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Review

Comparing Ultrasound-guided and Landmark-based Dorsal Penile Nerve Block Techniques in Pediatric Circumcision: A narrative review

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Abstract

Circumcision is among the most common elective pediatric surgical procedures and is frequently associated with significant perioperative and postoperative pain, posing challenges for effective pain management. Adequate analgesia is therefore essential, and multimodal strategies—including peripheral nerve blocks such as the dorsal penile nerve block (DPNB)—play a critical role in optimizing outcomes.
This narrative review seeks to evaluate the comparative efficacy and safety of ultrasound-guided versus landmark-based DPNB techniques in pediatric circumcision.
The traditional landmark-based DPNB method has been associated with variable success rates, depending on anatomical variability and clinician experience. In contrast, ultrasound guidance offers real-time visualization of the penile neurovascular structures, enhancing needle placement accuracy, optimizing local anesthetic distribution, and potentially reducing the required anesthetic volume. Several studies suggest that ultrasound-guided DPNB may lead to lower postoperative pain scores and a delayed need for rescue analgesia. However, other research indicates that both approaches may offer comparable analgesic efficacy. Despite this, ultrasound-guided DPNB has demonstrated advantages such as increased precision, a reduced risk of complications, and improved postoperative outcomes. Ultimately, the choice between these techniques should be guided by clinical factors such as resource availability and the operator's level of proficiency.

Keywords: Circumcision, penis, postoperative pain, regional anesthesia, nerve block, ultrasound; pediatric anesthesia, urology.

Introduction

Dorsal penile nerve block (DPNB) is a widely used regional anesthesia technique for managing pain during pediatric circumcision[1,2]. While other regional anesthesia methods, such as caudal block and subcutaneous penile ring block, have proven effective, DPNB is particularly successful in reducing pain and enhancing postoperative comfort[3,4]. Originally described by Kirya and Bateman in 1975, DPNB has undergone refinements, with the landmark-based approach being the most commonly used[5]. However, failure rates for the landmark-based technique range from 4% to 7%[3,6], and complications such as incomplete analgesia[2], bleeding, necrosis of the glans penis 7, and local anesthetic toxicity[3,6,8] have been reported.

Ultrasound-guided DPNB is proposed as an improvement over the traditional method, offering real-time visualization of anatomical structures[2]. This technique may reduce failure rates and improve nerve localization[9]. However, its clinical advantages over the landmark-based technique remain uncertain.

The most recent review examining the comparative effectiveness of landmark-based versus ultrasound-guided dorsal penile nerve block (DPNB) techniques in pediatric circumcision was conducted by Christophel-Plathier et al., published in September 2024. This study specifically compared reverse ultrasound-guided penile nerve block (RUS–PNB) to the traditional DPNB technique. Although RUS–PNB demonstrated improved analgesic efficacy and precision, it did not significantly reduce procedure time

when compared to landmark-based techniques. Additionally, a larger volume of anesthetic was required with RUS–PNB, and the minimum effective volume remains yet to be determined[10].

Since previous reviews, advancements in ultrasound technology have refined techniques like RUS–PNB, providing real-time visualization and potentially better outcomes. New studies continue to address uncertainties, such as optimizing anesthetic volume and reducing procedure time, further informing clinical practices.

A comprehensive review of the current evidence would enable clinicians to make informed decisions based on patient characteristics, procedural complexity, and resource availability. Such a review would also help institutions assess the cost-effectiveness of ultrasound guidance, guide training initiatives, and identify areas for future research to refine both techniques. Ultimately, this would contribute to more standardized, evidence-based practices in pediatric anesthesia, ensuring safer and more effective procedures.

This narrative review aims to provide a comparative analysis of ultrasound-guided versus landmark-based DPNB techniques in pediatric circumcision, evaluating their efficacy, safety, and clinical outcomes. The goal is to inform clinical decision-making and optimize perioperative pain management for pediatric patients.

