

Block of the Pericapsular Nerve Group of the Hip with and without Ultrasound Guidance: Comparative Cadaveric Study*

Bloqueio do grupo de nervos pericapsulares do quadril com e sem auxílio de ultrassonografia: Estudo cadavérico comparativo

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Abstract

Keywords

- ▶ analgesia
- ▶ anesthesia
- ▶ hip joint
- ▶ nerve block
- ▶ cadaver
- ▶ peripheral nerve injuries

Objective To evaluate the technical reproducibility of a block of the pericapsular nerve group (PENG) of the hip aided or not by ultrasound in cadavers.

Materials and Methods The present is a randomized, descriptive, and comparative anatomical study on 40 hips from 2 cadaver groups. We compared the PENG block technique with the method with no ultrasound guidance. After injecting a methylene blue dye, we verified the dispersion and topographical staining of the anterior hip capsule through dissection. In addition, we evaluated the injection orifice in both techniques.

Results In the comparative analysis of the techniques, there were no puncture failures, damage to noble structures in the orifice path, or differences in the results. Only 1 hip from each group (5%) presented inadequate dye dispersion within the anterior capsule, and in 95% of the cases submitted to either technique, there was adequate dye dispersion at the target region.

* Study performed at the Hip Group, Department of Orthopedics and Traumatology, Faculdade de Ciências Médicas, Santa Casa de Misericórdia de São Paulo (FCMSCSP), São Paulo, SP, Brazil.

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Conclusion Hip PENG block with no ultrasound guidance is feasible, safe, effective, and highly reliable compared to its conventional counterpart. The present is a pioneer study that can help patients with hip pain from various causes in need of relief.

Resumo

Objetivo Propor e avaliar a reprodutibilidade técnica do bloqueio do grupo de nervos pericapsulares (*pericapsular nerve group*, PENG, em inglês) do quadril sem o auxílio da ultrassonografia, em cadáveres, de forma comparativa à realização do bloqueio guiado pela ultrassonografia em outro grupo de cadáveres.

Materiais e Métodos Estudo anatômico randomizado, descritivo e comparativo, realizado em 40 quadris divididos em 2 grupos amostrais de cadáveres. Fez-se uma comparação da técnica do bloqueio do PENG à técnica não guiada por ultrassonografia injetando-se corante azul de metileno, seguida de dissecação para verificação da dispersão e da coloração topográfica da cápsula anterior do quadril, além de avaliação do pertuito das injeções entre as técnicas.

Resultados Na análise comparativa das técnicas, não houve falha na punção, lesão de estruturas nobres no pertuito, ou diferença nos resultados. Não houve adequada dispersão do corante pela cápsula anterior somente em 1 quadril de cada grupo (5%), e em 95% dos casos submetidos a qualquer uma das técnicas observou-se dispersão adequada do corante pela região alvo.

Conclusão O bloqueio do PENG do quadril sem auxílio de ultrassonografia é factível, seguro, eficaz, e com alta confiabilidade quando comparado à sua realização guiada pelo aparelho de imagem. Este estudo é pioneiro, e pode ajudar muito os pacientes que têm dor no quadril por diversas causas e necessitam alívio.

Palavras-chave

- analgesia
- anestesia
- articulação do quadril
- bloqueio nervoso
- cadáver
- traumatismos dos nervos periféricos

Introduction

The anterior joint capsule of the hip receives most of the sensory innervation from the entire joint.¹ Anatomical studies^{2–4} have revealed that this sensory innervation comes from branches of the femoral, obturator, and accessory obturator nerves.

In 2018, Girón-Arango et al.⁵ described, a technique to block the pericapsular nerve group (PENG) of the hip, which consists of the infusion of an anesthetic agent guided by ultrasound (US). Using some anatomical reference points and US images, this technique aims to reach the anterior capsule of the hip and its sensory nerve branches for anesthetic dispersion.¹

The PENG block has been described for pain management, either for analgesia after proximal femur fractures, or pain control after hip surgeries. With a low cost and good outcomes, it prevents the use of opioids and their side effects.^{5–8}

Although originally aided by US to guide the injection and anesthetic infusion, one of the orthopedist's challenges with the PENG block technique is the availability of the US equipment in all sectors and levels of care.

