

ULTRASOUND GUIDED IN-PLANE PENILE NERVE BLOCK FOR CIRCUMCISION: A NEW, MODIFIED TECHNIQUE SUGGESTS LOWER ANESTHETIC VOLUME AND NARCOTIC USE

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Abstract

Context: Circumcision is one of the most common surgical procedures in pediatric males. Anesthesia is often the classic dorsal penile nerve block (DPNB), which is based on landmark identification and tactile feel of tissue resistance during needle advancement. However, this technique is associated with technical failures and vascular complications.

Objective: We used an ultrasound-guided in-plane technique to avoid injury of penile vascular and neural tissues during DPNB. The aims of this retrospective study were to compare the success rate and efficacy of these two penile block techniques.

Methods: Male pediatric patients undergoing circumcision received general anesthesia before the penis and surrounding area were prepared with 0.5% chlorhexidine in 70% alcohol. Sixteen patients underwent classic DPNB, and 16 underwent the modified ultrasound-guided in-plane technique. The ultrasound machine was adjusted to the musculoskeletal setting, and a linear ultrasound probe with a frequency range of 5 to 10 MHz was placed transversely along the base of the penis, which received gentle traction.

Results: Though not statistically significant, patients who underwent the classic DPNB were approximately 1.8 times more likely to require rescue analgesia and approximately 2 times more likely to have a complication than those in the ultrasound-guided group. Results also showed lower volume requirements for local anesthetic and intraoperative narcotics, longer time until rescue analgesic, and lower incidence of vomiting in the ultrasound-guided group than in the landmark-guided group.

Conclusions: The ultrasound-guided DPNB technique appears to offer advantages over classic DPNB and warrants a prospective controlled trial to confirm these findings.

Keywords: circumcision, pediatric, anesthesia, nerve block, pain, ultrasound, in-plane.

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Introduction

Circumcision is one of the most frequent surgical procedures undergone by pediatric males^{1,2}. In an effort to relieve postoperative pain and improve safety, physicians use several anesthetic approaches with various efficacies, including topical analgesics such as lidocaine-prilocaine and lidocaine³⁻⁶, ring block⁷⁻⁹, and caudal block^{5,8,10}. A study by Weksler et al¹¹ revealed that children treated with caudal block experienced higher rates of tachycardia, motor block, and vomiting than those treated with penile block, although pain severity did not differ between the groups. The ring block procedure includes an 8% failure rate⁸ and edema¹², but complications have not been reported as a result of this technique¹³.

Dorsal penile nerve block (DPNB), a procedure first described in the mid-1970s¹⁴, requires a local anesthetic injection close to the dorsal nerve of the penis. Needle advancement is based on landmark identification and tactile feel of tissue resistance. Although the American Academy of Pediatrics approves the use of DPNB¹³, minor complications include swelling¹⁵, hematoma or edema¹⁶, and bruising at the injection site¹⁷. Other safe approaches for using DPNB in infants and children have been described^{12,18}.

More recently, Sandeman and Dilley² described the ultrasound-guided out-of-plane technique², which allows identification of both the subpubic space and

the penile structure and direct bilateral injections into the subpubic space¹, but some researchers are still unconvinced of its benefits¹⁹. DPNB needle placement described by Maxwell et al²⁰ has been a standard method to block the dorsal penile nerve.

In this retrospective study, we describe a modified DPNB ultrasound-guided in-plane penile block technique and compare the efficacy and safety to that of the classic, landmark-guided DPNB approach.

This ultrasound-guided in-plane penile nerve block technique was first described and presented at the Society of Pediatric Anesthesia on March 8, 2014 and published in *Anesthesiology NEWS*, May 2015. Vol. 41:5.

Methods

Patients

This study was carried out at Arkansas Children's Hospital/University of Arkansas for Medical Sciences. The institutional review board approved this study, and we received signed parental consent for the procedure and publication of results.

After administering general anesthesia to the patients, we prepared the penis and surrounding area, including the scrotum, with 0.5% chlorhexidine in 70% alcohol. Universal sterile technique was used to perform the DPNB. Sixteen patients underwent classic DPNB and 16 underwent the modified ultrasound-guided in-plane technique.

Fig. 1
Suleman's approach; Schematic of
ultrasound-guided in-plane dorsal penile
nerve block.

