



## Bone graft harvested from the olecranon—an anatomic study

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**Background:** Bone grafts are widely used in orthopedic surgeries. Although the conventional iliac crest graft is still the largest source of cancellous and cortical-cancellous bone grafts, it may require a new surgical field and additional anesthesia. In contrast, the use of the distal radius graft allows removal in the same field; however, it is often the recipient site; thus, only a limited amount is usually available. In the upper limb, one of the possibilities is the use of the cancellous and/or cortical-cancellous graft from the olecranon. This was a primary and experimental study that aimed to analyze the versatility of using olecranon bone grafts through anatomical assessment of cadavers.

**Methods:** Eight upper limbs were dissected from four fresh, unclaimed, young cadavers, with no history of the previous pathology at the removal site to demonstrate the method of graft removal and to measure the quantity obtained in two situations, namely, removal of the cancellous graft and removal of the cortical-cancellous grafts.

**Results:** The average volume of the cancellous bone graft from the olecranon was 3.9 cm<sup>3</sup> (3.6 to 4.2 cm<sup>3</sup>). The cortical-cancellous bone graft had an average length of 4.4 cm (4.1 to 5.0), a width of 0.8 cm (0.7 to 1.0), and an average thickness of 0.4 cm (0.3 to 0.6).

**Conclusion:** The technique for harvesting the olecranon graft is easy to perform, allowing a volume in average 3.9 cm<sup>3</sup> of cancellous graft and 4.4 cm and 0.8 cm of cortical-cancellous bone, for various upper limb defects, which require this need.

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Bone grafting has been an important tool in reconstructive surgery since its first use in the 19<sup>th</sup> century.<sup>6</sup> The main indications for bone grafting are frequently encountered situations of orthopedic practice, such as the reconstruction of post-traumatic segmental bone losses, filling of bone cavities or tumor defects, and performing arthrodesis or pseudarthrosis.<sup>2</sup> It is also used to fill defects in recent fractures or malunions. There is a demand for different needs in each of these situations.

The types of bone grafts can vary in structure and property. Cortical-cancellous grafts provide a greater structure for bone failures and are more resistant to external forces. In contrast, cancellous grafts help in the process of osteoinduction and osteoconduction, increasing the possibility of bone consolidation.<sup>3</sup> Cancellous autografts provide trabecular bone coated with

osteoblasts that stimulate osteogenesis under the influence of local cytokines and growth factors. These grafts are incorporated quickly, and the low content of oxygen in the graft takes the multipotent cells to the site through chemotaxis.

They can also be classified in accordance with their nutrition<sup>28</sup> and may be of conventional type, requiring nutrition in the newly inserted medium, generally being used in bone defects <6 cm or in vascular flaps for defects >6 cm, where nutrition will be provided by the nutrient artery removed from the donor site and anastomosed at the new recipient site. The donor may be autogenous or allogenic (bone bank).

The classic graft donor areas are the iliac bone and tibial tuberosity (sources located in the lower limbs).<sup>9</sup> In the upper limb, the proximal third of the ulna and distal third of the radius<sup>4,24</sup> are described as the graft sources.

In hand and wrist surgeries, the literature cites advantages in obtaining a graft removed from the upper limb itself.<sup>15,22</sup> The selection of the donor area should be guided by factors including those that result in less surgical morbidity, are easy to procure, and provide the type and quantity of graft required. The ability to

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provide both cancellous and cortical-cancellous conventional grafts as an attribute of the donor areas is considered important.

In the current literature, there is a preference for using the cancellous graft of metaphyseal origin from the distal radius as a graft source.<sup>5,15,18,22</sup> In contrast, the use of an olecranon graft is less cited<sup>7,10,13,15,22</sup> and, alternatively, would only be indicated when the graft source of the distal radius is not available.<sup>15,22</sup>

The olecranon is located on the posterior surface of the elbow and is the protrusion of the proximal ulna.<sup>16</sup> Its proximal portion receives the insertion of the triceps brachii muscle.<sup>13</sup> It is bordered on its radial side by the anconeus muscle insertion and, on its ulnar border, by the flexor carpi ulnaris. Nutrition is obtained through arterial supply mainly from a large nutrient vessel, a branch of the ulnar artery, entering the anterior cortex of the distal ulna toward the base of the coronoid, and two medium-sized branches of the posterior and medial arch entering close to the tip of the olecranon.<sup>10,13</sup> The posterior cortex of the olecranon, the area from which the graft is removed, varies from 2 to 4 mm in thickness, with its marrow containing cancellous bone. The skin around the elbow demonstrates significant mobility, allowing wide flexion and extension movements.