Methods

Literature Search Strategy

A comprehensive search was conducted across the following databases: PubMed, Cochrane Library, and Google Scholar, covering all studies published up to January 2025. The search utilized a combination of keywords and MeSH terms, including: "Circumcision," "penis," "postoperative pain," "regional anesthesia," "dorsal penile nerve block," "landmark-based," "ultrasound-guided," "pediatric anesthesia," "penile block," "comparison," "efficacy," "safety," "techniques," and "clinical outcomes." Boolean operators (AND/OR) were employed to refine the search. Additionally, manual searches of reference lists from relevant articles were performed to identify further studies.

Inclusion Criteria

- Studies that compare ultrasound-guided and landmark-based dorsal penile nerve block (DPNB) techniques.
- Pediatric population (ages 0–18 years).
- Published in English.
- Randomized controlled trials (RCTs), observational studies, retrospective studies, and systematic reviews.

Exclusion Criteria

- Case reports, letters to the editor, and commentaries.
- Studies focused on adult populations.
- Articles lacking comparative data on both techniques.

Data Extraction and Analysis

The data extracted from the included studies comprised the following:

- Study Design: Information on study design, sample size, and patient demographics.
- Efficacy Outcomes: Pain scores, need for rescue analgesia, and the onset and duration of analgesia.
- Safety Outcomes: Incidence of complications, failure rates, vascular or nerve injury, and adverse reactions.
- Postoperative Recovery: Time to the first analgesic request.

A qualitative synthesis of the findings was performed After an initial screening of titles and abstracts, full-text articles were evaluated for eligibility. Discrepancies in article selection were resolved through consensus or by consulting a third reviewer. This approach ensures transparency and reproducibility by clearly defining the search strategy, databases, keywords, and selection criteria.

Results

Outcomes and Study Selection

The outcomes of this review are presented in a PRISMA flow diagram (Fig. 1). Following the selection process, a total of 10 studies were included in the analysis. Of these, 6 were randomized controlled trials (RCTs), and the remaining 4 were observational cohort studies. A detailed summary of the included studies is provided in Table I.

A total of nine studies compared the ultrasound-guided dorsal penile nerve block (DPNB) technique to the traditional anatomical landmark approach. These include investigations conducted by Faraoni, Dottore, O'Sullivan, Teunkens, Yildirim, Plathier, Suleman, and Li[1,2,10–15]. Collectively, these studies assessed the efficacy, accuracy, and safety profile of ultrasound guidance in pediatric circumcision, demonstrating improved localization and reduced complication rates in comparison to landmark-based techniques.

In addition to these comparative studies, one article by Rufini described a reversal ultrasound-guided DPNB approach, proposing a novel needle

