Research Article

Trephine biopsy versus conventional open surgical technique for bone graft harvesting from the olecranon: A retrospective comparison of perioperative outcomes

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ABSTRACT

Objective: This study aimed to compare the perioperative clinical outcomes of trephine biopsy (TB) with the conventional open surgical method (COSM) in bone graft harvesting from the olecranon.

Methods: In this retrospective study, 130 patients who underwent bone graft harvesting from the olecranon using either TB or COSM were included. Patients were then divided into two groups: the COSM group (48 patients; 36 men and 12 women; mean age=32 years; age range=18-52) and the TB group (82 patients; 61 men and 21 women; mean age=34 years; age range=20-62). The mean follow-up was 30 months (range=17-57) in the COSM group and 26.8 months (range=6-48 months) in the TB groups. The two groups were compared in terms of pain intensity, operating time, complication rate, elbow range of motion, and the scar sensitivity of the graft donor site. Pain intensity was measured using the visual analogous scale (VAS) on postoperative days 1 and 15. Other outcome measures were evaluated at the final follow-up.

Results: In the TB group, the mean VAS score was 4±1.62 on postoperative day 1 and 1.6±0.76 on postoperative day 15. In the COSM group, the mean VAS score was 7.2±1.38 on postoperative day 1 and 3.1±1.34 on postoperative day 15. The early VAS scores were significantly higher in the COSM group than in the TB group (p<0.05). The mean operating time was 7±1.99 minutes in the TB group and 20±4.51 minutes in the COSM group. Hematoma occurred in one patient from each group, with an incidence of 2.1% in the COSM group and 1.2% in the TB group. There was no significant difference between the two groups regarding elbow range of motion at final follow-up p>0.05). No patient in the TB group showed sensitivity of the scar region, while scar sensitivity occurred in 3 of 48 patients (0.6%) in the COSM group.

Conclusion: Compared with COSM, TB seems to be a safe technique with similar complication rates. TB can provide shorter operating time, less postoperative pain, and smaller and less sensitive scar compared with COSM.

Level of Evidence: Level IV, Therapeutic study

Introduction

Hand surgeons use bone grafts to speed up fracture healing, fill bone defects, perform bone elongation operations, and arthrodesis (1). Currently, used bone graft materials include autografts, allografts, and bone substitutes. However, autografts are still the gold standard due to their osteoconductive, osteoinductive, osteogenic, and non-immunogenic features (2).

Bone grafts are obtained from donor sites, such as the ilium, trochanteric region, proximal tibia, distal radius, and olecranon (2). Autograft harvesting procedures cause donor site morbidities, including pain, local hematoma, urethral injury, incisional hernia, hypoesthesia, and even fracture (3, 4).

In general, lesser amounts of bone graft material are required for upper extremity reconstructions than for lower extremity reconstructions. Thus, a sufficient amount of bone graft material for the upper extremity surgery can be obtained from the ipsilateral olecranon. The olecranon is surgically easy to reach and has a relatively low complication rate after graft resection (5). Furthermore, the olecranon is suitable for the recently introduced trephine biopsy (TB) method of bone graft resection.

The purpose of this study was to compare the outcomes of olecranon bone graft harvested via TB with the conventional open surgical method (COSM), focusing on donor site complications and patient satisfaction. We hypothesized that the less invasive TB method would result in a lower donor site complication rate and greater patient satisfaction than the COSM method.

Materials and Methods

This study was approved by the ethical committee of the institution (2019/04-05) where the study was conducted, and all patients provided informed consent. A total of 130 patients underwent olecranon graft resection using either the COSM or TB at a single institution between 2005 and 2015.

There were 48 patients who underwent the COSM (COSM group); these patients comprised 36 men and

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12 women, with a mean age of 32 years (range: 18-52 years). There were 82 patients who underwent TB (TB group); these patients comprised 61 men and 21 women, with a mean age of 34 years (range: 20-62 years). The mean follow-up periods for the COSM and TB groups were 30 months (range: 17-57 months) and 26.8 months (range: 6-48 months), respectively.

A majority of grafts was obtained with the COSM in the earlier years of our practice, between 2005 and 2010. We started using TB more frequently after 2010. The inclusion criteria were: ipsilateral upper extremity surgery, age older than 18 years, and a minimum 6-month follow-up. Patients with upper extremity paresthesia and paralysis, a history of elbow fracture, olecranon bursitis, infectious skin lesions on elbow, and those with no recorded visual analog scale (VAS) pain score were excluded. The surgical procedures for which the bone grafts were used are shown in Table 1.