The olecranon graft can be an alternative or even considered the treatment of choice for many bone defects in the surgical treatment of the upper limb. The objective of this study was to analyze the possibilities of using bone grafts from the olecranon, whether cancellous or cortical-cancellous, through anatomical assessment.

## Methods

Four fresh young cadavers, two males and two females, aged between 20 and 40 years, with no history of the previous pathology at the site of removal, were dissected. We attempted to demonstrate the graft removal methodology as well as to measure its quantity obtained in two situations namely, cancellous and cortical-cancellous graft removal. Therefore, all four cadavers were dissected for each situation. The collection was carried out after the approval of the CAAE Ethics Committee - 37480320.8.0000.5481, No. 4.286.568.

### Cancellous graft procurement

A longitudinal incision of approximately 3 cm was made over the proximal ulna, avoiding damage to the subcutaneous bursa, subsequently dissecting the tissues up to the exposure of the periosteum. We used a Farabeuf raspatory to retract the periosteum bilaterally. With a fine-tipped chisel and a delicate hammer, we proceeded to remove the olecranon cortex, approximately 1 cm wide × 3 cm long, exposing the cancellous bone located just below (Fig. 1). Then, a 10-mm × 6-mm curette was introduced, and, with multidirectional and rotational movements, the entire cancellous portion of the olecranon was accessed. Almost the entire graft was removed, with the aid of a curette. With the posterior cortex inserted, the periosteum and skin were approximated.

Two 20-mL syringes were used to measure the material obtained. The cancellous graft was placed inside the syringe and completely filled with saline solution (Fig. 2, A). Next, the liquid was injected into the other syringe and residual space was measured, thus obtaining the amount of cancellous graft in cubic centimeter (Fig. 2, B).

### Cortical-cancellous graft procurement

A longitudinal incision was made over the entire length of the olecranon and proximal forearm. In the most proximal area of the olecranon, a 1.5-cm wide rectangular osteotomy was initiated, and

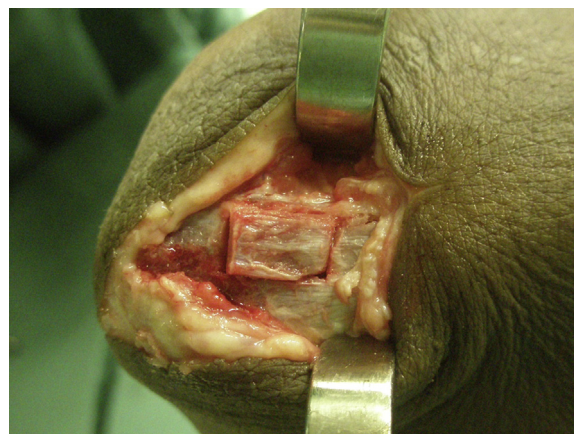


Figure 1 Removal of the olecranon cortex to obtain cancellous graft.

the maximum feasible distance to remove the cortical-cancellous bone maintaining a depth of 1 cm was measured (Fig. 3).

## Results

The dissection and removal of the bone and cancellous graft from the olecranon had an average volume of 3.9 cm<sup>3</sup>, ranging from 3.6 to 4.2 cm<sup>3</sup> (with no statistical differences in the amount removed from male and female cadavers) (Table I). In the second part of the anatomical study, the length in centimeters in which it was possible to remove cortical-cancellous bone varied from 4.1 to 5.0 cm, with an average of 4.4 cm, and the width varied from 0.7 to 1.0 cm, with an average of 0.8 cm. The average thickness was 0.4 cm and ranged from 0.3 to 0.6 cm (with no statistical differences in the amount removed from male and female corpses) (Table II).