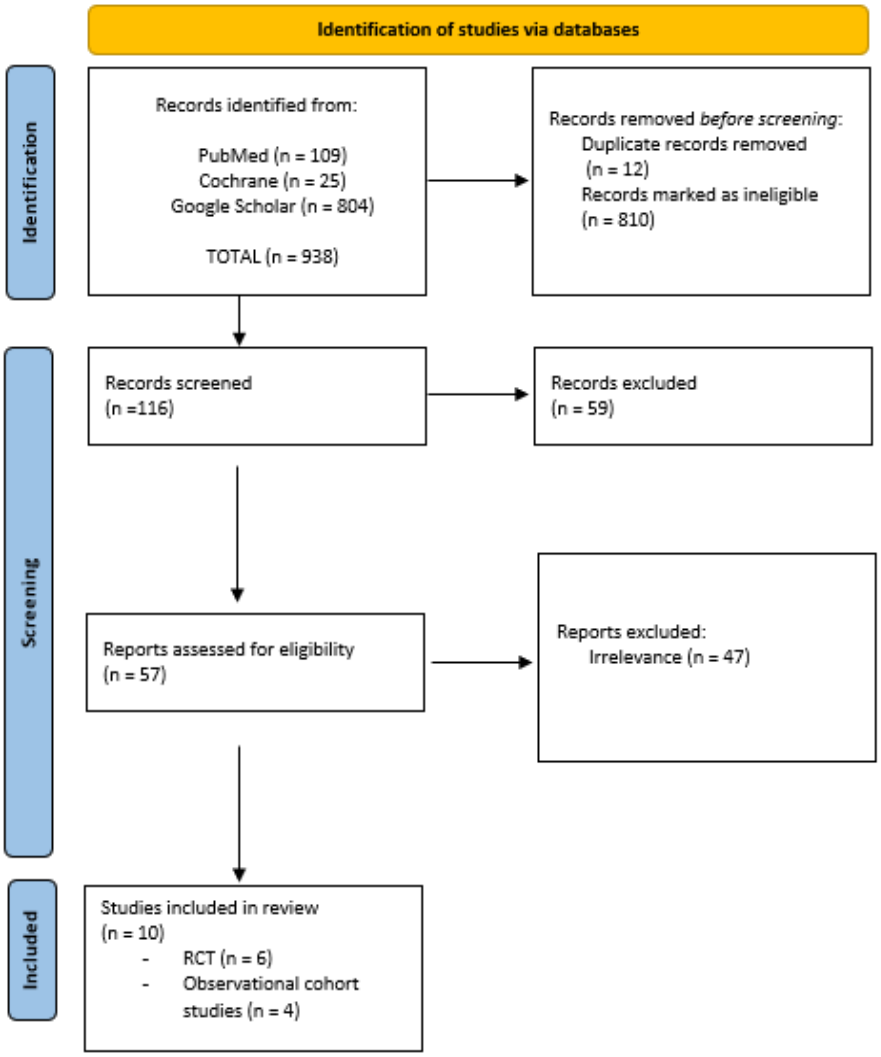

Fig. 1 — Flow Diagram. Schematic representation of the literature search strategy and study selection process employed in the present review.

trajectory and positioning method[16]. Furthermore, Zadrazil analyzed the use of in-plane ultrasound-guided DPNB performed under light sedation, highlighting its feasibility and potential benefits in terms of patient comfort and procedural success[17].

Evolution of the Technique

The dorsal penile nerve block (DPNB) has evolved from a conventional landmark-based method to the more advanced ultrasound-guided approach[2]. The landmark-based technique relies on surface anatomical landmarks to approximate the location of the dorsal nerves, a method that has been utilized for decades[2,5]. While cost-effective and simple, its main limitations include imprecise needle placement and a variable success rate. In contrast, ultrasound guidance, introduced in 2007[18], offers real-time visualization of the penile neurovascular structures, including the dorsal penile artery, vein, and nerve[2,12,18]. This advancement has significantly improved the precision of needle placement and is increasingly favored in pediatric regional anesthesia[16,19], as highlighted in recent reviews.

Landmark-Based Dorsal Penile Nerve Block

The landmark-based technique, originally described by Maxwell et al., involves identifying anatomical landmarks to locate the dorsal penile nerve. This method, though widely used, is highly dependent on the clinician's skill and may show considerable variability in success rates[2,12]. The procedure is commonly performed using the Dalens technique, which focuses on specific landmarks along the penis to guide the injection.

Anatomical Landmarks and Technique (Fig 2.)

The dorsal penile nerves, which are branches of the pudendal nerve (S1-S4), lie beneath the pubic symphysis. These nerves travel along the deep fascia of the penis, known as Buck's fascia[20]. The technique for performing the dorsal penile nerve block (DPNB) involves the following steps[5,13,21]:

- Patient Positioning: The patient is placed in a supine position, with the penis gently stretched to expose the anatomical landmarks.
- Identification of Landmarks: The midline of

Table I. — Summary of Randomized Controlled Trials, Observational Studies, and Narrative Reviews on Ultrasound-Guided Nerve Blocks in Pediatric Circumcision.