Therefore, we propose a PENG block with no US guidance. Our objective was to analyze the outcomes of the PENG block based only on anatomical parameters and compare them to the conventional, US-guided technique.

A PENG block with no US guidance could be part of several strategies, including preoperative care, pain management,

follow-up, and postoperative care with less need for special equipment.

Materials and Methods

The present is a randomized, descriptive, and comparative anatomical study conducted at the Hip Group of a teaching hospital and performed in the Capital City's Death Verification Service (Serviço de Verificação de Óbitos da Capital, SVOC, in Portuguese), of the City of São Paulo, Brazil. The study team is duly registered at SVOC under number 18/2022, and the study followed its guidelines. The institutional ethics committee approved the study (CAAE 58212220.9.0000.5479).

The present study included a sample of 20 cadavers, with 40 hips not preserved with formalin. We excluded four subjects with skeletal immaturity from the analysis.

Procedures

In a parallel study, Tran et al.⁹ performed a technical comparison of infusions of 10 mL and 20 mL of methylene blue dye in cadaveric hips. They concluded that, although the dispersion of 20 mL was more extensive, both injections stained the entire region between the iliopsoas and the anterior capsule of the hip, in which Gerhardt et al.¹ identified nociceptive nerve branches.

In the present study, we used 20 mL of methylene blue dye to also mimic the anesthetic block originally described by

Girón-Arango et al.⁵ Next, we performed an anatomical dissection to determine the appearance and dye dispersion within the anterior capsule region and compare both methods.

In group 1 (G1), which was randomly composed of the first 10 cadavers (20 hips), we followed the proposed anesthetic block technique,⁵ but taking as parameters only the local anatomical structures herein described, with no direct visualization of adjacent structures using a US equipment. In group 2 (G2), which was also composed of 10 cadavers (20 hips), we performed the conventional US-guided infiltration technique.

Infiltration Technique

We placed the cadaver in horizontal dorsal decubitus (HDD), with no traction, and the hip in a neutral position. The G1 underwent infiltration with no US guidance as follows:

- Identification by palpation of the anterosuperior iliac spine (ASIS) and the pubic symphysis (PS), drawing a straight line between these points.
- Segment division in three equal portions and marking of the midpoint of the lateral third as the needle entry point (►Fig. 1).
- Positioning of a disposable needle for spinal anesthesia (0.7 × 88 mm, 22 G × 3.5", Spinocan, B. Braun, Melsungen, Germany) at the demarcated point, approximately 1 cm from the medial edge of the ASIS. The needle was inclined at 70° in the inferior medial direction and towards the midpoint of the line connecting the ASIS to the PS (►Fig. 2).
- The needle is introduced until it touches the bone.
- Needle is receded for about 1 mm and slow, continuous infiltration of 20 mL of methylene blue is performed.



Fig. 1 Demarcated segment between the anterosuperior iliac spine (ASIS) and the pubic symphysis (PS).

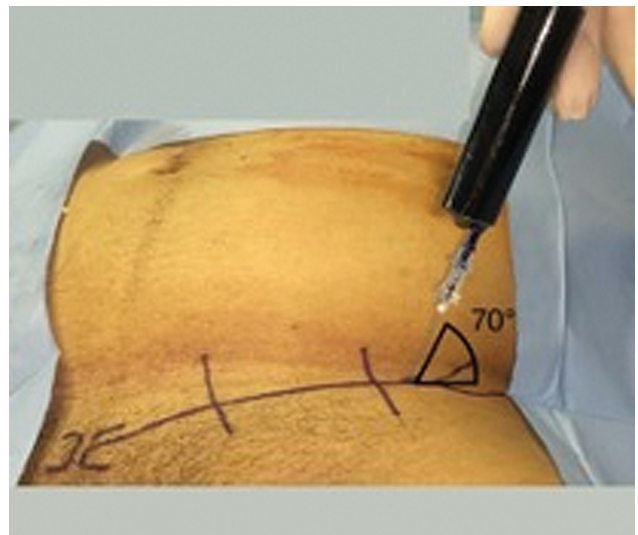


Fig. 2 Needle insertion at a 70° of inclination at the midpoint of the lateral third.

