








Research Article | Araştırma Makalesi

ANTERIOR ILIAC BLOCK FOR BONE GRAFT HARVESTING: A CADAVERIC STUDY

KEMİK GREFTİNDE ANTERİOR İLİAK BLOK: KADAVRA ÇALIŞMASI

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ABSTRACT

Objective: Anterior iliac crest (AIC) is frequently used as a donor site for various constructive surgeries. However, it is associated with severe postoperative pain that increases morbidity. To provide analgesia in the donor site with a low volume, a novel technique was described named anterior iliac block (AIB). It provides effective analgesia, but the mechanism of action is not clear. We designed this study to demonstrate the mechanism of AIB.

Methods: In this cadaveric study, AIB was performed with 10 mL (right side) and 20 mL (left side) of drug containing methylene blue and radiopaque dye on opposite sides. Following the block application, the spread on both sides was evaluated with 3D computed tomography. Afterwards, systematic layer-by-layer cadaver dissection was carried out by an orthopedic surgeon and anatomist experienced in pelvic anatomy.

Results: The spread was more extensive on the left side, it predominantly extended in a cranial direction. In contrast, on the right side, where a lower volume was administered, the injectate remained localized within the fascial plane surrounding the iliac crest. On the left side, spread was observed in the fascial plane above the iliacus muscle, and the cutaneous branches of spinal nerves were stained. Additionally, dye was observed in the ilioinguinal nerve. On the right side, dye staining in the cutaneous branches above the iliac crest was observed.

Conclusion: This cadaveric study demonstrates that AIB effectively targets the cutaneous branches of the subcostal, iliohypogastric, and ilioinguinal nerves with low volume.

Keywords: Regional anesthesia, anterior iliac block, cadaveric study, postoperative analgesia

ÖZ

Amaç: Anterior iliak krest (AİK), rekonstrüktif cerrahilerde sıklıkla greft donör sahası olarak tercih edilmektedir. Ancak bu bölgeye yönelik girişimler, morbiditeyi artıran ciddi postoperatif ağrılarla ilişkilidir. Donör bölgesine düşük hacimde lokal anesik ile analjezi sağlamak amacıyla “anterior iliak blok (AİB)” adı verilen yeni bir teknik tanımlanmıştır. AİB etkili bir analjezi sağlasa da etki mekanizması açık değildir. Bu çalışmayı, AİB’nin etki mekanizmasını araştırmayı amaçladık.

Yöntem: Bu kadavra çalışmasında, AİB sol tarafa 20 mL ve sağ tarafa 10 mL olacak şekilde metilen mavisi ve radyopak boya içeren ilaçla uygulandı. Blok uygulamasının ardından, her iki taraftaki yayılım üç boyutlu bilgisayarlı tomografi ile değerlendirildi. Daha sonra, pelvik anatomi konusunda deneyimli bir ortopedi cerrahı ve bir anatomist tarafından sistematik olarak katman katman kadavra diseksiyonu gerçekleştirildi.

Bulgular: Sol tarafta yayılım daha genişti ve özellikle kranial yönde ilerleme gözlemlendi. Buna karşılık, daha düşük hacmin uygulandığı sağ tarafta, enjeksiyon sıvısı iliak krest çevresindeki fasyal plan içinde sınırlı kaldı. Sol tarafta, iliakus kası üzerindeki fasyal planda yayılım gözlemlendi ve spinal sinirlerin kutanöz dalları boyandı. Ayrıca, ilioinguinal sinirde de boya izlendi. Sağ tarafta ise iliak krest üzerindeki kutanöz dallarda boya tutulumu saptandı.

Sonuç: Bu kadavra çalışması, AİB’nin düşük hacimle uygulandığında subkostal, iliohipogastrik ve ilioinguinal sinirlerin kutanöz dallarını etkili bir şekilde hedef aldığını göstermektedir.