Study (Citation)	Year	Study Design	Population	Intervention / Comparison	Outcome Measures	Key Findings
Faraoni et al.[2]	2010	Single-blind RCT	40 pediatric patients (1–14 years)	US-guided PNB vs. landmark technique	Block failure, pain scores, first analgesia, procedure duration	US guidance reduced pain, delayed analgesia, and increased procedure time (~10 min).
O'Sullivan et al.[13]	2011	RCT	66 pediatric circumcision patients	US-guided vs. anatomical landmark technique	Efficacy, success rate, safety profile	Both techniques were effective; US may enhance precision and safety.
Li J et al. [11]	2016	Prospective Clinical Study RCT	80 pediatric circumcision patients	Modified US-guided DPNB vs. landmark-guided DPNB	Efficacy and safety profile. FLACC score, success rate	Lower intra- and postoperative pain scores, rapid onset, prolonged analgesia, no major complications observed.
Suleman et al. [12]	2016	Observational Study	Pediatric males	In-plane ultrasound-guided DPNB vs. landmark-technique	Volume of local anesthetic used (mL) Intraoperative opioid use , Postoperative narcotic use, FLACC score, block success rate	The in-plane technique achieved effective nerve block with reduced anesthetic volume, lower opioid use, and minimal complications. Pain control was adequate.
Teunkens et al. [15]	2018	Prospective, observer-blinded RCT	310 pediatric circumcision patients (0-11 years)	US-guided DPNB vs. landmark technique	Analgesia quality, block performance time	Both methods were effective; US improved visualization but increased block time.
Yildirim et al. [14]	2021	Prospective, single-blinded RCT	40 newborns scheduled for circumcision	US-guided penile block vs. landmark method	FLACC pain scores, heart rate, fentanyl use, parent satisfaction	US-guided block reduced pain, heart rate, fentanyl use, and increased satisfaction.
Rufini et al. [16]	2022	Retrospective Study	Pediatric circumcision patients	Reversed ultrasound-guided DPNB	Pain scores (FLACC/VAS depending on age), Technical feasibility, Incidence of complications, fentanyl use.	Reversed technique was feasible and effective in achieving pain control. No complications were reported.
Dottore et al. [1]	2023	Prospective observational study	70 pediatric circumcision patients (6 months–17 years)	US-guided DPNB with sedation vs. conventional management	Time to discharge, opioid use, pain levels, hemodynamic parameters	US-guided DPNB reduced discharge time, opioid use, and pain; lowered arterial pressures.
Zadrazil et al. [17]	2023	Anatomical-based observational study (with cadaver dissection).	20 pediatric circumcision patients	Ultrasound-guided in-plane DPNB under light sedation.	Surgical blockade success (without additional anesthesia).	Achieved 100% surgical blockade success without the need for additional general anesthesia; provided detailed anatomical insights.
Plathier et al. [10]	2024	Retrospective study	139 pediatric circumcision patients	Reverse US-guided nerve block vs. Landmark guidance	Block efficacy, complication rates, postoperative pain outcomes	Reverse US-guided block improved efficacy and reduced pain vs. landmark method.