The US-assisted technique, to which the G2 was submitted, consists of the following:

- With the patient in HDD, we positioned a low-frequency (2–5 MHz) convex US probe (Sonosite Edge II, Fujifilm Healthcare, Lexington, MA, United States) over the midpoint of the lateral third of the segment marked in ►Fig. 1 in a transverse plane with 45° counterclockwise rotation of the PS (►Fig. 3).
- Visualizing the iliopsoas tendon and muscle, and the femoral artery and vein, we inserted a needle with the same specification up to the plane between the iliopsoas structures anteriorly and the iliopubic branch, with the iliopectineal eminence posteriorly (►Fig. 4).
- We infused 20 mL of methylene blue in the region.
- We dissected the region and analyzed the correlation and distance between the needle and local significant structures in both techniques.



Fig. 3 Probe positioning in the midpoint of the demarcated segment, with the PS at 45° of inclination.

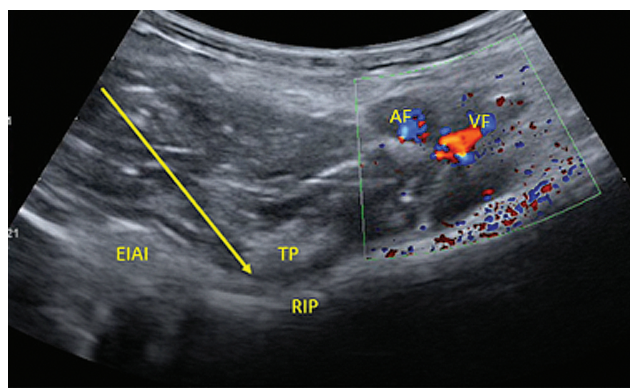


Fig. 4 Ultrasonographic image of the needle path (arrow).
Abbreviations: ASIS, anteroinferior iliac spine; FA, femoral artery; VF, femoral vein; IPB, iliopubic branch; PT, iliopsoas muscle tendon.

Infiltration Analysis

We determined the reliability of the injection per the number of puncture attempts to reach the expected location of the needle at the iliopectineal eminence of the iliopubic branch.

We dissected the anterior region of the hip using a quadrangular skin flap whose apex is on the line from the ASIS to the PS and the base is between the inferior gluteal fold and the midline of the thigh, extending along the antero-lateral aspect of the hip (►Fig. 5). After dissection, we identified the ASIS, the anteroinferior iliac spine (AIAI), the inguinal ligament, the femoral neurovascular bundle, the joint capsule, and the iliopsoas tendon and muscle.

After identifying the aforementioned anatomical structures, we evaluated the integrity of the neurovascular bundle

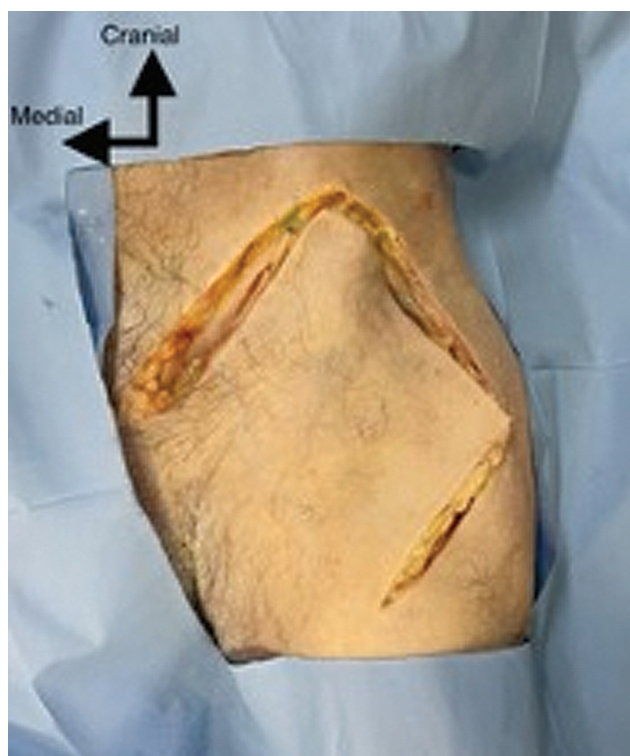


Fig. 5 Quadrangular skin flap for dissection.