Anahtar Kelimeler: Rejyonel anestezi, anterior iliak blok, kadavra çalışması, postoperatif analjezi

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Introduction

Anterior iliac crest (AIC) is frequently used as a donor site for various constructive surgeries.¹ It is preferred because it can be accessed in the supine position. However, it is associated with severe postoperative pain that increases morbidity.²

To provide analgesia in the donor site, local anesthesia infiltration can be used.³ Nevertheless, it is performed after the harvesting and has a short duration of action. There are several regional anesthesia techniques that can be performed to provide analgesia in the donor site such as transversus abdominis plane (TAP) block, erector spinae plane (ESP) block, transmuscular quadratus lumborum block (QLB) and transversalis fascia plane (TFP) block in order to block the T12-L1 spinal nerves which innervates AIC.⁴⁻⁷ However, these techniques are fascial plane blocks and high volumes of local anesthetic is needed. Considering the primary surgical procedure and the need for high-dose regional blocks (e.g., brachial plexus block, sciatic nerve block) to achieve adequate analgesia, the additional use of a high-volume fascial plane block for the donor site may substantially increase the risk of local anesthetic systemic toxicity.

Therefore, we described a new technique called anterior iliac block (AIB) which requires low volumes, such as 10 mL.⁸ The injection point is in the vicinity of the donor site, medial to anterior iliac crest, between the iliacus muscle and aponeurosis of transversus abdominis muscle, which lies below internal oblique muscle. The injection point is also the junction where the thoracolumbar fascia merges with the iliac fascia, where small cutaneous branches that innervates anterior iliac crest may exist, this may also explain why a small volume is effective. However, the mechanism of action is not clear and cadaveric studies demonstrating the spread of the injectate are needed.

We designed this study to demonstrate the mechanism of the anterior iliac block. In this cadaveric study, we aimed to compare the spread of 10 mL and 20 mL of drug injected on opposite sides, in order to assess whether a

higher volume is essential. Our primary objective was to assess the spread of the injectate using computer tomography (CT) imaging, and the secondary objective was to identify the cutaneous nerve branches blocked.

Methods

Cadaver selection and preparation

Dissections were performed on a cadaver, from woman aged 65. The human tissue, acquired via an institutional body donation program with agreement for exclusive use in teaching and research, were embalmed using Thiel's method. The cadaver had no history of surgical interventions or significant operations in the pelvic or abdominal area. The study was conducted following the procedures approved by the Non-Interventional Ethical Committee of Kocaeli University School of Medicine (GOKAEK-2024/13.31).

Solution

For the anterior iliac block, a total of 30 mL mixture containing 1% methylene blue was obtained using 15 mL of 2% methylene blue, 13 mL of 0.9% saline solution, and 2 mL of radiopaque dye (Iohexol, Kopaq 350 mg/1 mL, Koçsel).⁹

Ultrasound guided anterior iliac block

The probe was placed on the anterior aspect of the anterior iliac crest (Figure 1A). Afterward, the probe was advanced medially and tilted cranially to visualize the iliacus muscle where it attaches to AIC. In the ultrasound image, the iliacus muscle, internal oblique muscle above, aponeurosis of transversus abdominis muscle between these muscles, and ilium were seen (Figure 1B). With an in-plane approach, an 80-mm block needle was advanced from lateral to medial, and 10 mL of the solution on the right side and 20 mL of solution on the left side was injected in the plane between the iliacus and aponeurosis of transversus abdominis muscle.