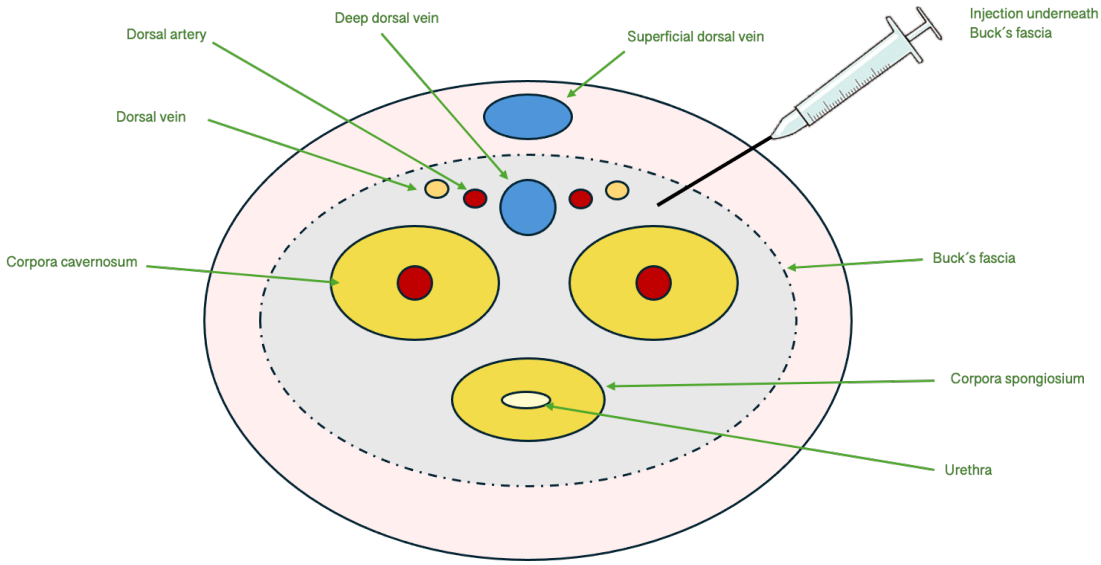

Fig. 2 — Landmark-Based DPNB Anatomy. Anatomical illustration demonstrating the key landmarks used in performing dorsal penile nerve block via the conventional technique.

the penis and the base just below the pubic symphysis are identified as key reference points.

- Injection Sites: The needles are inserted at the 10 o'clock and 2 o'clock positions, approximately 1 cm lateral to the midline.
- Injection Technique: The needle is advanced until it contacts the pubic bone, then slightly withdrawn before a small volume of local anesthetic is injected. According to Brown, the recommended dosage is 1–2 mL for children up to 3 years of age, with an additional 1 mL for each subsequent 3-year age group, up to a maximum of 5–6 ml.

Ultrasound-Guided Dorsal Penile Nerve Block

Ultrasound-guided dorsal penile nerve block (DPNB), first introduced by Sandeman[18], offers substantial advantages over the traditional landmark-based technique. It allows for real-time visualization of the anatomy, including the penile neurovascular bundle[2,16,22].

Technique Overview for Ultrasound-Guided DPNB

A linear ultrasound probe is utilized to visualize the dorsal arteries, veins, and fascia layers, facilitating precise needle placement[18]. Under ultrasound guidance, the needle is advanced to ensure accurate anesthetic delivery[2]. The needle is introduced into the subpubic space, which is bordered inferiorly by Buck's fascia, enclosing the penile neurovascular bundle and corpora cavernosa, superiorly by the pubic symphysis, and anteriorly by Scarpa's fascia[2,15,18]. The paired neurovascular structures are located just beneath the deep penile fascia on either side of the midline[10,15,18]. Most authors recommend a dose of local anesthetic 0.1–0.2 mL/kg[1,15].

A modified approach described by Suleman involves scanning at the base of the penis using an in-plane technique, which may further reduce the risk of complications[10,12].

Comparative Studies, Observational Analyses, and Anatomical Insights

The current body of evidence indicates that the use of ultrasound-guided dorsal penile nerve block (DPNB) enhances multiple perioperative outcomes in pediatric circumcision when compared to conventional landmark-based techniques.

Suleman et al. (2016) introduced a modified in-plane ultrasound-guided technique, demonstrating a significant reduction in both the required volume of local anesthetic and intraoperative narcotic use ($p < 0.05$)[12]. Faraoni et al. further supported these findings by reporting lower postoperative pain scores at both arrival in the postanesthesia care unit (PACU) and at 30 minutes postoperatively (both $p < 0.01$), as well as a significantly prolonged time to first analgesic administration ($p < 0.0001$) in the ultrasound-guided group[2].

In the study by Li et al., children receiving ultrasound-guided DPNB required a lower total dose of propofol during anesthesia maintenance. Additionally, this group exhibited shorter block placement times (3.9 ± 1.6 minutes vs. 5.5 ± 2.7 minutes; $p < 0.05$) and fewer intraoperative body movements, indicating improved block efficacy and patient stability[11].

