JSES Reviews, Reports, and Techniques 2 (2022) 254–259

Contents lists available at ScienceDirect

JSES Reviews, Reports, and Techniques

journal homepage: www.jsesreviewsreportstech.org

Surgical treatment of humeral medial column stress fracture in a baseball pitcher: a case report

Satoshi Nezu, MD[a], Yasunori Shimamura, MD, PhD[a,*], Tadashi Yamawaki, MD[b], Taichi Saito, MD, PhD[a], Toshifumi Ozaki, MD, PhD[a]

[a]Department of Orthopaedic Surgery, Graduate School of Medicine, Dentistry and Pharmaceutical Sciences, Okayama University, Okayama, Japan
[b]Department of Orthopaedic Surgery, Kousei Hospital, Okayama, Japan

A R T I C L E I N F O

Keywords:
Surgical treatment
Humeral medial column
Stress fracture
Baseball

Stress fractures of the upper limb can occur in athletes from a wide range of sports.[13,9] Athletes with throwing motions are especially susceptible to elbow stress fractures due to the high load and valgus forces across the elbow during the acceleration and deceleration phases of throwing. Kinematical analysis in baseball pitchers has shown that 64 Nm of valgus stress is loaded on the elbow during the late cocking to early acceleration phase.[6,16] The anterior bundle of the ulnar collateral ligament of the elbow functions as the primary resistance structure against this valgus force,[1] and it is thought that the valgus extension overload syndrome develops when the resistance of the ligament is decreased.[12,17] Many of the elbow bone disorders associated with baseball pitching are reported to be based on the valgus extension overload syndrome,[2,14] resulting in stress fractures of the olecranon[15] and impaction of the posteromedial olecranon against the olecranon fossa.[5] However, stress fracture of the medial column has been few reported. We report on our experience of surgical treatment of this rare humeral medial column stress fracture.

Case presentation

The patient is a 19-year-old male, left-handed college baseball pitcher. Although he had never been injured his elbow or shoulder in baseball, discomfort in his left elbow appeared after pitching practice in college. His team's training coach started him on conservative treatment under limited throwing, suspecting thoracic outlet syndrome. However, he presented to our clinic because discomfort remained in his left elbow after pitching for a total of 6 months. Physical examination at first presentation had normal range of motion (ROM) of the elbow joint, no tenderness in the ulnar collateral ligament (UCL), but was presented posteromedial elbow pain in forced elbow extension, discomfort in the left ulnar

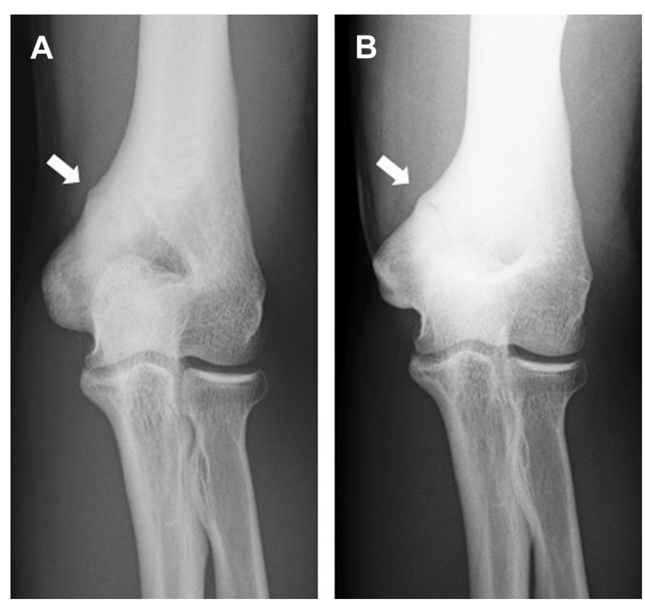

Figure 1 Plain radiograph of the dominant elbow at the first presentation. (**A**) Elbow extension position. (**B**) Elbow 45 degrees flexion position. *White arrow* shows a bony prominence in the medial column.

No institutional review board approval was required for this case report.