Fig. 6 Rectus femoris (RF) muscle retracted for better visualization of the methylene blue dispersion and anterior capsule staining..

due to potential lesions related to a path error and their correlations with the orifice. In addition, we determined the dispersion of the methylene blue dye within the desired plane and the anterior capsule staining to compare the effectiveness of both techniques (►Fig. 6).

Results

The G1 consisted of 8 male (80%) and 2 female (20%) cadavers with a mean age of 70 years and 2 months, a mean weight of 59 Kg, and a mean height of 168 cm. ►Table 1 shows the data from this analysis (►Figs. 7 and 8).

Table 1 Anthropometric data from the group submitted to the technique with no ultrasound guidance

Identification	Gender	Age (years)	Height (meters)	Weight (kilosg)
C1	Male	70	1.73	46
C2	Female	77	1.44	44
C3	Male	69	1.76	85
C4	Male	93	1.63	49
C5	Male	64	1.68	55
C6	Female	62	1.73	60
C7	Male	48	1.66	69
C8	Male	52	1.7	71
C9	Male	78	1.76	68
C10	Male	89	1.7	43

Abbreviation: C, cadaver.

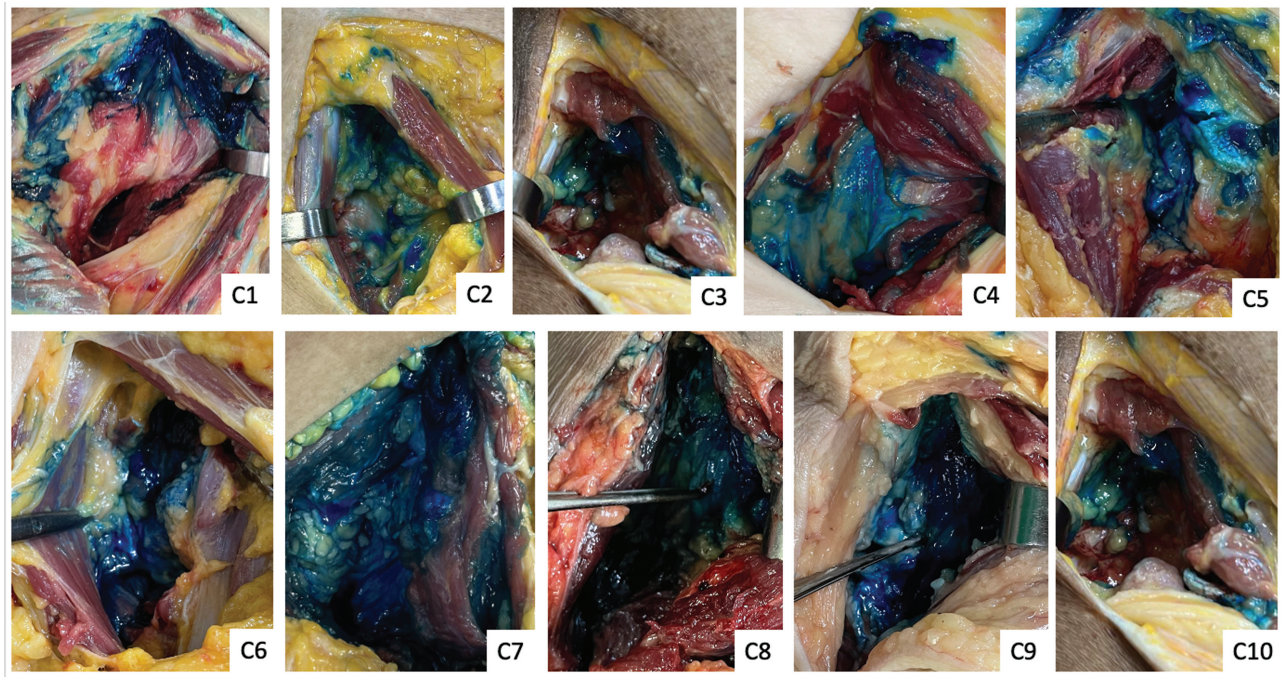


Fig. 7 Right hips from the group submitted to the technique with no ultrasound guidance, showing all capsules stained. Abbreviations: C1 to C10, cadavers 1 to 10.

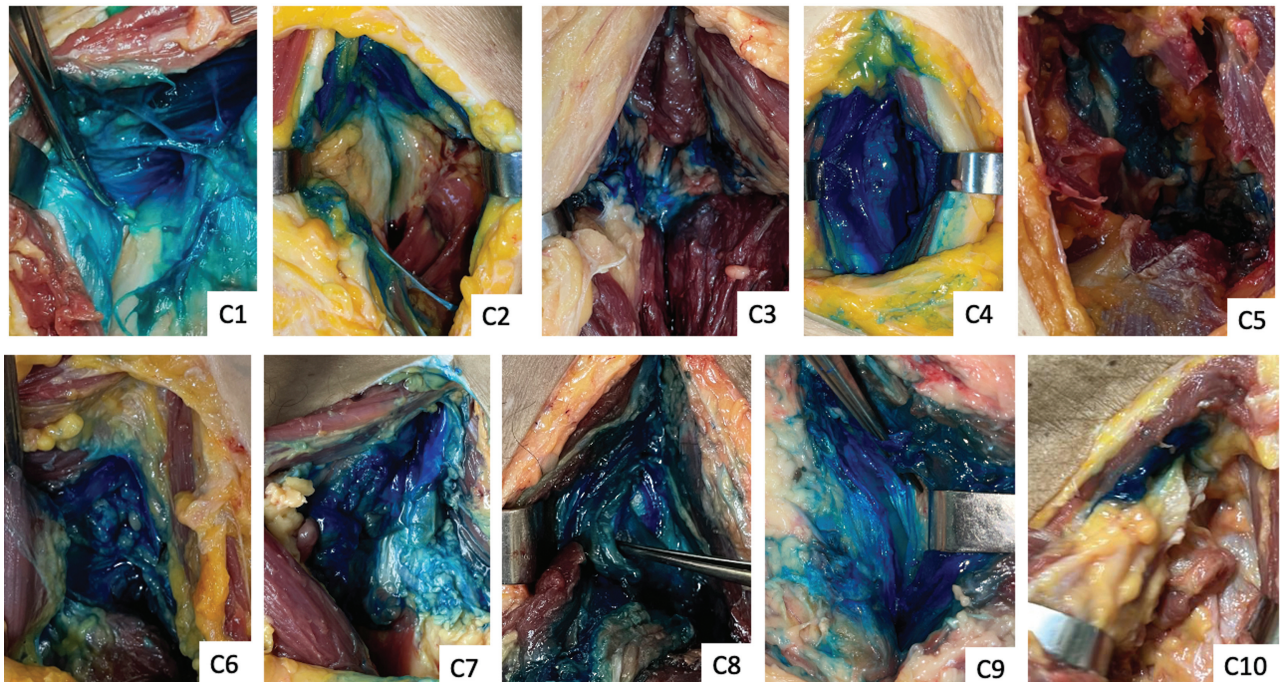


Fig. 8 Left hips from the group submitted to the technique with no ultrasound guidance, showing all capsules stained. Abbreviations: C1 to C10, cadavers 1 to 10.

The G2 consisted of 6 male (60%) and 4 female (40%) cadavers with a mean age of 68 years and 6 months, a mean weight of 72.6 Kg, and a mean height of 169 cm. ►**Table 2** shows the data from this analysis (►**Figs. 9** and **10**).

