Int J Clin Exp Med 2016;9(8):16544-16547
www.ijcem.com /ISSN:1940-5901/IJCEM0033524

Original Article

Anatomic study on anteromedial approach exposure of coronoid process fracture

Hongwei Chen[1], Xindong Yang[2], Guodong Liu[3]

[1]*Department of Orthopedics, Yiwu Central Hospital, Wenzhou Medical University, Zhejiang, China;* [2]*Department of Anatomy, Wenzhou Medical University, Yiwu 322000, Zhejiang, China;* [3]*Affiliated Daping Hospital of The Third Military Medical University, Zhejiang, China*

Received June 10, 2016; Accepted August 4, 2016; Epub August 15, 2016; Published August 30, 2016

Abstract: Purpose: This study aimed to measure anteromedial-approach exposure of coronoid process fracture via anatomy in order to provide anatomic foundation of clinical operations. Methods: A total of 20 adult upper limb specimens (12 male side limbs and 8 female side limbs) were dissected. Each value was measured separately. Superficial layer: Humeral medial epicondyle is point A, the intersection between connecting line of medial & lateral epicondyle and medial edge of median nerve is point B, distance between A and B was measured. Middle layer: distance of point A is from bifurcation (D) and muscle entering point (E) of pronator teres of median nerve. The intersection is point C between ulnar artery and ulnar nerve. Bifurcation between ulnar recurrent artery and ulnar artery is point F. Deep layer: The apex of coronoid process is 0, the bifurcation between articular surface plane and lateral border of ulnar collateral ligaments is as M. Results: AB was (10.37±2.67) cm and BC was (10.19±2.57) cm, AC was (3.03±0.84) cm, AD was (3.53±1.55) cm, AE was (4.61±1.55) cm, AF was (4.96±1.74) cm, BF was (4.51±1.56) cm, AM was (2.75±0.57) cm, OM was (1.59±0.26) cm. Conclusion: This study provided anatomy application foundation for anteromedial-approach exposure of coronoid process fracture and structured a safe zone for anteromedial-approach exposure of coronoid process fracture surgery.

Keywords: Coronoid process fracture, surgical approach, anatomy

Introduction

For surgical treatment of coronoid process fracture, there is a bigger dispute on surgical approaches currently due to its anatomic specificity and complexity. Anteromedial approach of elbow joints can directly expose and fix coronoid process. Three methods reported in current documents can be adopted to expose coronoid process [1-3] from anteromedial elbow joints. Taylor and Scham described [1] that whole flexor pronator teres in medial ulna was uplifted from back side to palm side to expose the coronoid process. But this required a wide incision. Ring et al. [2, 3] suggested that approach of flexor carpi ulnaris was split between two heads. This approach must sufficiently free ulnar nerve to reduce pressure. Elbow joint bundle branches needed to be cut in a majority of elbow joints. Hotchkiss et al. [3, 4] used a more ventral top-cross approach to expose coronoid process. Pronator teres, flexor carpi radialis muscles and palmaris longus were pulled to radial side and flexor carpi ulnaris was pulled to ulnar. Due to important nervus and vessels are in front of elbow joint and rich in muscles, the coronoid process was particularly hard to be exposed. Anteromedial elbow joint approach is not frequently used, so orthopedists are not familiar with it and it has not been widely applied clinically. Present documents are mainly involved in treatment of coronoid process, there were few anatomy studies reported on anteromedial-approach treatment of coronoid process fracture. This study aimed at anatomy studies on anteromedial-approach exposure of coronoid process fracture to propose the safe surgical zone and provide guidance for anteromedial-approach treatment of coronoid process fracture clinically.

Methods

This study has been proved by the Ethics Committee of Yiwu Center Hospital (Reference Number: 2014-12-2A). And all subjects gave