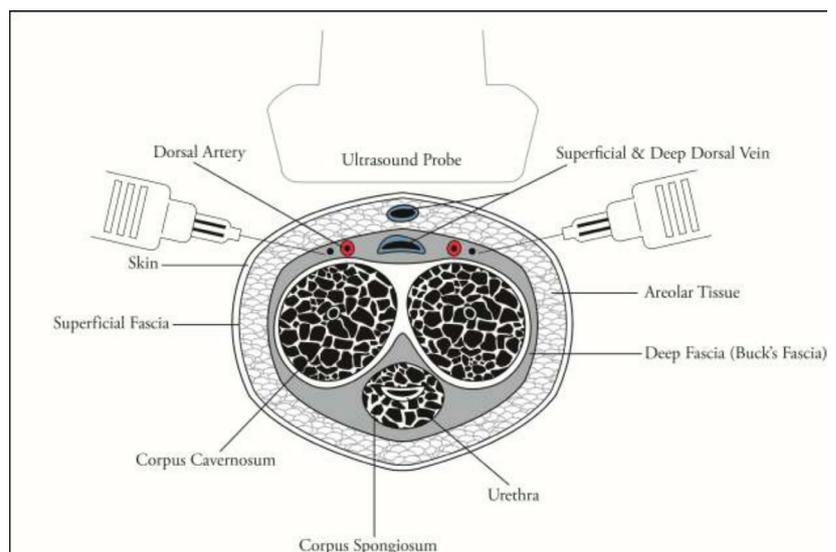


Fig. 2

Image of patient receiving an ultrasound-guided in-plane dorsal penile nerve block before a circumcision.



Modified Ultrasound-guided In-plane DPNB

We used a linear ultrasound probe with a frequency range of 5 to 10 MHz and adjusted the Sonosite M-Turbo® (Bothell, WA) ultrasound machine to the musculoskeletal setting. We placed the probe transversely along the base of penis and applied gentle traction to the penis (Figs. 1 and 2). The corpora cavernosa, dorsal arteries, dorsal veins, and superficial and deep penile Buck’s fascia were identified. A 25-gauge, 1.5-inch hypodermic needle was advanced by the in-plane technique until loss of resistance was felt when the needle passed through the hyperechoic superficial lining of Buck’s fascia. Immediately after it passed through this superficial layer, the needle tip was positioned lateral to the dorsal artery into the substance

of Buck’s fascia. After confirming negative aspiration, we injected 1 ml of bupivacaine 0.25% while monitoring the spread (Fig. 3)²¹. The same procedure was performed on the other side. We also injected 0.5-1 mL of the same solution at the penoscrotal junction to block the scrotal branches of the pudendal nerve as recommended by Sandeman and Dilley².

We used a total of 2-3 ml of plain 0.25% bupivacaine for the complete block in the ultrasound guided DPNB group. The landmark-guided technique was performed as described by Maxwell et al²⁰.

Statistical Methods

All analyses were carried out with R version 3.0.2 (Vienna, Austria: R Development Core Team). The two patients groups were compared for potential confounding factors, including age, weight, and pain on arrival. Because of the small sample size and the non-normality of data, we applied a Wilcoxon rank sum test to examine whether the distribution of each variable differed between the two groups. Among the outcomes of interests, four were of continuous variables (i.e., volume of bupivacaine, total intraoperative opioids, postoperative opioid use, and time to first dose of rescue pain medication), and two were binary variables (i.e., rescue medication requirements and complications). For each continuous outcome, a Wilcoxon rank sum test was applied to compare the difference between the two groups. For each binary outcome, a Fisher’s exact test was applied.



DA - Dorsal Artery DV - Dorsal Vein DPN - Dorsal Penile Nerve BF - Buck's Fascia
CC - Corpus Cavernosum CS - Corpus Spongiosum

Fig. 4

Box-whisker plot of bupivacaine volume usage by treatment. Bupivacaine volume was generally less in the ultrasound-guided DPNB group than in the landmark-guided DPNB group (DPNB; i.e., quartiles are lower for ultrasound-guided group).

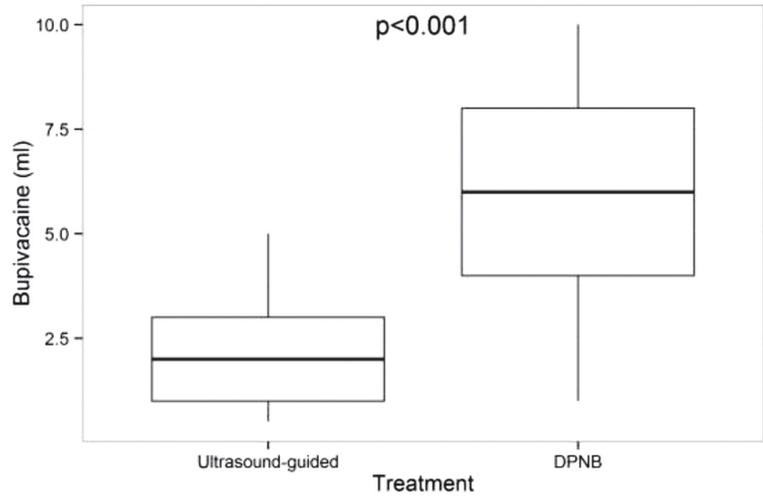


Fig. 5

Box-whisker plot comparing intraoperative narcotic use in the landmark-guided and ultrasound-guided DPNB groups.