*Corresponding author: Yasunori Shimamura, MD, PhD, Department of Orthopaedic Surgery, Graduate School of Medicine, Dentistry and Pharmaceutical Sciences, Okayama University, 2-5-1, Shikatacho, Kitaku, Okayama City 700-8558, Japan

E-mail address: y-shima@md.okayama-u.ac.jp (Y. Shimamura).

https://doi.org/10.1016/j.xrrt.2021.11.007

Figure 2 Preoperative computed tomography. (**A**) An axial and (**B**) coronal views show a sclerotic change surrounding the fracture line. (**C, D**) *White and black arrows* show a posteromedial osteophyte of the olecranon.

nerve area, and mild pain in the medial humeral column. The Roos test for thoracic outlet syndrome was negative.

Radiograph examinations

A plain radiograph of the elbow joint showed bony prominence and radiolucency of humeral medial column (Fig. 1). Preoperative computed tomography (CT) images show osteosclerotic changes throughout the medial column. The stress fracture line runs obliquely from the medial wall of the olecranon fossa to the proximal medial of the medial column, and there is an enlargement of the fracture line on the posterior aspect of the medial column. There is an osteophyte formation on the posterior medial side of the olecranon (Fig. 2).

Magnetic resonance imaging examination

Magnetic resonance imaging (MRI) of the left elbow was performed 1 week after CT examination to exclude other causes of elbow symptoms such as UCL injuries, ulnar neuritis, tendonitis, synovitis. MR images of T1 and T2 fat suppression show high signal fracture lines in the medial columns (Fig. 3). The MR images in T1 showed a low-intensity area extending from media column to the metaphysis around the fracture line in the coronal view (Fig. 3*B*). The low-intensity areas are consistent with osteosclerotic lesions, meaning poor blood flow and depression of biological environment. The anterior band of the UCL showed an increased signal intensity in the proximal medial attachment, suggesting a partial tear (Fig. 3*A*).

Surgical treatment

Preoperative examination and patient positioning

General anesthesia is administered along with preoperative antibiotics. A contrast agent was injected into the bilateral elbow joint under anesthesia. An intraoperative valgus stress test was performed, confirming widening of the medial joint space at 45° of elbow flexion (Fig. 4). The patient was positioned right lateral supine position on the operating table, and the left upper limb was placed on the upper limb stand with an air tourniquet (Fig. 5*A*). The operative side is prepped and draped in the standard fashion.

Exposure of the posterior aspect of the medial column

An Esmarch is used to exsanguinate the surgical limb, and an air tourniquet is inflated to 240 mm Hg. The ulnar nerve should be

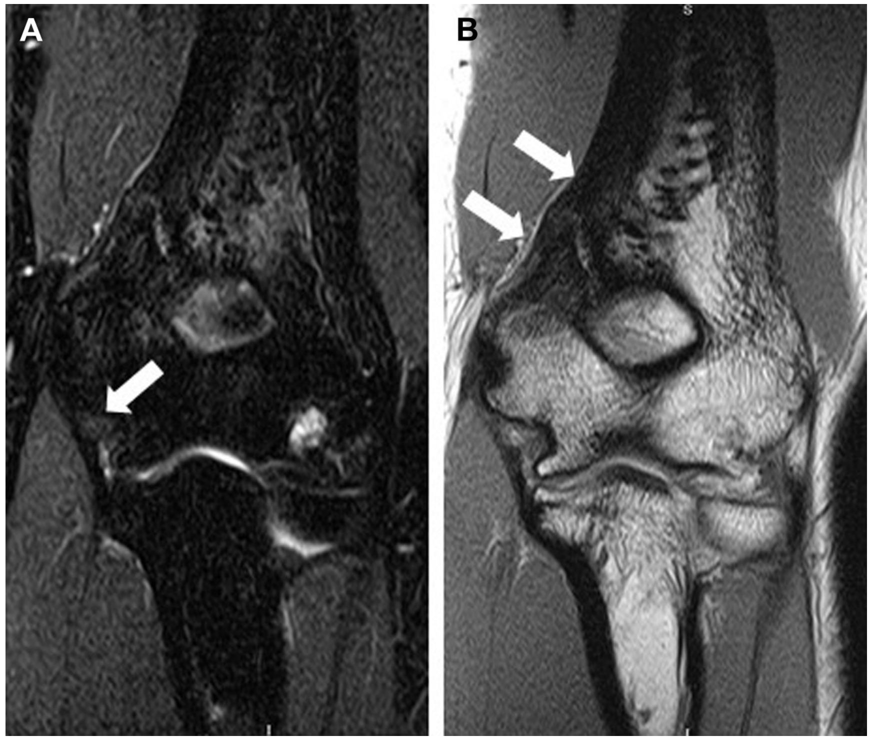

Figure 3 Preoperative magnetic resonance imaging. (**A**) The proximal attachment of the UCL has an increased signal suggesting a partial tear (*white arrow*). (**B**) The sclerosis area revealed as a low-intensity area extending from the medial column to the metaphysis (*white arrows*).