The COSM and TB groups were compared with regard to patient age, sex, harvested side (dominant or non-dominant), indication for surgery, complications, and mean surgical procedure duration. The VAS score was measured for all patients on postoperative days 1 and 15. The final follow-up examination also included an assessment of the scarring of the graft donor site, and a comparison of the range of motion of the elbow used for bone graft resection with the contralateral side.

Bone grafting techniques

Conventional open surgical method
A 3-4 cm longitudinal incision was created on olecranon, and an adequate exposure was obtained by removing the periosteal flap from the bone. A bone window (1 cm long and 1-4 cm wide) was resected using an osteotome or a surgical saw (Figure 1). The cortical lid was closed after the cancellous bone graft was obtained from the bone window. The overlying periosteal flap was closed with a 3-0 absorbable suture and the skin was closed with a 4-0 non-absorbable suture. Patients were permitted to move their elbows postoperatively (6).

Trephine biopsy
A 4-10 mm trephine (Shenzhen Sinowares, Guangdong, CHN) was used, depending on the graft amount needed. A 1-1.5 cm long skin incision was created 5 mm proximal to the olecranon tip (similar to the incision made for the introduction of an intramedullary rod). The tendon of the triceps was separated using the split approach. The trephine was pushed forward with rotational movements along the long axis of the ulna under fluoroscopic guidance (Figure 2); anteroposterior and lateral fluoroscopic controls were used to prevent ulnohumeral joint injury. The trephine was pushed forward until the desired amount of graft material was obtained. The trephine was removed while still oscillating from the point where the desired amount of graft material was obtained. About 1-3 cm^3 bone graft was obtained according to the diameter of the selected trephine. The graft was ex-
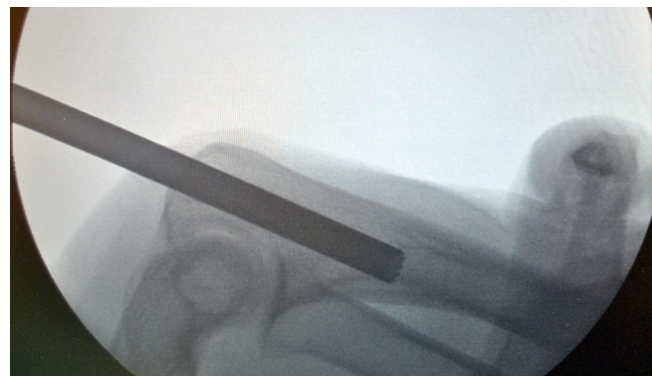
Table 1. Surgical procedures for bone grafting.

	TB	COSM
Bone defect Forearm both fracture	9	
Ulna diaphysis fracture	5	
Distal radius fracture	6	
Metacarpal fracture	6	4
Proximal phalanx fracture	6	
Middle phalanx fracture	5	3
Distal phalanx fracture	6	
Pseudoathrosis Scaphoid	12	3
Pseudoathrosis Metacarpal	3	
Pseudoathrosis Proximal phalanx	2	
Pseudoathrosis Middle phalanx	4	
Pseudoathrosis Distal phalanx	3	20
Arthrodesis Metacarpophalangeal joint	3	1
Arthrodesis Proximal interphalangeal joint	2	6
Arthrodesis Distal interphalangeal joint	2	4
Curettage Enchondroma	8	7

TB: trephine biopsy; COSM: conventional open surgical method
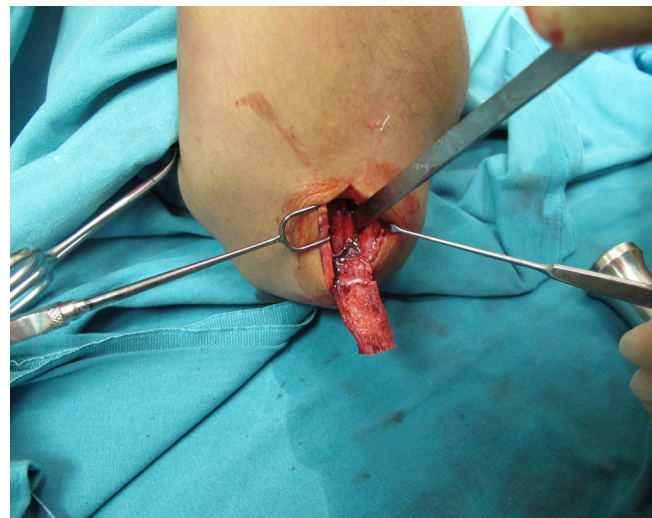
Figure 1. Intraoperative photograph showing the creation of the cortical window in the conventional open surgical method. An approximately 4×1 cm^2 cortical window is opened and preserved