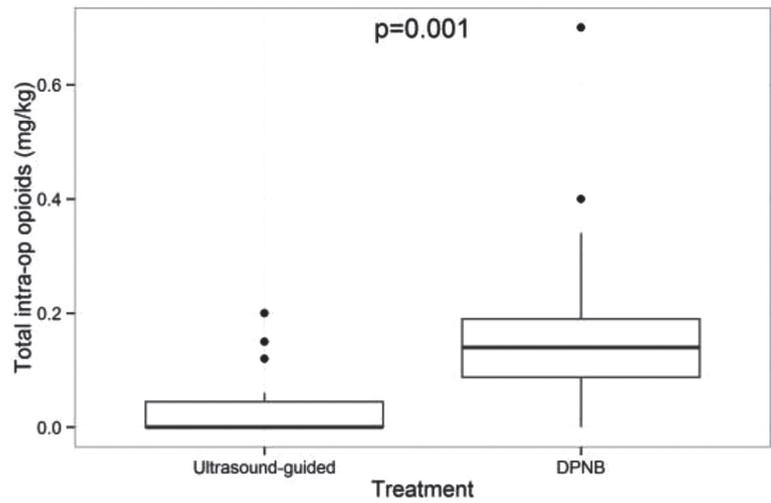


Fig. 6

Box-whisker plot comparing postoperative opioid use in the landmark-guided and ultrasound-guided DPNB groups.

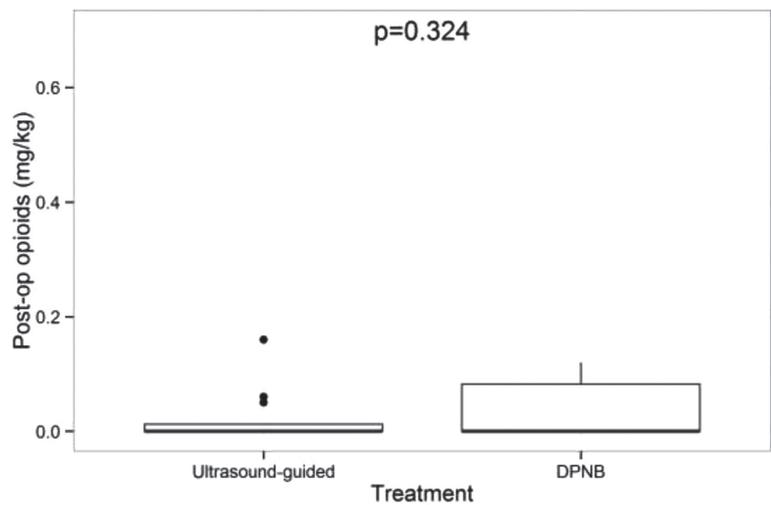
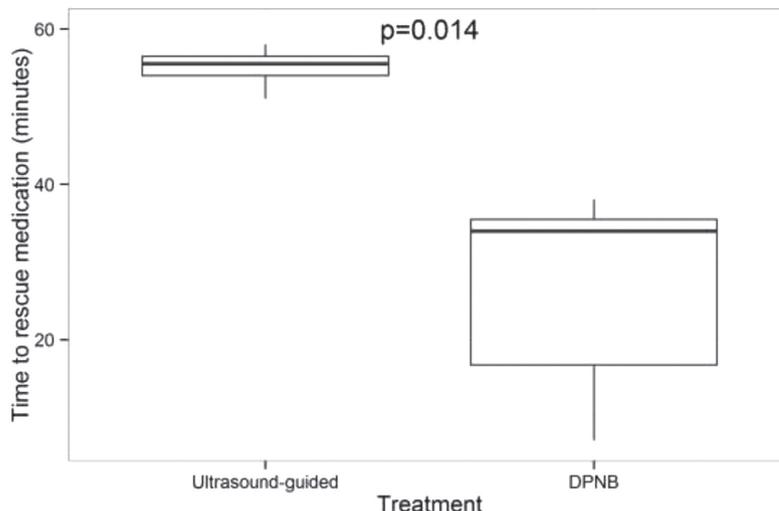


Fig. 7
Box-whisker plot comparing time to first rescue medication in the landmark-guided and ultrasound-guided DPNB groups.



Ethics

Our institutional review board approved the study described here, and we received signed parental consent for the procedure and publication of results.

Results

The two groups of patients showed no significant differences in baseline variables of age, weight, and pain level on arrival (all *p* values >0.05; Table 1). The median volume of bupivacaine used was larger in the landmark-guided DPNB group (6 ml) than in the ultrasound-guided DPNB group (2 ml, *p*<0.001; Fig. 4). The total intraoperative opioid use also was greater in the landmark-guided group than in the ultrasound-guided group (median 0.14 mg/kg vs. 0.0 mg/kg,

respectively, *p*=0.001; Fig. 5). Postoperative opioid use did not differ significantly between the two groups (*p* = 0.324; Fig. 6).