O'Sullivan et al. found no significant difference in intraoperative fentanyl use between groups. However, the ultrasound-guided cohort required less postoperative codeine, despite a modestly longer procedure time, suggesting benefits in postoperative analgesia[13].

Plathier et al. evaluated a reverse ultrasound-guided technique vs landmarks technique, noting that although RUS–PNB required a slightly higher volume of local anesthetic (median 0.3 mL/kg vs. 0.2 mL/kg), it resulted in a significantly lower intraoperative morphine equivalent dose (mean 0.2 mg/kg vs. 0.5 mg/kg; $p < 0.001$). Ruffini et al. also described this reverse approach, reporting a favorable safety profile with no complications and a reduced need for intraoperative opioid supplementation[10].

In a large randomized controlled trial (n = 310), Teunkens et al. found no significant difference in the proportion of patients requiring postoperative piritramide between the ultrasound-guided and landmark groups (38% vs. 47%; $p = 0.135$). However, the ultrasound-guided technique was associated with a longer anesthesia induction time (median 13 minutes [IQR: 11–15] vs. 11 minutes [IQR: 9–13]; $p < 0.001$)[15].

Yildirim et al., focusing on neonates, reported that ultrasound-guided DPNB resulted in significantly lower intraoperative and early postoperative FLACC pain scores ($p < 0.01$), along with a reduction in intraoperative fentanyl requirements[14]. Lastly, Zadrazil et al., using an ultrasound-guided anatomical approach under light sedation, achieved a 100% block success rate, with no additional analgesics required until discharge, highlighting the potential for effective and opioid-sparing perioperative analgesia in this population[17].

Efficacy in Pain Management

Faraoni et al. (2010) demonstrated that ultrasound-guided dorsal penile nerve block (USG-DPNB) provided a more effective sensory blockade than the landmark-based technique, resulting in significantly lower pain scores in the immediate postoperative period[2]. Similarly, O'Sullivan et al. (2011) corroborated these findings in a randomized trial, showing that USG-DPNB provided a significantly longer duration of analgesia compared to the landmark-based technique[13]. Li et al. (2016) reported that USG-DPNB reduced perioperative adverse events and enhanced postoperative analgesia in pediatric patients[11]. In a study by Suleman et al. (2016), it was found that patients who received USG-DPNB required fewer intraoperative narcotics and experienced a longer delay before requiring rescue analgesia[12]. Conversely, Teunkens et al. (2018) found no significant difference in the need for supplemental analgesia between the ultrasound-guided and landmark-based DPNB techniques[15]. Finally, Dottore et al. (2023) reported that USG-DPNB resulted in significantly better postoperative pain management than conventional techniques, as evidenced by a reduced need for supplemental analgesia[1].

Block Success Rate and Procedural Efficiency

O'Sullivan et al. (2011) noted that while the time required to perform the block was slightly longer with ultrasound guidance, this was offset by enhanced efficacy and a lower failure rate[13]. Similarly, Li et al. (2016) observed that the ultrasound-guided technique reduced the required dose of anesthetic agents and improved the quality of anesthesia[11]. Teunkens et al. (2018) reported that although ultrasound guidance required additional training, it significantly improved first-attempt success rates compared to the landmark-based technique[15]. Rufini et al. (2021) emphasized that the in-plane technique provides continuous and safe visualization of the needle throughout the procedure, allowing for the precise deposition of minimal amounts of local anesthetic. While this ultrasound-guided approach enhances accuracy and safety, it may involve a learning curve[16]. Zadrazil et al. (2023) observed that ultrasound-guided DPNB has the potential to reduce airway manipulation and decrease the need for general anesthetic agents. However, the results of their study, which involved only 20 children, may warrant further scrutiny with a larger sample size[17]. Finally, Christophel-Plathier et al. (2024) compared the reverse ultrasound-guided nerve block technique with the landmark-based approach and found that ultrasound guidance resulted in a higher success rate and a lower incidence of incomplete analgesia[10].