Figure 2. Intraoperative photograph showing the trephine being pushed forward along the long axis of the ulna under fluoroscopic guidance

tracted using the rod within the biopsy needle (Figure 3). Drainage was not used due to the small amount of bleeding. Patients were permitted to move their elbows postoperatively (5).

Table 2. Mean elbow range of motions, VAS scores, mean harvesting time and complications

Olecranon Graft (130)	Operative-Side elbow extension (SD)	Operative-Side elbow flexion (SD)	Non-operative side elbow extension (SD)	Non-operative side elbow flexion (SD)	Post-operative (1st day) VAS Score (SD)	Post-operative VAS (15th day) score (SD)	Mean Harvesting Time (minutes) (SD)	Complications
TB (82)	50 (1.54)	1410 (4.31)	50 (1.41)	1430 (4.67)	4 (1.62)	1.6 (0.76)	7 (1.99)	• Hematoma formation in one patient
COSM (48)	60 (3.24)	1400 (7.82)	40 (2.30)	1450 (5.33)	7.2 (1.38)	3.1 (1.34)	20 (4.51)	• Hematoma formation in one patient • Scar sensitivity in three patients

TB: trephine biopsy; COSM: conventional open surgical method; VAS: visual analog scale; SD: standard deviation

Statistical analysis

A software the Statistical Package for Social Sciences version 22.0 (IBM SPSS Corp.; Armonk, NY, USA) was used for statistical analysis. Data were analyzed using the Shapiro-Wilk test to determine whether the tested variables were normally distributed. The Mann-Whitney U test was used to compare continuous variables with non-normal distribution. Fisher's exact test was used to compare the categorical variables.

Results

There were no significant differences between the TB and COSM groups with regard to age, sex, follow-up duration, and whether the graft was obtained from the dominant or non-dominant side (p>0.05). However, the postoperative VAS scores significantly differed between the groups (p<0.05) (Table 2). The VAS scores on postoperative days 1 and 15 in the TB group were 4 and 1.6, respectively, while those in the COSM group were 7.2 and 3.1, respectively. In total, 9 patients (11%) in the TB group and 1 patient (2%) in the COSM group reported no pain in the donor site.

The mean surgical procedure time in the TB group was 7 minutes compared with 20 minutes in the COSM group (Table 2). Hematoma occurred in 1 patient in each group, giving an incidence of 2.1% in the COSM group and 1.2% in the TB group. There was no significant difference between the two groups with regard to elbow range of motion at final follow-up (p>0.05) (Table 2). No patient in the TB group showed sensitivity of the scar region, while scar sensitivity occurred in 3 out of 48 patients (0.6%) in the COSM group.

Discussion

The choice of donor site depends on the experience of the surgeon, the required amount of bone graft material, site accessibility, and predicted morbidity rate. A greater amount of cancellous bone can be harvested from the ilium than from the other donor sites (7). The average volume of cancellous bone that can be obtained from the olecranon is similar to that which can be obtained from the distal radius, and approximately half of that which can be obtained from the iliac crest (7). However, the olecranon usually provides sufficient bone graft material for upper extremity surgery (2, 5-7). Furthermore, the upper extremity surgery can be performed under regional anesthesia, and olecranon bone graft resection does not require the preparation of an additional surgical area. Another advantage of the olecranon as a donor site is that it is accessible in patients with obesity, while it is difficult to obtain bone graft material from the iliac crest in such patients.