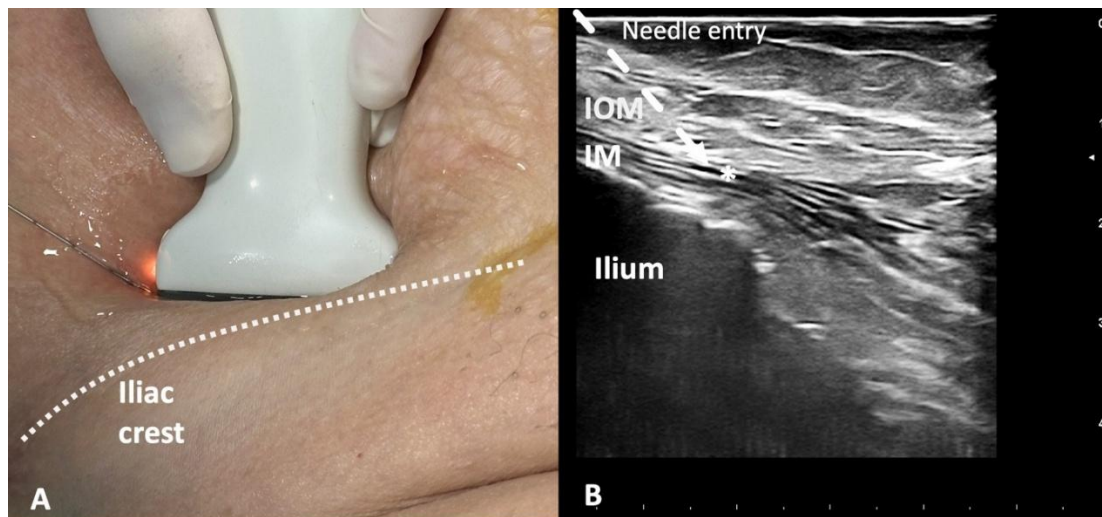


Figure 1. Ultrasound guided anterior iliac block. A: Probe position, B: Ultrasound image, IOM: Internal oblique muscle, IM: Iliacus muscle, *Injection point

Computed Tomographic Scanning

One hour after the block application, the imaging procedures described below were applied to both sides in order to evaluate post-injection spread:

Scanning was conducted with the cadaver in the supine position using a 640-slice CT apparatus (Aquilion One, Canon). Images scanned in helical mode at 120 kV with a rotation duration of 0.5 seconds were examined in the soft tissue window (level: 40, width: 400) using Vital Vitrea software (Canon Group, Minnetonka, MN, USA). The radiologist assessed the images in the axial, coronal, and sagittal planes.

Anatomical Dissection and Stain Spread Analysis

Following the imaging procedures, systematic layer-by-layer cadaver dissection was carried out by an orthopedic surgeon and anatomist experienced in pelvic anatomy (2 hours after the block application).

Results

The three-dimensional distribution of the injectate, as visualized on computed tomography, is presented in Figure 2 (Figure 2A: right side, Figure 2B: left side). Although the spread was more extensive on the left side, it predominantly extended in a cranial direction. In contrast, on the right side, where a lower volume was administered, the injectate remained localized within the fascial plane surrounding the iliac crest.

On the right side, methylene blue spread was observed in the fascial plane above the iliacus muscle. In addition, dye staining in the cutaneous branches of spinal nerves above the iliac crest was seen (Figure 3). On the left side, dye staining in the cutaneous branches above the iliac crest was observed (Figure 4A). Additionally, dye was observed in the ilioinguinal nerve (Figure 4B).