Postoperative Outcomes and Recovery

Faraoni et al. (2010) and Dottore et al. (2023) reported that ultrasound-guided dorsal penile nerve block (USG-DPNB) was associated with faster recovery times, less postoperative discomfort, and earlier readiness for discharge[1,2]. Similarly, Suleman et al. (2016) found that ultrasound-guided DPNB required a lower volume of local anesthetic and was associated with a reduced incidence of vomiting compared to the traditional landmark-guided technique[12]. Christophel-Plathier et al. (2024) suggested that the reverse ultrasound-guided (USG) nerve block technique further enhanced post-circumcision comfort and reduced the need for rescue analgesia[10].

Discussion

Advantages and Limitations of Landmark-Based Technique

The landmark-based technique for dorsal penile nerve block (DPNB) is widely recognized for its simplicity, cost-effectiveness, and minimal

equipment requirements[15]. This approach is accessible and can be performed without advanced technology, making it a viable option in many clinical settings[13,15]. However, its success is highly dependent on the clinician's expertise and anatomical knowledge, which introduces variability in both success rates and patient outcomes[2,15]. Several studies have indicated that the landmark-based technique may result in higher postoperative analgesic requirements, potentially due to less precise block placement compared to ultrasound-guided techniques[1,2]. This variability underscores a significant limitation, particularly in pediatric populations where accurate and effective pain control is paramount.

Advantages and Limitations of Ultrasound-Guided DPNB

The use of ultrasound-guided in-plane dorsal penile nerve block (USG-DPNB) offers several advantages in pediatric circumcision. This technique allows for continuous, precise visualization of the needle, enabling accurate deposition of minimal volumes of local anesthetic[1,2,9,10,15,18,19,22,23]. Ultrasound guidance facilitates the use of smaller volumes of local anesthetic[1,2,19], thereby reducing the risk of systemic toxicity and minimizing local complications, such as hematoma or ischemia due to artery compression[1,7,12,24–26]. Additionally, several studies have demonstrated that USG-DPNB yields higher success rates and more consistent block performance compared to the landmark-based approach[2,9].

However, despite its advantages, USG-DPNB has some limitations. The technique necessitates specialized equipment and trained personnel[15], which may not be readily available in all clinical settings, especially in resource-limited environments. Furthermore, although ultrasound guidance enhances the precision of the block, it does not fully eliminate the possibility of failure or complications. For instance, some studies have reported failure rates of up to 27%, possibly due to the complex anatomy of the distal abdominal wall or the fascial layers in the area[16]. This suggests that while ultrasound improves precision, variability in outcomes may still occur.

Contextualizing Results with Existing Literature

The findings of this review align with the existing literature, which highlights the advantages of ultrasound-guided dorsal penile nerve block (USG-DPNB) in improving postoperative pain management. Several studies have confirmed that ultrasound guidance enhances the efficacy of nerve blocks, resulting in better pain control during the initial postoperative hours and delaying the need for additional analgesia, thereby decreasing the incidence of postoperative nausea[2,14,17,18]. These results support the growing consensus that ultrasound guidance is a superior technique, particularly when high precision is crucial.

However, studies by Teunkens et al. and O'Sullivan et al. suggest that the benefits of ultrasound guidance may be offset by an increased procedure time, with the latter study reporting no significant difference in postoperative pain control between the two techniques[13,15]. This discrepancy raises important questions about balancing the enhanced precision of ultrasound guidance with the practical limitations of longer procedure times, especially in busy clinical settings.

Additionally, as noted by Plathier, some studies suggest that the use of a reverse ultrasound-guided technique (e.g., Suleman approach) may address concerns about procedure time without compromising efficacy[10,12]. Regarding the total volume of anesthetic administered, the use of ultrasound guidance generally reduces the volume requirement, as highlighted by Rubin, Dottore, and Suleman[1,12,19]. However, in Plathier's study, a higher volume was necessary when using the ultrasound technique, likely due to unfamiliarity with the technique[10].