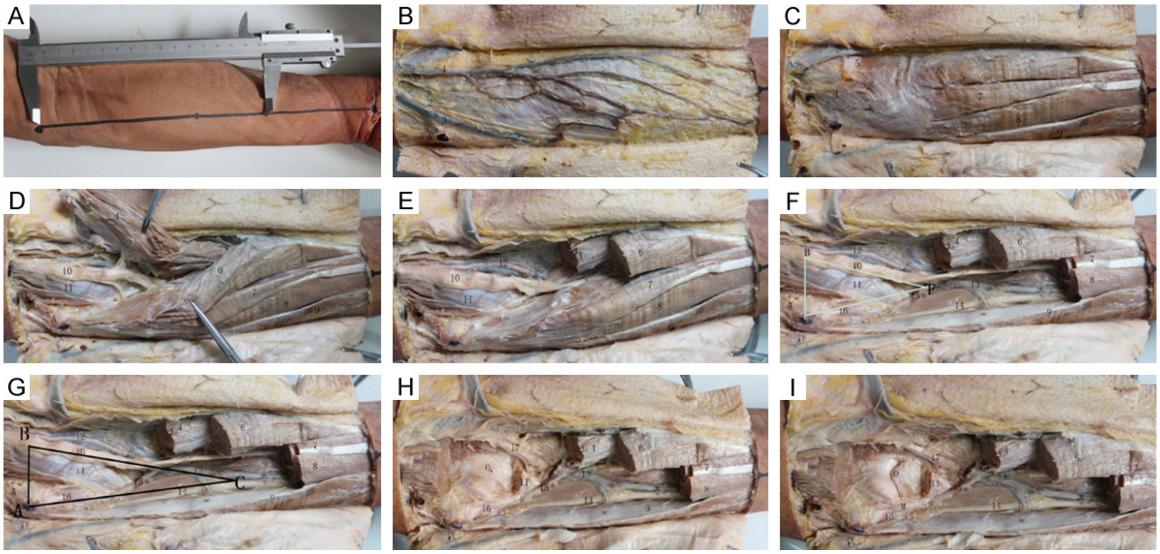

Figure 1. A: Schematic diagram of skin incision; B: Exposure of superficial vein cutaneous nerve after skin incision; C: Exposure of shallow section of forearm muscles after deep fascia incision; D: Lift the gap between pronator teres muscle and flexor carpi radialis; E: Exposure of median nerve by cutting pronator teres muscle and flexor carpi radialis; F: Measurement and exposure of absolute safety triangle of coronoid process; G: Measurement and exposure of absolute safety triangle of coronoid process; H and I: Relationship of coronoid process with medial collateral ligament and brachialis muscle. The meanings of the number and letters in the figures: 1. Median antebrachial vein; 2. Medial cutaneous nerve of forearm; 3. Basilic vein; 4. Pronator teres; 5. Biceps; 6. Flexor carpi radialis muscle; 7. Palmaris longus; 8. Superficial flexor of fingers; 9. Flexor carpi ulnaris; 10. Median nerve; 11. Brachialis; 12. Brachial artery; 13. Ulnar artery; 14. Ulnar nerve; 15. Ulnar recurrent artery; 16. Ulnar collateral ligaments; 17. Bicipital tendon. A. Medial epicondyle; B. Intersection between connecting line of medial & lateral epicondyle and inner margin of median nerve (can be deemed as the distance from A to median nerve); C. Intersection between ulnar artery and ulnar nerve and F as the bifurcation between ulnar recurrent artery and ulnar artery; O. Apex of coronoid process; M. Intersection between articular surface and ulnar collateral ligaments (can be deemed as a point projected to the ligament by O).

their consent to participate in this study. Adopted formalin fixed fresh adult upper limb samples in 20 body sides with 12 males and 8 females. All samples had no significant malformation and they all had not performed any operations around elbow joints. Measure related data in the case that anatomical structure was not damaged and twisted. A measuring tool was introduced a vernier caliper with the accuracy of 0.01 mm. The anatomical process was carried out together by two professional teachers in anatomy and the key links of the procedure were pictured.