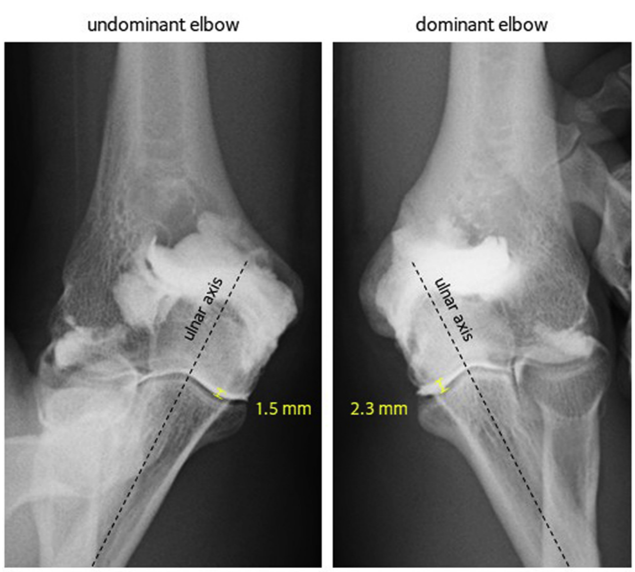

Figure 4 Measurements of medial joint space opening under the arthrography valgus stress test. The medial elbow joint space opening on the nondominant elbow was 1.5 mm, and the dominant elbow was 2.3 mm.

identified by palpation and marked posterior to the medial epicondyle. A 6-8 cm incision is marked and made through the skin only over the posterior aspect of the medial column. Scissors are used to proceed with blunt dissection into the deep layer of the subcutaneous tissue. The medial antebrachial cutaneous nerve is identified and is protected throughout the operation. The fascia of the medial triceps musculature is released by scissors; the ulnar nerve is identified and dissected; and a vessel rubber loop is placed around the nerve to anterior mobilize it throughout the case. The triceps muscle is retracted to posterior by retractors and exposed the posterior aspects of medial column. The bone prominence was running transverse through the posterior aspects of the medial column (Fig. 5*B*).

Decortication and bone graft harvest

The dorsal cortical bone was open in an area of 30 mm x 10 mm centered on the bony prominence using a motorized bone saw. A bone chisel was inserted under the opened cortical bone and resected, the intramedullary cancellous bone was replaced by sclerosis (Fig. 5*C*). To induce fresh bone marrow blood, the sclerotic bone was reamed with a 2.5-mm diameter cortical drill and passed through the distal metaphysis (Fig. 5*D*). Autologous bone graft for the medial column defect was planned by harvesting from the anterior iliac crest. An anterior incision was made above the anterior superior iliac spine, and monocortical structural graft block was obtained with size of the 30 mm × 10 mm × 10 mm and grafted into the medial column.

Plate fixation

When the elbow joint was fully extended, the posteromedial tip of the olecranon and the medial wall of the olecranon fossa were contacted (Fig. 5*F*). Stryker VariAx hand 3D plate (Stryker, Kalamazoo, MI, USA) was fixed over the grafted bone as a compression fixation (Fig. 5*G*). The ulnar nerve transfer did not perform, and the wound was closed in its original position (Fig. 6).

