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Minimally invasive percutaneous technique for harvesting iliac crest graft using a tap and drill sleeve

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ABSTRACT

Introduction and aim. Orthopedic surgeries often require acquiring cancellous bone grafts, commonly sourced from the iliac crest. Traditional harvesting methods pose risks of donor site morbidity, prompting interest in minimally invasive techniques. This study introduces and evaluates the efficacy and safety of a percutaneous technique using a tap and drill sleeve for iliac crest bone graft harvesting. This study aims to assess outcomes and complications associated with a minimally invasive percutaneous technique for iliac crest bone graft harvesting through a retrospective analysis of twenty patients undergoing upper limb reconstructive surgery.

Material and methods. A retrospective analysis was conducted on twenty patients who underwent upper limb reconstructive surgery between January and March 2023. The technique involved making a bone deep stab incision, precisely positioning a drill and tap sleeve, utilizing controlled tapping techniques, and extracting the graft. Post-operative assessments included evaluating pain levels, ambulation, and patient satisfaction.

Results. The minimally invasive percutaneous technique demonstrated favorable outcomes, with reduced donor site morbidity observed. Within 24 hours post-operatively, 70% of patients reported low visual analogue scale scores, and 80% regained normal walking ability. No instances of post-operative paresthesia were reported.

Conclusion. The examined minimally invasive percutaneous technique for iliac crest bone graft harvesting showed reliability and safety, particularly in low resource settings. Utilizing basic orthopedic tools such as tap and drill sleeves offers accessibility and affordability. This approach could effectively mitigate donor site morbidity in orthopedic reconstructive treatments.

Keywords. bone grafting, donor site morbidity, iliac crest, minimally invasive technique, percutaneous, tap and drill sleeve

Introduction

Bone grafting procedures are routine in orthopedic surgeries, often requiring the acquisition of cancellous bone grafts. An autograft is usually preferred because it possesses osteogenic, osteoconductive, and osteoinductive properties. Additionally, its usage helps prevent graft rejection and the transmission of viral infections.[1] The iliac crest is often the preferred source of autogenous bone grafts due to its abundance.[2] However, traditional harvesting techniques pose significant risks of donor site morbidity, including pain, neurovascular injury, and prolonged recovery.[3] In response, researchers have increasingly shown interest in developing minimally invasive methods to address these concerns. The classic approach to iliac crest bone harvesting involves a larger incision and the use of specialized tools such as Steinmann pin, chisels and osteotomes, which may not be readily available in all surgical settings.[4] In contrast, minimally invasive techniques utilize basic orthopedic tools, such as a drill fitted with a tap sleeve, to achieve graft extraction with reduced tissue trauma and shorter recovery times.

This paper aims to introduce a minimally invasive percutaneous technique for harvesting iliac crest bone grafts, utilizing a tap and drill sleeve, and compare its efficacy and safety with traditional harvesting methods. By conducting a retrospective analysis of twenty patients undergoing upper limb reconstructive surgery. We seek to evaluate the outcomes and complications at the donor site associated with this novel approach. By emphasizing affordability, accessibility, and reduced morbidity particularly in scenarios where access to specialized instruments is limited. We aim to contribute to the ongoing optimization of orthopedic reconstructive treatments.

Aim

A retrospective study of twenty patients undergoing reconstructive surgery on the upper limbs demonstrates favorable outcomes with reduced donor site morbidity. The presented method entails thorough preparation of the iliac crest, a bone deep stab incision, and graft extraction utilizing a drill equipped with a tap sleeve. The study uncovers the potential benefits of this minimally invasive approach in mitigating typical concerns associated with iliac crest bone graft harvesting.

Material and methods

A retrospective examination analyzed 20 patients (15 males and 5 females) who underwent bone grafts for various upper limb reconstructive procedures between Jan 2023 and Mar 2023. Each patient provided written informed consent for publication. When assessing bone graft volume requirements, the surgeon considered factors such as bone loss, degree of comminution, and post-fixation fracture gap. Grafting the transplant according to each patient's specific requirements ensured optimal outcomes. Patients positioned supine or lateral depending on the location of the fracture. Sterility maintained by cleaning the anterior iliac crest with a povidone-iodine solution and covering the donor site.

Results

The process of initiating the minimally invasive bone graft harvesting technique involved creating a bone deep stab incision, approximately 2 cm in length, directly above the widest area of the iliac crest (Fig.1).