In the comparative analysis of the dissections, 1 hip from each group (5%) did not show adequate dye dispersion within the anterior capsule. Both techniques led to the expected

location of the needle next to the iliopectineal eminence in the first puncture. There was no lesion, transfixion, or dye staining in neurovascular structures adjacent to the anterior capsule. ►**Tables 3** and **4** show the data from this analysis.

There was no difference between the techniques regarding these parameters. We obtained an adequate dye dispersion at the expected region in 95% of the cases in each group.

Table 2 Anthropometric data from the group submitted to the technique with ultrasound guidance

Identification	Gender	Age (years)	Height (meters)	Weight (kilos)
C11	Male	70	1.72	69
C12	Female	94	1.55	45
C13	Male	45	1.77	57.6
C14	Male	71	1.77	102
C15	Female	79	1.67	87
C16	Male	82	1.75	75
C17	Male	49	1.71	74
C18	Female	50	1.71	72
C19	Male	65	1.71	81
C20	Female	81	1.55	64

Abbreviation: C, cadaver.

Discussion

The proposed technique with no US guidance showed similar results to the PENG block technique aided by US, with no variations between them.

The failure in staining a single anterior capsule in each group occurred in the specimens with the lowest weight (43 Kg and 45 Kg) and oldest ages (89 and 94 years) among the remaining cadavers. This finding may result from the tissue atrophy inherent to advanced age and the smaller space between tissue planes in subjects with lower weights, which impair the effectiveness of the block using a liquid anesthetic dispersion.³

The pioneer study can help patients with hip pain of various causes in need of relief. It is worth mentioning that the technique with no US guidance is technically easy and cheap. Since it can be performed with basic hospital

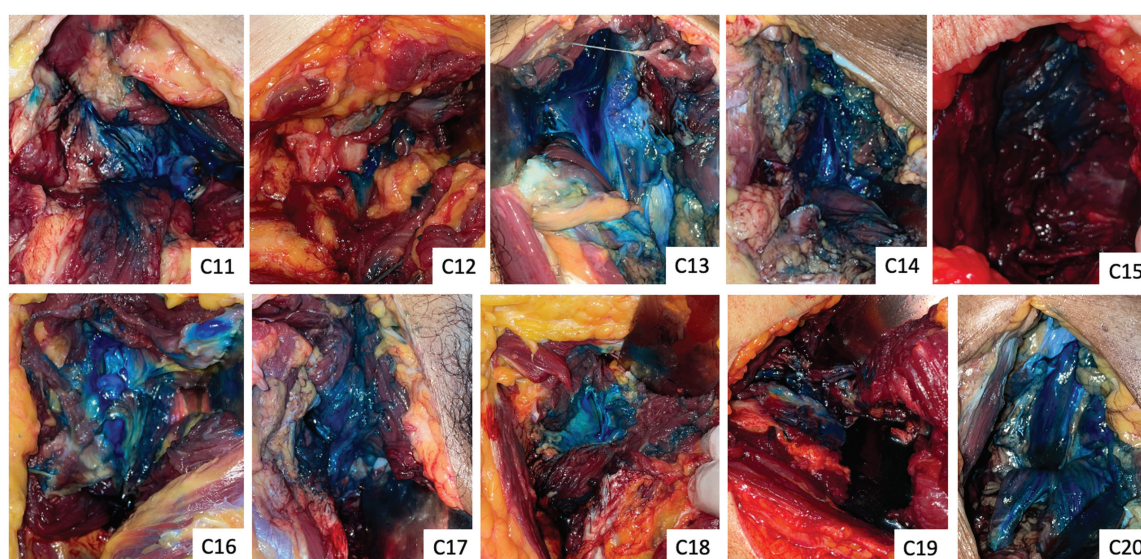
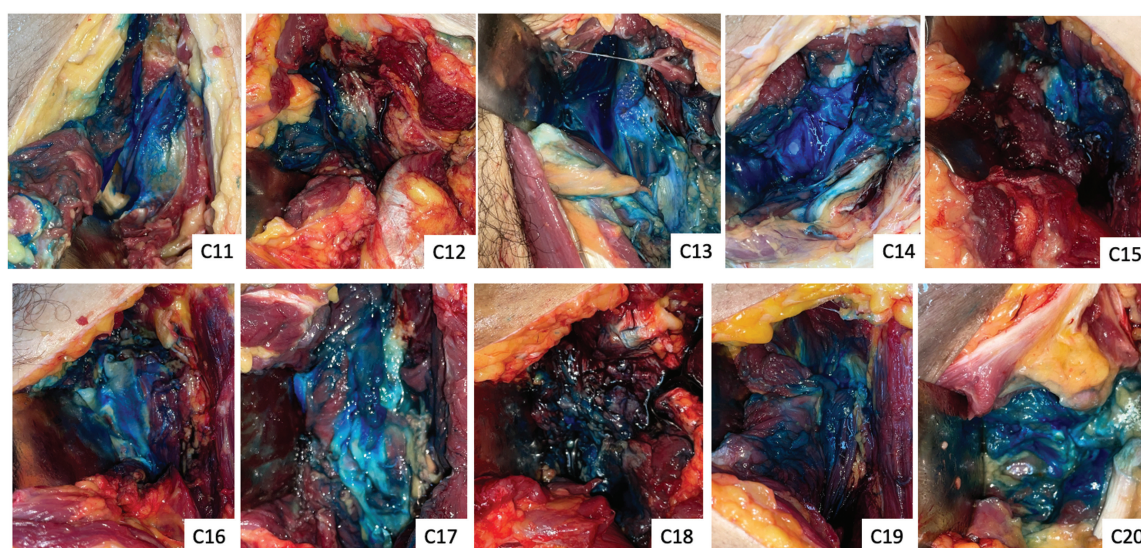
**Fig. 9** Right hips from the group submitted to the technique with ultrasound guidance, showing no capsule staining. Abbreviations: C11 to C20, cadavers 11 to 20.**Fig. 10** Left hips from the group submitted to the technique with ultrasound guidance, showing no capsule staining. Abbreviations: C11 to C20, cadavers 11 to 20.