Forearm was placed in supination of 90° and fixed. Point A was identified as humeral media epicondyle, a skin incision (expanded as needed) about 8 cm was taken 2 cm above the wrist median line (**Figure 1A**). In order to clearly reveal the incision, along with the incision the skin was turned up medial and lateral sides to fully expose the superficial fascia, removed the fat and saw forearm's medial cutaneous nerve and surface layer veins moving towards inside in an inclined trend under the internal epicondyle. It was pulled and fixed towards inner side after free (**Figure 1B**). The deep fascia was cut open and the bicipital aponeurosis could be seen and the bicipital aponeurosis was cut open longitudinally (**Figure 1C**). Carefully separate the muscle interval between pronator teres and flexor carpi radialis muscle. In order to gain more revealed parts, parts of starting points were released peeling and the pronator teres was pulled towards radical side. Flexor muscle group including flexor carpi radialis muscle was pulled towards ulnar to expose interior brachialis. In order to measure the safe zone, the median nerve (regular operation is no need to expose the nerve) shall be exposed. The intersection between the connecting line of medial & lateral epicondyle and medial edge of median nerve served as the point B, the distance of AB was measured (AB can be regarded as distance from the medial epicondyle to the inner margin of median nerve). Median nerve was slowly separated from starting point of medial epicondyle of pronator teres, in order to reveal the positional relation between the bifurcation (D) and muscle entering point (E) of median nerve of pronator teres with point A and the distance was measured (**Figure 1D** and **1E**). It was bounded by medial muscle interval of flexor carpi ulnaris, muscle group was completely removed from top to bottom to expose the intersection (C) of ulnar artery and ulnar nerve and AC and BC were measured. Similarly, AF and BF distance were measured based on the bifurcation F between upper ulnar recurrent artery and ulnar artery (**Figure 1F** and **1G**). The stop of brachialis of peeling parts of subperiosteum was pulled to radical side. The front branch of medial collateral ligament attached to top node of coronoid process shall be protected. The articular capsule was cut open in anterior elbow joint. In order to reveal the coronoid process more clearly in this study, the brachialis was cut open horizontally at medial epicondyle and then turned up downward. The articular was exposed and opened. The top coronoid process was identified as O. The intersection between the articular surface plane and lateral border of ulnar collateral ligaments was as M, and the length of AM, OM and OA were measured separately (**Figure 1H** and **1I**).

Primary data was processed using SPSS15.0 statistical software to record each mean value and reference range of each numerical value. $\overline{X}$ ±S indicated the measuring range.

Results

After measurement, AB was (10.37±2.67) cm and BC was (10.19±2.57) cm, AC was (3.03± 0.84) cm, AD was (3.53±1.55) cm, AE was (4.61±1.55) cm, AF was (4.96±1.74) cm, BF was (4.51±1.56) cm, AM was (2.75±0.57) cm, and OM was (1.59±0.26) cm. Two safe zones of ABC and ABF were built in deep muscle tissues. The distance from brachialis attachment point to coronoid process was (1.56±0.93) cm.

Discussion

Both recent biomechanics and clinical research confirmed that coronoid process is an important structure [5-9] of elbow joint stabilization. The coronoid process is an anterior support that prevents posterior dislocation of elbow joint. The front branch of medical collateral ligament is attached to top node of coronoid process and plays an important role in providing elbow joint to resist eversion stress. Therefore, the integrity of coronoid process fracture is important to elbow joint stabilization and it should be fixed through surgery.

The optimal exposure approach of coronoid process fracture has been controversial. In recent years, we have applied anteromedial-approach to treat coronoid process fracture clinically. Anatomical structures of elbow joint are complex and surrounded by some important structures including front branch of medical collateral ligament, ulnar nerve, median nerve, and ulnar artery. If this approach is correctly exposed, superficial and deep anatomy knowledge should be known by surgeons. If those important structures are damaged, it may cause serious consequences. The purpose of this study was to find a detailed anatomy from shallower to deeper by an anteromedial-approach, to measure related data, to propose an operating range for a safe operation and to provide anatomy basis to guide the clinical practices.