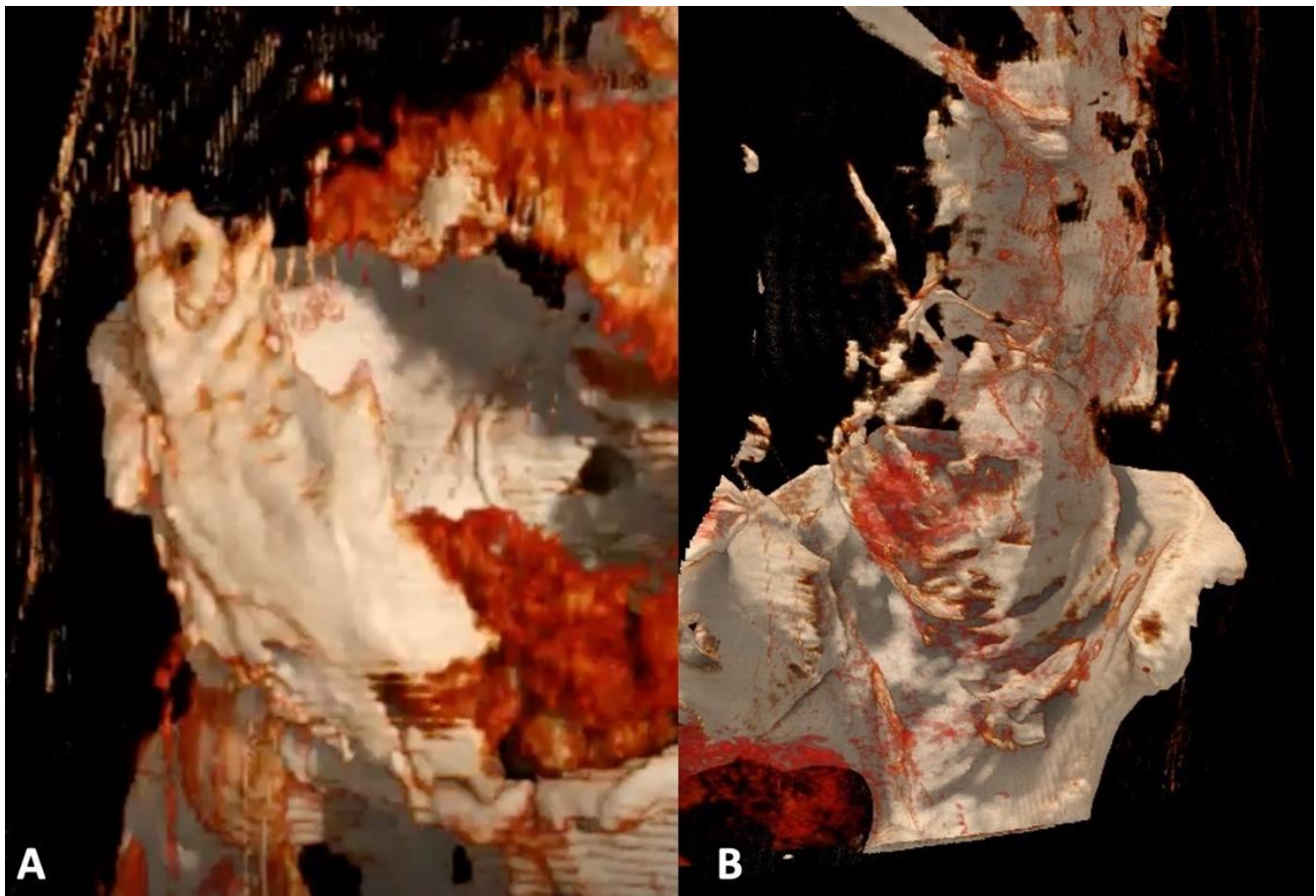


Figure 2. 3D CT images of the drug spread. A: Spread on the right side (10 mL), B: Spread on the left side (20 mL)



Figure 3. Dissection of the left side (20 mL). White arrows show the cutaneous branches of spinal nerves.