Postoperative follow-up

Postoperative immobilization was not performed, and we started rehabilitation from gently passive range of motion

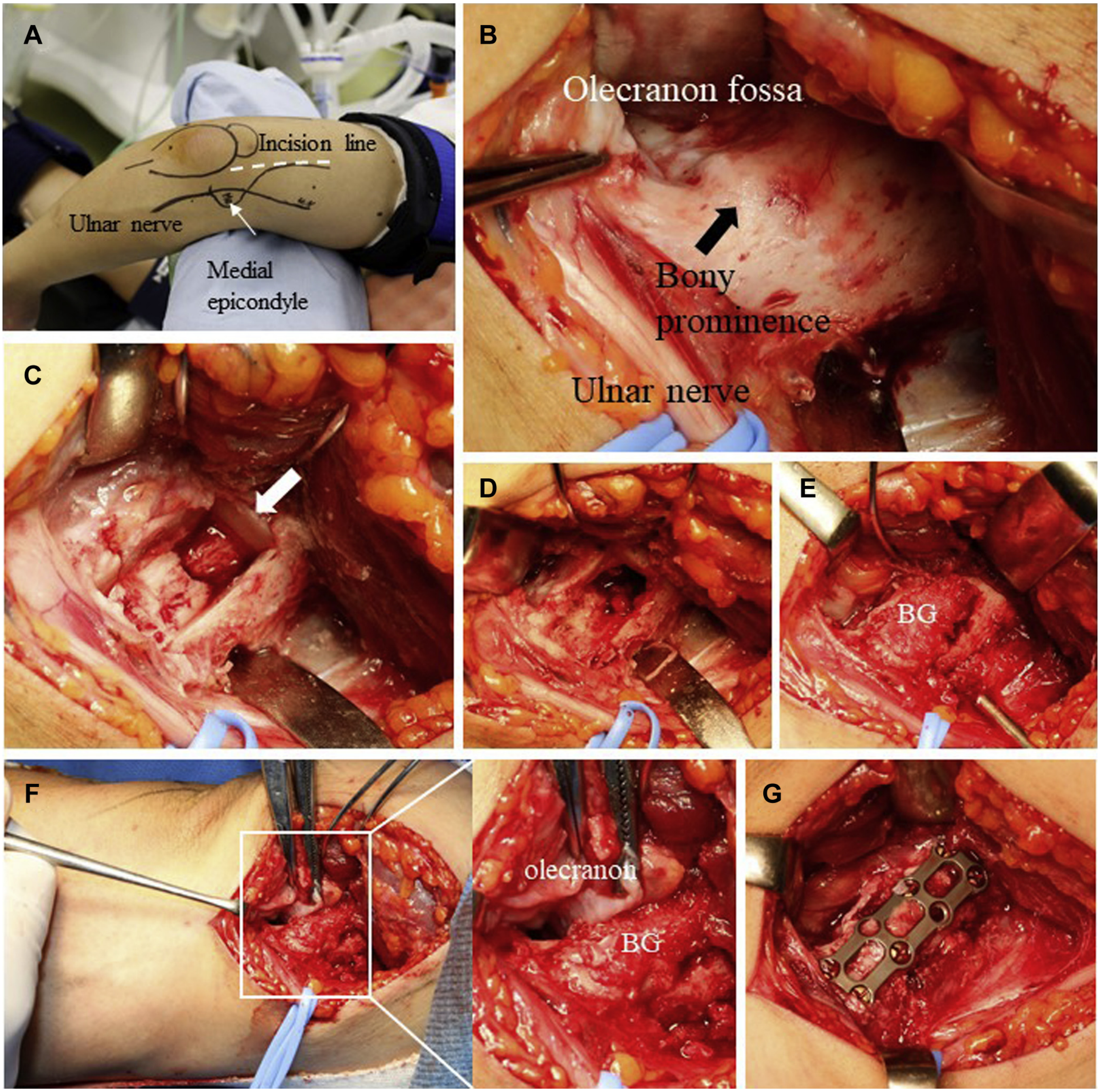

Figure 5 Intraoperative photographs. (**A**) *Right* lateral supine position on the operating table and marking of the posteromedial approach's skin incision line. (**B**) A posteromedial approach was applied to expose the posterior aspect of the humeral medial column. The medial column had a bony prominence (*black arrow*). (**C**) The dorsal cortical bone was removed with a size of the 30 mm × 10 mm centered on the bony prominence using a motorized bone saw. The bone cavity was replaced by a sclerotic lesion (*white arrow*). (**D**) Bone cavity was reamed with a 2.5 mm diameter drill. (**E**) Bone graft (BG) harvested from the iliac bone was implanted with the cortical bone surface facing dorsal. (**F**) In full extension of the elbow, the posteromedial of the olecranon and the medial wall of the olecranon fossa were contacted. (**G**) Plate was fixed over bone graft.

exercises of the elbow a few days after surgery. A physical conditioning during rehabilitation including stretched motion of the lower extremity was performed to prevent throwing injuries. Three months after the surgery, we started a throwing program with acceptable bone union. The patients were allowed to return to competition level at 6 months postoperatively and continue to play baseball as a pitcher without preoperative findings at 18 months after treatment.