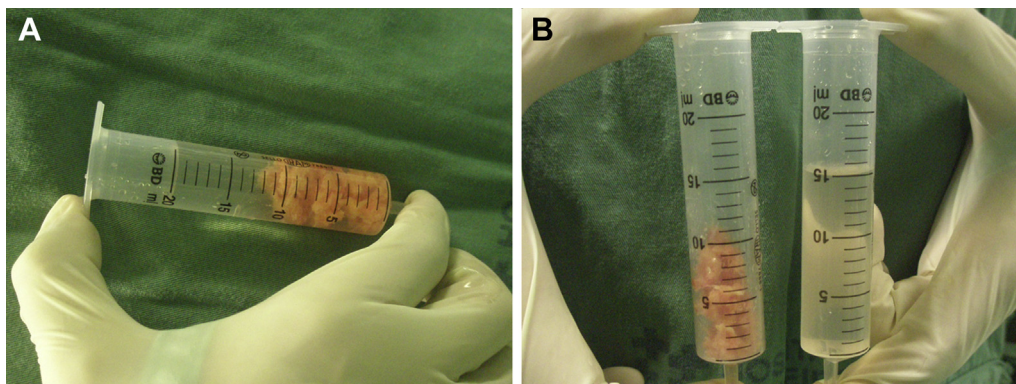
## Discussion

The decision to use a conventional bone graft should be made carefully because the procedure involves some damage to the donor area and patient. The less traumatic grafting techniques simultaneously harvesting the desired amount and type of graft must be achieved.

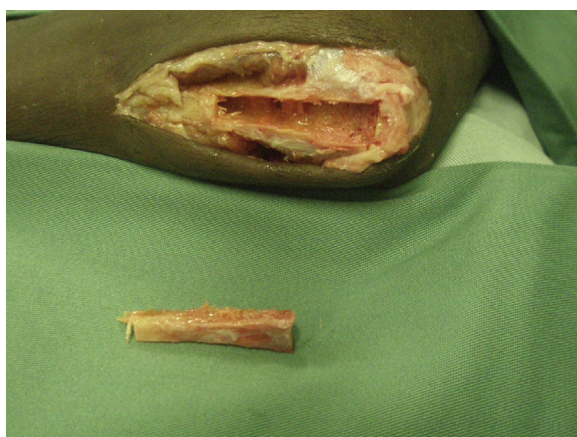
One of the most recommended donor areas of the cancellous bone is the iliac bone, which commonly provides up to 10 cm<sup>3</sup> from the anterior crest<sup>26</sup> and up to 30 cm<sup>3</sup> from the posterior crest<sup>8</sup> with a length of up to 7 cm.<sup>12</sup> However, there are some disadvantages, such as pain, walking difficulty, risk of considerable bleeding during surgery, and relative local morbidity.<sup>4,15</sup> When used for upper limb grafting, it requires a second surgical field and an additional anesthetic procedure.<sup>9</sup>

On comparing the use of the iliac bone structure and distal radius *in vitro*, Schnitzler<sup>24</sup> concluded that the latter was structurally worse with less bone removal; however, the radius graft adapted well to the filling of small bone defects. Moreover, biological differences have minimal clinical significance when used as a graft.<sup>4</sup> When a large volume of cancellous bone is not required, removal of the graft from the upper limb areas is preferred.<sup>5</sup>

When removing the graft from the upper limb, the radial styloid process is a commonly used surgical approach, which may occasionally have some long-term complications already described, such as De Quervain's tenosynovitis, superficial neuroma of the radial nerve, fracture at the donor site, and infections.<sup>22</sup> Micev et al observed no statistical differences on comparing the use of graft harvested from the olecranon and distal radius regarding pain, consolidation, and complications of both techniques.<sup>17</sup> Recently,



**Figure 2** (A) Cancellous graft (total amount removed) with saline. (B) The syringe with the liquid part of the residual space to measurement of the cancellous graft (in cm<sup>3</sup>).