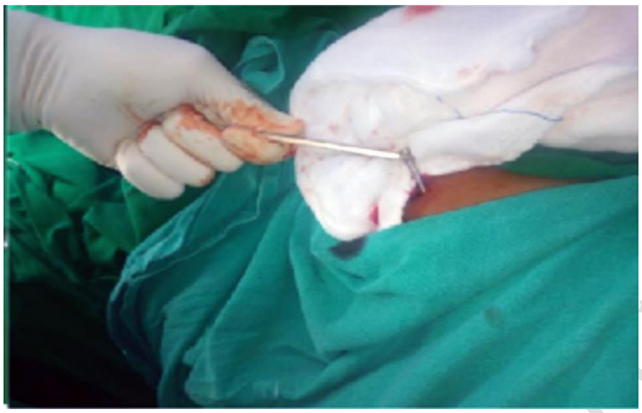

Fig. 1. Bone-deep stab incision positioned above the widest point of the iliac crest

To safeguard the integrity of the lateral femoral cutaneous nerve, this incision was carefully placed away from the anterior superior iliac spine (ASIS) using a surgical blade No. 11. By palpating the surfaces of the iliac crest, precise positioning of a 3.5mm drill and tap sleeve with base teeth at the midpoint of the crest was achieved. This ensured accurate placement for subsequent steps in the procedure. To optimize alignment between the drill sleeve edge and the core bone, employ meticulous rotational adjustments and controlled tapping techniques. This ensures direct contact between the drill sleeve and the core bone (Fig. 2).

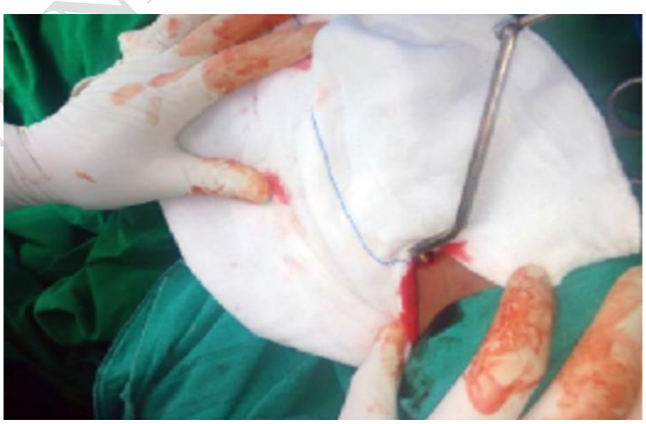

Fig. 2. Palpation-guided drill placement with meticulous adjustments for optimal alignment with core bone

Employing gentle hammering followed by screwing to initiate the fracture of the core. Subsequently, the sleeve was adjusted through either hammering or screwing into the crest, tailored according to the size of the defect and the specific needs of the patient.

Rotating the sleeve in a 360-degree arc facilitated the entrapment of the core graft within the sleeve, after which we expelled it along with the core bone. Additional crestal perforations were made as necessary to enable the acquisition of multiple corticocancellous bone pegs. The core cancellous bone is pushed out from the sleeve along with the core bone. Average extracted core bone size is approximately 1.5 cm (Fig. 3).

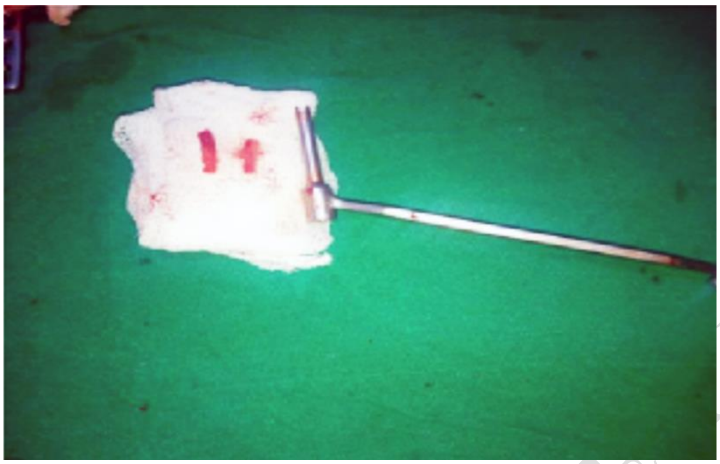

Fig. 3. A cylindrical shaped cancellous bone graft delivered by tap sleeve

The wound closure entailed using a full thickness 1-0 nylon suture, supplemented with absorbent dressing (Fig. 4).