Acknowledging Study Limitations

While this review underscores the advantages of ultrasound-guided dorsal penile nerve block (USG-DPNB), it is important to recognize the limitations inherent in the studies included in this analysis. A significant number of the reviewed studies lacked standardization in both technique and patient selection, which may introduce variability in outcomes. Additionally, several studies did not include long-term follow-up, limiting the ability to evaluate the durability of analgesic effects or the occurrence of delayed complications. Inconsistent reporting and the relatively small sample sizes in some trials further highlight the need for additional research to validate these findings across larger and more diverse populations. Future research should aim to standardize protocols, investigate the long-term effects of different techniques, and evaluate cost-effectiveness, thereby providing more robust evidence to guide clinical decision-making.

Conclusion

Both landmark-based and ultrasound-guided dorsal penile nerve block (USG-DPNB) techniques are effective in providing postoperative analgesia for pediatric circumcision. While landmark-

based DPNB remains a well-established method, ultrasound guidance offers significant enhancements in safety by improving needle precision and reducing complications. Notably, the in-plane approach provides superior anatomical visualization, thereby minimizing potential risks. Given these advantages, ultrasound-guided DPNB is recommended for clinical practice. However, the selection of technique should be tailored to factors such as clinician expertise, resource availability, and patient-specific considerations. Future research should aim to refine ultrasound-guided DPNB protocols to further improve safety and efficacy. Additionally, comparative studies addressing long-term outcomes, cost-effectiveness, and training methodologies are essential to optimize best practices and broaden accessibility.

Ten Unanswered Questions and Future Directions in the Use of Dorsal Penile Nerve Block (DPNB) for Pediatric Circumcision

Despite increasing interest in enhancing perioperative analgesia for pediatric circumcision, several important questions remain regarding the comparative effectiveness and implementation of landmark-based versus ultrasound-guided dorsal penile nerve block (DPNB). Addressing these knowledge gaps through focused research could meaningfully inform clinical practice and support the development of standardized, evidence-based protocols.

1. Comparative Analgesic Efficacy:
   Does ultrasound-guided DPNB consistently offer superior perioperative pain control compared to landmark-based techniques?
2. Safety and Complication Rates:
   To what extent does ultrasound guidance mitigate the risk of complications such as hematoma, vascular injury, or nerve damage?
3. Optimization of Anesthetic Volume:
   Can ultrasound guidance facilitate a reduction in local anesthetic volume without compromising the quality or duration of analgesia?
4. Cost-Effectiveness and Resource Utilization:
   Is ultrasound-guided DPNB a cost-effective alternative, considering equipment investment, staff training, and procedural efficiency?
5. Learning Curve and Training Implications:
   What is the learning curve associated with ultrasound-guided DPNB, and how might it influence its adoption and integration into routine pediatric surgical practice?
6. Standardization of Technique:
   What constitutes the most reproducible and standardized approach for performing ultrasound-guided DPNB across various pediatric age groups?
7. Age-Specific Effectiveness:
   Does the efficacy of ultrasound-guided DPNB vary among neonates, infants, and older children, and should techniques be age-adapted?
8. Impact on Procedural Time:
   Does ultrasound guidance decrease total procedural time by improving accuracy, or does image acquisition increase overall duration?
9. Long-Term Outcomes and Patient Satisfaction:
   Are there measurable differences in long-term pain control, complication rates, or patient and caregiver satisfaction when comparing both techniques?
10. Feasibility in Resource-Limited Settings:
    Can ultrasound-guided DPNB be effectively and sustainably implemented in low-resource environments where imaging technology and expertise may be limited?

A coordinated research effort addressing these ten critical questions will be essential for advancing the field. Such investigations will not only clarify the relative benefits and limitations of ultrasound-guided versus landmark-based DPNB but will also promote safer, more effective, and context-appropriate analgesic strategies in pediatric circumcision.

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Conflicts of Interest: The authors declare no conflicts of interest related to this work.

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