Table 3 Puncture data and dissection analysis from the group submitted to the technique with no ultrasound guidance

Identification	Bone reached at first puncture	Neurovascular bundle hit	Right anterior capsule staining	Left anterior capsule staining
C1	Yes	No	Yes	Yes
C2	Yes	No	Yes	Yes
C3	Yes	No	Yes	Yes
C4	Yes	No	Yes	Yes
C5	Yes	No	Yes	Yes
C6	Yes	No	Yes	Yes
C7	Yes	No	Yes	Yes
C8	Yes	No	Yes	Yes
C9	Yes	No	Yes	Yes
C10	Yes	No	Yes	No

Abbreviation: C, cadaver.

materials and supplies, it constitutes a viable alternative in situations with limited access to US equipment in different sectors and levels of care. In addition, it may be a good option for analgesia, preventing the use of oral opioids and their side effects.^{5,6}

The limitation of the present study is the use of cadaveric specimens, which may present tissue and anatomical plane changes despite the recent post-mortem period.

Conclusion

The proposed method of hip PENG block with no US guidance is reproducible, safe, effective, and highly reliable when compared with the US-guided technique.

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Conflict of Interests

The authors have no conflict of interests to declare.

Table 4 Puncture data and dissection analysis from the group submitted to the technique with ultrasound guidance

Identification	Bone reached at first puncture	Neurovascular bundle hit	Right anterior capsule staining	Left anterior capsule staining
C11	Yes	No	Yes	Yes
C12	Yes	No	No	Yes
C13	Yes	No	Yes	Yes
C14	Yes	No	Yes	Yes
C15	Yes	No	Yes	Yes
C16	Yes	No	Yes	Yes
C17	Yes	No	Yes	Yes
C18	Yes	No	Yes	Yes
C19	Yes	No	Yes	Yes
C20	Yes	No	Yes	Yes

Abbreviation: C: cadaver.

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