to be higher than the general population. This, though statistically insignificant ($P = 0.35$), has clinical implications.

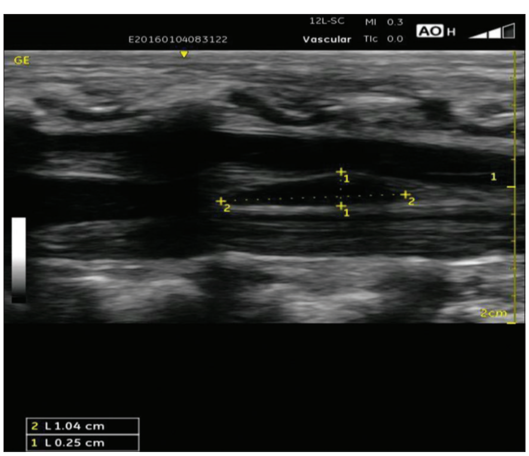

Figure 1: Filar Cyst

Discussion

Regional anesthesia in pediatric population has evolved over the last century from caudal-based analgesia to peripheral nerve blocks and lumbar/thoracic epidurals. With the advent of using ultrasound in regional anesthesia, while the safety and effectiveness has multiplied manifold, it has also resulted in identification of the previously unseen anomalies.[6] The study by Koo *et al*.[5] concluded that prevalence of occult spinal dysraphism in children with urogenital anomalies was higher than the general population, and that it warranted ultrasound evaluation of the spinal structures prior to performing central neuraxial block.[5] Kim *et al*.,[7] from their study of 120 patients with anorectal malformation, concluded that prevalence of occult spinal dysraphism is high among patients with anorectal anomalies. With 41 of the 120 patients having spinal

Table 1: Demography

Demography	Sub-classification	Number	Mean
Gender	Male	134	
	Female	25	
Age (years)	Neonates	8	
	Infants	96	
	Less than 2 years	55	
Weight (kg)	neonate		2.99
	1–6 months		4.72
	6–12 months		8.6
	12–24 months		10.37
ASA	Grade 1	139	
	Grade 2	20	
Skin marker	Yes	41	
	No	118	
Type of cutaneous marker	Dimple	36	
	Deep gluteal cleft	1	
	Nevus	1	
	Coccygeal pit	1	
	Cleft	2	

Table 2: Type of Surgeries

Type of Surgeries	Frequency
Hernia	46
Pyeloplasty	41
Orchidopexy	17
Hypospadias	14
Anorectal surgeries	14
Others	27

Table 3: Abnormal Ultrasound Findings

Abnormal Ultrasound Findings	Frequency
Filar cyst	1
Low-lying spinal cord	1
Thickened filum terminale	3
Low-lying dura	1

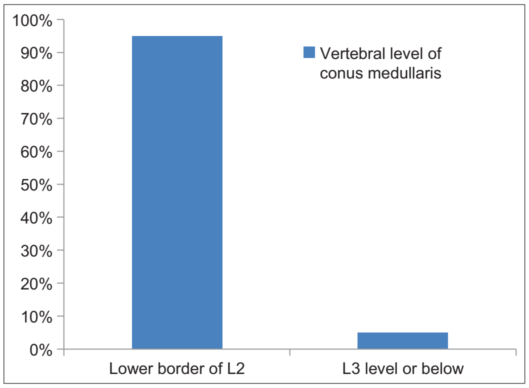

Figure 2: Vertebral level of conus medullaris

dysraphism, it was agreed upon that children with anorectal malformation need to undergo ultrasound screening of the spinal anatomy.[7] This was corroborated by Samuk *et al*. in his study of 790 patients with anorectal malformations,[8] and Scottoni *et al*.[9] Medina *et al.* conducted a study to identify the sensitivity and specificity of ultrasound as a screening tool to detect occult spinal dysraphism, which was found to be high at 86.5% and 92.9%, respectively.[10]

In our study, we found that the prevalence of occult spinal dysraphism in children with urogenital and anorectal anomalies at 3% was higher than the prevalence in normal population which was at 1–3 per 1000 births.[11] The presence of skin marker over the lumbosacral region is considered a relative contraindication for performing a neuraxial block. However, in our stud, of the 41 patients with a cutaneous marker, only one patient had a spinal dysraphism. This has been corroborated by several other studies. Robinson *et al.*, from their study of 229 patients, suggested that simple cutaneous markers like a skin dimple were not the sole indicator of occult spinal dysraphism.[12] Chern *et al*., in their retrospective study of 973 children referred for lumbar ultrasound due to the presence of skin marker for occult spinal dysraphism, found that only seven patients (0.007%) had the same.[13] Based on this, we concluded that neuraxial blocks could be safely performed even in the presence of a cutaneous marker if the ultrasound screening revealed normal anatomy. Additionally, ultrasound enables one to accurately locate the level at which the spinal cord and the dural sac ends with reference to the vertebral level. In our study, a majority of the children had their spinal cord end at the lower border of L1 vertebrae with only one child having a low-lying spinal cord. Another important information obtained by ultrasound is the lower endpoint of dural sac which is known to vary with age. In neonates, it can be as low as S4 vertebrae level which by infancy ascends to S2 level. The presence of low-lying dura can be either a normal anatomical variant or a pathological condition. Patients with anorectal malformations can have low-lying dura as a part of the spectrum of occult spinal dysraphism. Afshan *et al.* published a case report wherein an 18-month-old syndromic baby developed total spinal anesthesia after caudal block with surface anatomy palpation using bupivacaine due to accidental dural puncture.[14] In our study, we had one patient with low-lying dura with associated tethered cord. The ultrasound screening done in our study helped us decide whether to proceed with planned regional block, thus contributing significantly to the safety of anesthetic practice.

The following are the limitations of our study: (1) Recruitment of 159 patients gave an alpha error of 4%. Further studies in a larger group would be required to improve the accuracy. (2) The study group restricts the age group up to 2 years due to inability to get clear ultrasonic images of spinal cord structures and its details in older children, and thus results can be applied to this age group. (3) Though USG scan can diagnose occult spinal dysraphism with fairly good sensitivity and specificity, MRI scan remains the gold standard. There is a small possibility that spinal dysraphism can be missed despite ultrasound screening before performing caudal epidural block. MRI could not be performed in all patients to correlate the findings due to financial constraints. (4) The researcher was assisted for the initial 20 ultrasound scans under direct supervision of a radiologist and beyond which the recorded scans were shown to the radiologist and repeated on-table scanning was performed by the radiologist in case of an abnormal finding. The learning curve of spinal ultrasound could not be studied as it was beyond the scope of this study.

Conclusion

The prevalence of occult spinal dysraphism in children with urogenital and anorectal anomalies was 3%, which was 10 times higher than the incidence in the general population. Preprocedural ultrasound screening of the spine will be able to pick up occult spinal dysraphism prior to performing caudal block.

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Conflicts of interest

There are no conflicts of interest.

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