Patients in the landmark-guided DPNB group were approximately 1.8 times more likely to require rescue medication and approximately 2 times more likely to have a complication than patients in the ultrasound-guided group (Fig. 7). However, neither comparison was statistically significant, most likely because of the small sample size. Among patients who required rescue medication, the median time to rescue medication was 34 minutes in the landmark-guided DPNB group (n=6) and 55.5 minutes in the ultrasound-guided DPNB group (n=4). This decrease of 21.5 minutes was statistically significant (*p* = 0.014; Table 1).

Table 1
Comparison of Baseline Variables/Continuous-type Outcomes

Characteristic	DPNB Ultrasound (N=16)		DPNB Landmark (N=16)		Wilcoxon <i>p</i> Value
	Median	(Q1, Q3) ^a	Median	(Q1, Q3)	
Age (yrs)	6.0	(5.0, 9.0)	6.5	(5.0, 10.0)	0.985
Weight (kg)	21.5	(19.1, 33.7)	23.0	(19.1, 32.0)	0.806
Pain on arrival	0	(0, 0)	0	(0, 0)	>0.999
Bupivacaine (ml)	2.0	(1.0, 3.0)	6.0	(4.0, 8.0)	<0.001
Total intraoperative opioid (mg/kg)	0.00	(0.00, 0.04)	0.14	(0.09, 0.19)	0.001
Postoperative opioid requirements (mg/kg)	0.00	(0.00, 0.01)	0.00	(0.00, 0.00)	0.324
Time to first rescue medication (min) ^b	55.5	(54.0, 56.5)	34.0	(16.8, 35.0)	0.014

^aQ1: lower quartile; Q3: upper quartile.

^bTime to first rescue medication (min) for patients who required rescue medication (n=4 for ultrasounds, n=6 for landmark controls).

Discussion

Interest in the use of ultrasound imaging techniques for pediatric regional anesthesia is growing²² because the technology allows the practitioner to visualize the target nerve directly, maneuver the needle under real-time observation, precisely navigate from complex or sensitive anatomy, and accurately administer local anesthetics. Our data suggested that patients in the ultrasound-guided DPNB group required less local anesthetic volume, required intraoperative narcotics less frequently, had a longer duration before rescue pain medication, and experienced less vomiting than patients who underwent the classic, landmark-guided DPNB technique.

The ultrasound-guided method appeared to be safe, as patients were less likely to experience complications than those in the landmark-guided group. At least one study has suggested that ultrasound use offers little benefit to the DPNB technique¹⁹. However, in our study, ultrasound enabled us to clearly recognize two-dimensional anatomy of the subpubic space and penile structures and thereby place the needle directly into the substance of Buck's fascia. Thus, we were able to avoid damage to the surrounding structures and resultant problems that could occur. Several studies have concluded that when needles are placed correctly close to the nerves, the frequency of adverse events declines^{2,23,24}.

The primary limitation of this pilot study was the small number of study subjects. Although patients in the ultrasound-guided group were less likely to require rescue medication for pain relief and experienced fewer complications, the differences between groups were not statistically significant. We expect that the statistical power will increase when follow-up studies are carried out with a larger sample size.

Placing needles close to the nerves with ultrasound guidance appears to be a reliable technique that minimizes adverse events, thus supporting the existing studies. We think that the ultrasound-guided DPNB technique will improve clinical care for patients undergoing circumcision and is a promising approach to improve efficacy and safety of penile nerve block in children, particularly in newborns and infants. A prospective control trial in a large study population is warranted to confirm the findings of this small pilot study.

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^{*} Train-of-four
[†] Post tetanic counts
[‡] Second twitch

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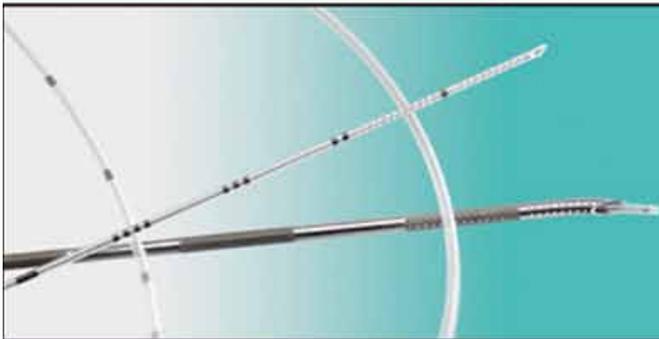
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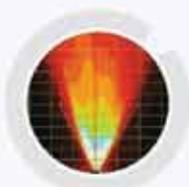
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