Graft resection from the iliac bone can cause pain, paresthesia, walking difficulties, fracture, and hematoma, with reported major and minor complication rates of 8.6% and 20.6%, respectively (8, 9). Among 110 patients who underwent iliac crest bone graft resection, 16.5% reported pain at the primary surgery site, 29% experienced numbness, 3.9% were dissatisfied with the scar appearance, and 5.1% reported activity restriction (4). Furthermore, the risk of pain after iliac bone graft resection increases in tandem with the body mass index (10). In terms of graft resource, the proximal tibia is another rich region after the iliac bone. However, graft resection from the proximal tibia can cause fractures (11). Another potential donor site is the distal radius. A previous study of 1,670 patients who underwent distal radius bone graft resection reported a 4% complication rate, including fracture at the donor site, neuroma in the radial sensory field, and de Quervain's tenosynovitis (12). Another study evaluating distal radius bone graft resection reported that fracture occurred in one of 131 patients (13).

Several studies have evaluated the olecranon as a bone graft donor site. Two studies reported fracture after olecranon bone graft resection (14, 15); the cortical defects in the 2 patients with fractures were 1.5×2 cm² and 0.8×2.5 cm² (15). Another study reported superficial wound infection in one of 25 cases of olecranon bone graft resection (16). A study in which olecranon bone graft material was used for distal phalanx pseudoarthrosis reported hematoma at the donor site in 1 patient (17). In this study, hematoma at the donor site occurred in 2.1% of the COSM group and 1.2% of the TB group, but no patient developed iatrogenic fracture. The incidence of iatrogenic fracture is reportedly decreased by the use of a circular rather than a square cortical window for graft resection, and a smaller hole diameter (18).

We hypothesized that TB would reduce the risk of fracture during olecranon graft resection compared with COSM. During the closure of the cortical lid, the periosteal repair must be performed meticulously and carefully in COSM. In this study, only one case of hematoma occurred in each group, suggesting that TB is as safe as COSM. The cylindrical shape of the resected graft created by TB makes it particularly appropriate for metacarpal and phalangeal defects. Furthermore, the compact structure of the graft enables K-wire insertion without fragmentation and provides additional stability (5). For these reasons, we primarily use TB to harvest olecranon grafts for phalangeal and metacarpal defects in our daily practice.

TB bone graft resection results in a shorter surgery time compared with the COSM. In one study, the required surgical time for tibial bone graft resection via a non-trephination technique was 58 minutes (19). Another study in which iliac crest bone grafts were resected reported a mean surgical time of 11 minutes using TB and a bone grinder, compared with 20 minutes for the COSM (20).

TB results in a smaller incisional scar than COSM. The average surgical incision length for iliac crest bone graft resection is reportedly 1-1.5 cm for TB and 5 cm for the COSM (20). TB of the olecranon does not result in scarring at the elbow pressure site, while this type of scarring does occur after graft resection by COSM. In this study, 3 patients in the COSM group reported scar tissue discomfort during elbow pressure. In contrast, TB creates less scar tissue than the COSM, and does not cause scarring at the elbow pressure site.

Iliac crest bone graft resection via TB reportedly results in a lesser analgesic requirement compared with COSM (20). Similarly, in this study, the VAS scores showed that the TB group had less pain in the early postoperative period than the COSM group. While the COSM group reported pain for 15 days postoperatively, the TB group reported very little pain even in the early postoperative period. Furthermore, the TB group had a lower incidence of scar sensitivity than the COSM group at the final follow-up. This suggests that TB is superior to COSM with regard to patient comfort.

In conclusion, the olecranon is an appropriate donor site for graft resection because it is easily accessible, bone graft resection can be performed under regional blockage with a tourniquet, an adequate amount of cancellous bone can be resected, and it has a relatively lower complication rate. We prefer olecranon graft resection via the TB because of its shorter surgical duration, greater patient satisfaction, less pain, and smaller and less sensitive scar compared with COSM. Furthermore, the compact structure of the graft harvested via TB provides additional stability and facilitates the K-wire insertion without fragmentation.

Author Contributions: Concept - İ.B.Ö.; Design - İ.B.Ö.; Supervision - B.M., F.K.; Materials - S.S.Ü., T.Y.; Data Collection and/or Processing - S.S.Ü., T.Y.; Analysis and/or Interpretation - İ.B.Ö, S.S.Ü.; Literature Search - S.S.Ü, T.Y.; Writing Manuscript - S.S.Ü, T.Y.; Critical Review - B.M., F.K.

Conflict of Interest: The authors have no conflicts of interest to declare.

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