**Figure 3** Removal of the cortical-cancellous bone segment and residual area.

Yang et al conducted an anatomical study of the removal of a vascularized graft from the olecranon based on the recurrent posterior ulnar artery for complex defects requiring a structured and vascularized bone supply.<sup>27</sup>

The literature has few references regarding anatomical studies and the versatility of using olecranon graft.<sup>23</sup> Because olecranon is an excellent cancellous bone donor area, in this study, attempts were made to approach it with the lowest possible morbidity.

With the described technique, the incision is small and the approach of the donor area is relatively simple, with easy removal of the posterior cortex. Local bleeding and soft tissue dissection are also very minimal, thus reducing procedure morbidity. In addition, the described method allowed wide access so that it is possible to remove the entire cancellous bone from the olecranon, as illustrated in our dissections, comparable with the amount of graft from other harvesting techniques in upper limbs.<sup>1</sup>

In some situations, as in cases of scaphoid nonunion with carpal collapse, the correction of malalignment is essential, provision of bone graft in addition to mechanical compression and solid fixation. In humpback scaphoid cases, pure cancellous grafting may lack sufficient mechanical strength to maintain anatomic scaphoid and lunate alignment. The use of corticocancellous bone graft seems to be an efficient option in these circumstances.<sup>14</sup>

Mesa et al<sup>22</sup> treated 48 patients with olecranon bone grafts. The patients were diagnosed with phalanx pseudoarthrosis, scaphoid pseudoarthrosis, traumatic metacarpal osseous defects, and osseous defects after curettage for enchondroma and for arthrodesis of proximal interphalangeal, distal interphalangeal, and

**Table I**

Measurement of the amount of cancellous bone graft from the olecranon obtained from four dissected cadavers.

Identification of the cadaver	Sex	Upper limb	Volume of cancellous graft (cm <sup>3</sup> )
1	Male	1	3.6
1	Male	2	4.2
2	Male	3	3.9
2	Male	4	3.8
3	Female	5	4.1
3	Female	6	4.0
4	Female	7	3.7
4	Female	8	3.9

**Table II**

Measurement of the amount of cortical-cancellous bone graft from the olecranon obtained from four dissected cadavers.

Identification of the cadaver	Sex	Upper limb	Length	Width	Thickness
1	Male	1	4.8	0.8	0.5
1	Male	2	5.0	1.0	0.6
2	Male	3	4.3	0.8	0.4
2	Male	4	4.5	0.7	0.3
3	Female	5	4.1	0.8	0.4
3	Female	6	4.4	0.8	0.4
4	Female	7	4.2	0.9	0.3
4	Female	8	4.1	0.7	0.4

carpometacarpal joints. At a mean of 19-month follow-up, all the patients had healed well with a single complication of hematoma formation requiring drainage. Ashish and Surendher<sup>11</sup> studied the use of olecranon bone grafting in neglected forearm fractures of 20 patients and concluded that despite lack of popularity, olecranon bone grafts are an excellent option for augmenting union in fractures of the forearm as these grafts are easily obtained and cause no donor site complications. Regarding the possibility of occurrence of olecranon fracture after removal of a graft, whether cancellous or cortical-cancellous, we did not find any description in the literature, which would allow its use in a procedure considered to be safe.

A technique was proposed for harvesting a conventional olecranon bone graft following an easy procedure with low morbidity and is proposed when cancellous or corticocancellous bone grafting is required in hand and wrist surgeries, such as scaphoid fractures,<sup>19</sup> distal radius fractures,<sup>21</sup> phalanx fractures,<sup>20</sup> forearm fractures,<sup>11</sup> and thumb reconstruction.<sup>25</sup> This technique is recommended because it restricts trauma only to the region that is being operated. Besides, these are surgeries typically requiring moderate

amounts of graft, which were definitively achieved with the method described here.

## Conclusion

The technique for harvesting the olecranon graft is easy to perform, allowing a volume in average 3.9 cm<sup>3</sup> of cancellous graft and 4.4 cm and 0.8 cm of cortical-cancellous bone, for various upper limb defects, which require this need.

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