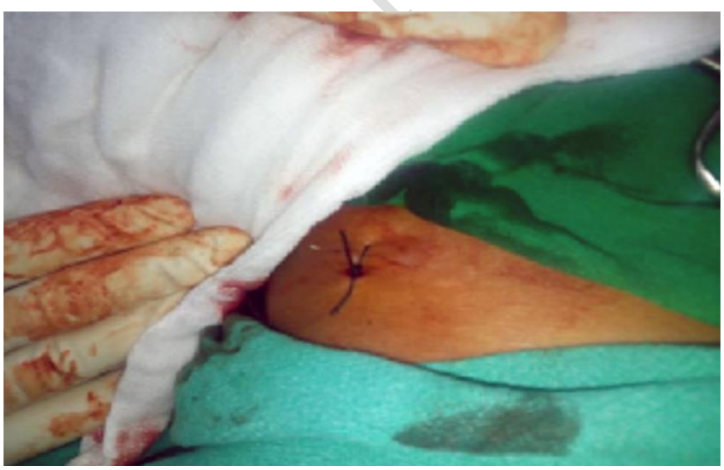

Fig. 4. Wound closure performed with a full-thickness 1-0 nylon suture, complemented by absorbent dressing

In terms of bone grafts, 40% of patients received grafts from their left crests, whereas 60% received grafts from their right. Stable fixation required bone grafting for four ankle fractures, two humerus fractures, one lateral condyle fracture, and thirteen forearm fractures. Post-operatively, visual analogue scale scores over 24 hours indicated that 70% of individuals reported a score of 0, while 15% reported a score of 1, 10% reported a score of 2, and 5% reported a score of 4. No post-operative reports of paresthesia were recorded. Within 24 hours, 80% of patients with upper limb fractures regained normal walking ability, while the remaining 20% required assistance for up to 72 hours. Moreover, all patients were satisfied with the aesthetic outcome of the procedure.

Discussion

Bone grafting is one of the most common procedures performed in orthopedic surgery. Bone graft harvesting from iliac donor sites can cause complications, such as pain, neurovascular injury, and avulsion fractures.[5] Minimally invasive techniques, such as the custom bone graft harvester, allow harvesting of autologous bone from the iliac crest, potentially reducing morbidity in fusion procedures.[6] Drill tap sleeve techniques result in fewer complications, reduce hospitalization durations, and earlier ambulation compared to traditional open harvesting methods. It also linked with less postoperative pain, local tenderness, discomfort on walking, and sensory disturbances.[7] Various sophisticated bone harvesting instruments available on the market are quite expensive. Accessing such tools might not always be possible, especially in a remote location having basic amenities.

The percutaneous method entails making a bone deep stab incision, approximately 2 cm in length, over the widest portion of the iliac crest, which is smaller compared to the traditional classic technique involving a larger incision providing direct access to the iliac crest, with the incision size typically varying but generally being larger than the percutaneous approach.[8] Current technique utilizes a 3.5mm tap sleeve with a drill for graft harvesting, relying on basic orthopedic operating room tools, whereas the classic harvesting technique typically employs specialized tools like Steinmann pin, chisels and osteotomes to create a larger bone graft.[9] Iliac crest is cleansed with a povidone-iodine solution, and the donor site is covered during the procedure, while the other technique may require preparation of a larger area and more extensive cleaning owing to the larger incision.[10] Our method aims to mitigate donor site morbidity, such as discomfort, hematoma, infection, nerve damage, and iliac crest fractures, contrasting with the traditional technique, which is linked to greater donor site morbidity due to the larger incision and more invasive instruments used. The study highlights fluctuating levels of postoperative pain, with many patients achieving low VAS scores within 24 hours and regaining normal walking ability within the same timeframe. This contrasts with potential variations in postoperative pain, increased discomfort, and a prolonged recovery period in the classic technique.

Conclusion

The findings of this study suggest that the examined approach can harvest bone grafts reliably and safely, especially in low demand scenarios. Drill tap sleeves emerge as an essential tool for our method particularly in settings with limited access to complex instruments, such as peripheral environments with only basic amenities. Additionally, their widespread availability entails no extra expenses. We propose that embracing a minimally invasive approach to graft harvesting could reduce donor site morbidity. Our institution has extensively employed the technique outlined in this study confirming its efficacy and practicality over an extended period.

Declarations

Funding

No funds were received.

Author contributions

Conceptualization, R.K., A.M., N.S., A.S., R.R. and A.B.; Methodology, R.K., A.M., N.S., A.S., R.R. and A.B.; Investigation, R.K., A.M., N.S., A.S., R.R. and A.B.; Resources, R.K., A.M., N.S., A.S., R.R. and A.B.; Writing – Original Draft Preparation, R.K., A.M., N.S., A.S., R.R. and A.B.; Writing – Review & Editing, R.K., A.M., N.S., A.S., R.R. and A.B.; Project Administration, R.K., A.M., N.S., A.S., R.R. and A.B.

Conflicts of interest

The authors declare that there are no conflicts of interest associated with this work.

Data availability

Not applicable.

Ethics approval

Written informed consent for publication was obtained from the patient. We complied with the policy of the journal on ethical consent.

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