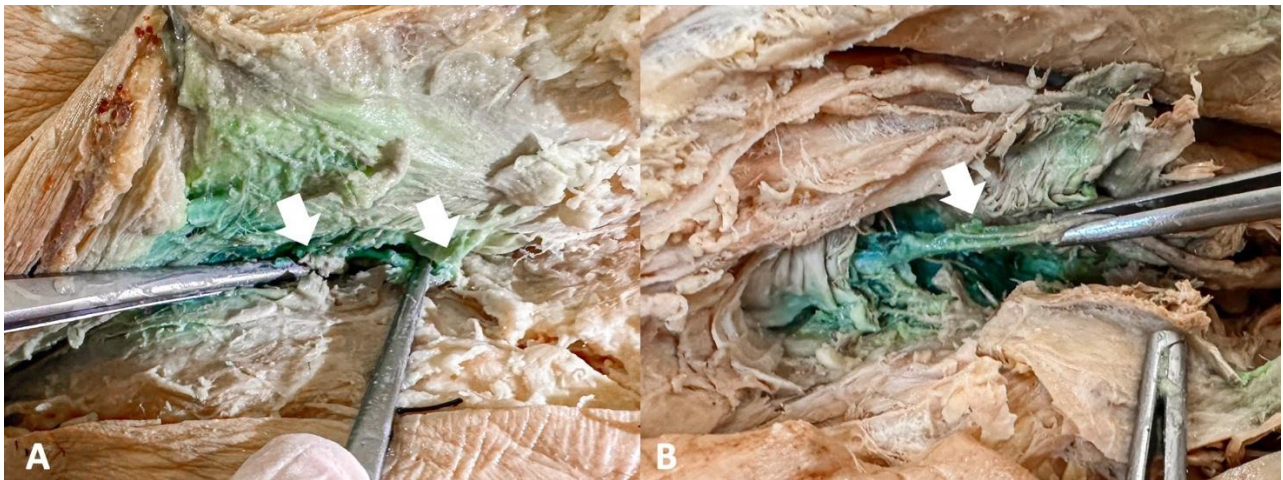


Figure 4. Dissection of the right side (10 mL). A: White arrows show the cutaneous branches of spinal nerves, B: White arrow shows the ilioinguinal nerve

Discussion

In this cadaveric study investigating the mechanism of action of the anterior iliac block and comparing the effects of low and high volumes, we observed that the cutaneous branches of spinal nerves innervating the anterior iliac crest as well as the ilioinguinal nerve were consistently involved. Our findings suggest that a high injectate volume is not necessary for the effectiveness of this technique.

Innervation of the ilium is complex, however anterior iliac crest is mainly innervated by subcostal, ilioinguinal, and iliohypogastric nerves.^{10, 11} Cutaneous branches of these nerves are responsible with this innervation. These

nerves also innervate the skin and the subcutaneous tissue above the iliac crest. Cutaneous branches of these nerves and the ilioinguinal nerve are located above the iliacus muscle in the vicinity of anterior iliac crest.¹²⁻¹⁴ Therefore, we thought that low-volume local anesthetic injection at this site can provide analgesia at both the anterior iliac crest—the graft harvest site—and the surgical incision area and defined the anterior iliac block (AIB).⁸ Indeed, we found that low-volume injection was effective in providing postoperative analgesia. With this cadaveric study, we demonstrated the mechanism of action of the AIB and confirmed that low volumes are sufficient to block the nerves involved in the innervation of the anterior iliac crest. While high-volume injection resulted in more cranial spread and potentially involved additional dermatomes, this extended distribution is

unlikely to contribute to postoperative analgesia for bone graft harvesting from the iliac crest.

There are a number of limitations to this study. The first involves a cadaver. Drug spread might usefully be investigated with more cadavers. In addition, the contrast material added to visualize the spread with CT may also have affected the drug diffusion. Finally, this was a cadaver study, and the tissues being non-living may also have impacted the drug spread. Although cadavers embalmed using the Thiel method are regarded as providing the best physical and functional characteristics in investigating the mechanisms of regional techniques, the present research now needs to be supported by in vivo clinical studies.

In conclusion, this cadaveric study demonstrates that AIB effectively targets the cutaneous branches of the subcostal, iliohypogastric, and ilioinguinal nerves, which are responsible for the sensory innervation of the anterior iliac crest. Our findings indicate that low-volume local anesthetic injection at the defined site may be sufficient to achieve postoperative analgesia in the graft harvest region, without the need for higher volumes. However, further studies are needed to validate the mechanism of action.

Ethical Approval

The study was conducted following the procedures approved by the Non-Interventional Ethical Committee of Kocaeli University School of Medicine (GOKAEK-2024/13.31).

Conflict of Interest

There is no conflict of interest to declare.

Author Contributions

HUY: Study conception and design, data collection and analysis, manuscript drafting, final approval; AÖ: Study conception and design, data collection, manuscript drafting; SD: Data collection, manuscript revision; VA: Data collection, literature review, manuscript drafting; SC: Literature review, manuscript revision; ÖÇ: Study conception and design, data collection and analysis, methodological supervision; CA: Study conception and design, data collection, methodological supervision.

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