An incision was taken on a straight line between medial epicondyle and wrist midpoint and it was easily positioned (**Figure 1A**) on body surface. Skin was cut along with the incision and then only basilica vein and partial medial cutaneous nerve went by this incision in superficial fascia. Hence it must watch out the basilica vein and medial cutaneous nerve when operation is going through this layer. Because the cutaneous nerve and rete venosum in the superficial fascia are easily to be distinguished, the neurovascular network injuries can be avoided. Deep fascia was removed to expose the muscular tissue and then to see biceps' aponeurosis coated with those parts connected with medial epicondyle including pronator teres, flexor carpi radialis muscle, palmaris longus and flex carpi ulnaris. The biciptal aponeurosis was cut to breaks before separating the muscle interval. Better postoperative suture won't seriously impact its function. Ulnar recurrent artery is an important artery across this area slanting inward (**Figure 1F** and **1G**), so when operation enters into deep layer, this artery shall not be damaged as far as possible. Triangle ABF area can be used as an absolute secure zone to expose the coronoid process. In addition to damages of partial median nerve branches that control the flexor muscle group may rise minimum impacts on forearm's motor and sensory function, there are no other important nerves and blood vessels included. However, brachialis attachment point impacts the exposure of coronoid process, so it is necessary to partially peel off the stop. During the elbow joint horrific follicular occlusion triad damages, the average height of fracture blocks of coronoid process is 7 mm [10], so the operating space of this area is enough to expose and fix. For type III huge coronoid process fracture, in order to easily exposed and fixed, the ulnar recurrent artery can be ligatured. Ulnar artery was separated from brachial artery and then downward, continuously close to ulnar nerve after the median nerve was crossing with upper ulnar recurrent artery at crotch, and meeting at point C with the ulnar nerve. There are deep veins of the same name running along both sides. Middle segment of median nerve, lower segment of ulnar artery and ulnar nerve have formed a delta-shaped region ABC that can be deemed as a relative safe area for surgery after ligating the ulnar recurrent artery, which can be used to expose and fix the huge coronoid process fracture. However, it is rarely needed in clinical practice. Meanwhile, the length range of AC can provide the reference data for the needs of extending the incision and expanding the operating field in severe fracture or merged dislocation in order to avoid the damages of neurovascular network in this area. The front branches of ulnar collateral ligaments were attached at top node of coronoid process within 3.2 mm [11], closely connected with the brachialis. It can cause accidentally injuries when using anteromedial-approach in operation of coronoid process, so the brachialis stop is needed to be peeled off during the procedure and pulled towards radialis, and the front branches of ulnar collateral ligaments shall be watched out and protected at the same time.

There are few limitations in our study. Firstly, anatomy quantity was a small sample size which influenced the precision of statistical data to some extent. Secondly, because there was no enough sample size, there was no comparative analysis between men and women, left and right.

Acknowledgements

This study was supported by the Project of Science and Technology Hall of Zhejiang Province (2013C33216), the Project of Health Department of Zhejiang Province (2014KYB-296), and the Key Project of Science and Technology of Yiwu City (2013-G3-02).

Disclosure of conflict of interest

None.

Address correspondence to: Hongwei Chen, Department of Orthopedics, Yiwu Central Hospital, Wenzhou Medical University, Yiwu 322000, Zhejiang, China. E-mail: chenhongweiywchw@163.com

References

[1] Taylor TK and Scham SM. A posteromedial approach to the proximal end of the ulna for the internal fixation of olecranon fractures. J Trauma 1969; 9: 594-602.
[2] Ring D and Jupiter JB. Surgical exposure of coronoid fractures. Tech Shoulder Elbow Surg 2002; 3: 40-56.
[3] Huh J, Krueger CA, Medvecky MJ and Hsu JR. Medial elbow exposure for coronoid fractures: FCU-split versus over-the-top. J Orthop Trauma 2013; 27: 730-734.
[4] Hotchkiss RN and Kasparyan NG. The medial “Over the top” approach to the elbow. Tech Orthop 2000; 15: 105-112.
[5] Budoff JE. Coronoid fractures. J Hand Surg Am 2012; 37: 2418-2423.
[6] Closkey RF, Goode JR, Kirschenbaum D and Cody RP. The role of the coronoid process in elbow stability. A biomechanical analysis of axial loading. J Bone Joint Surg Am 2000; 82-A: 1749-1753.
[7] Gray AB, Alolabi B, Ferreira LM, Athwal GS, King GJ and Johnson JA. The effect of a coronoid prosthesis on restoring stability to the coronoid-deficient elbow: a biomechanical study. J Hand Surg Am 2013; 38: 1753-1761.
[8] Fitzgibbons PG, Louie D, Dyer GS, Blazar P and Earp B. Functional outcomes after fixation of “terrible triad” elbow fracture dislocations. Orthopedics 2014; 37: e373-376.
[9] Jeon IH, Sanchez-Sotelo J, Zhao K, An KN and Morrey BM. The contribution of the coronoid and radial head to the stability of the elbow. J Bone Joint Surg Br 2012; 94: 86-92.
[10] Doornberg JN, van Duijn J and Ring D. Coronoid fracture height in terrible-triad injuries. J Hand Surg Am 2006; 31: 794-797.
[11] Munshi M, Pretterklieber ML, Chung CB, Haghighi P, Cho JH, Trudell DJ and Resnick D. Anterior bundle of ulnar collateral ligament: evaluation of anatomic relationships by using MR imaging, MR arthrography, and gross anatomic and histologic analysis. Radiology 2004; 231: 797-803.