Discussion

A medial column stress fracture of the humerus is a rare case. Although Chang et al reported a case of conservative treatment in a 16-year-old baseball pitcher,[3] there are no reports of primary surgical treatment. In their case, axial CT images showed osteophyte formation on the posteromedial side of the olecranon, suggesting impingement of the posteromedial compartment by VEOS, but no

Figure 6 Plane radiographs and CT images at 6 months after surgery. Bone healing was obtained without recurrence of sclerosis in the medullary cavity. *CT*, computed tomography.

evaluation of medial instability was performed. Park et al reported 23% of posteromedial osteophyte formation of the olecranon caused by VEOS is not associated with a UCL injury.[14] However, Molenaars et al summarized the measurement of medial elbow joint space under valgus stress on radiographs without arthrography and reported a mean opening of 4.6 mm in injured UCL elbows and 4.2 mm in uninjured UCL elbows, with a mean joint opening gap of 0.4 mm in relation to the presence or absence of UCL injury.[11] Ahmad et al concluded that increased posteromedial compartment contact force was observed only during the deceleration phase of throwing with low elbow flexion in the non-intact UCL and that abnormal contact pressure was a factor in the development of osteophyte formation in the posteromedial elbow.[2] In our case, preoperative CT recognized osteophyte formation on the posteromedial side of the olecranon, and we investigated preoperatively bilateral elbow arthrography to evaluate the amount of medial elbow laxity gaps with valgus stress. The results of the medial elbow joint space opening on the dominant elbow were 0.8 mm (2.3 mm > 1.5 mm) looser than the nondominant elbow. Preoperative MRI showed findings suspicious of a nonsymptomatic UCL partial tear at the proximal UCL attachment, which may be the cause of the medial elbow laxity. The intraoperative findings also confirm that the posterior medial osteophyte of the olecranon contacts the fracture of the medial column in the elbow extension position. Therefore, we concluded that instability of the medial support structures to valgus stress induced osteophytes on the posterior medial side of the olecranon during joint extension, increasing the contact pressure with the medial wall of the olecranon fossa.

Moreover, the morphological characteristics of this fracture are that the fracture line runs obliquely through the medial column, and gaps of the fracture line occur on the posterior surface. The anterior surface of the medial condyle is attached to the elbow superficial flexors including origin of the flexor carpi radialis, flexor carpi ulnaris, and palmaris longus muscles, whereas the posterior surface is not attached to the antagonist muscles due to the floor of the ulnar nerve.[8] In short, the anterior and posterior surfaces of the medial column have an asymmetrical relationship in muscle attachment. Moreover, these superficial flexor muscles are very active during the acceleration and deceleration phases, pulling on the anterior surface of the medial epicondyle.[4] Although this rare stress fracture of the elbow has no evidence of mechanism, we hypothesize that the contact between the posterior medial side of the olecranon and the medial wall of the olecranon fossa works as a pivot point at the release point, and the asymmetric muscle traction on the medial column produces extension stress against the posterior surface of the medial column during the release point to the deceleration phase.

Regarding the blood supply of the distal humerus, Kimball et al reported that intraosseous vessel supply into the distal medial humerus enters medial epiphysis distal to the medial epicondyle and travels transversely across the trochlea, larger anterior than posterior in a ratio of 2:1, with no vessels actually entering the medial column.[10] The area of the medial column to the medial column metaphysis is usually the watershed area. In the preoperative images, the fracture site represents bony prominence and may be the recovery phase of a stress fracture. However, the fracture line is clearly still present, and the surrounding area has already been replaced by osteosclerosis. This is a result that the repetitive stress of the throwing motion was more significant than the capacity for self-healing. This situation is similar for transitional, classical, and distal types of olecranon stress fractures, and Furushima et al reported that surgery for these stress fractures is indicated after 3 months of conservative treatment for these stress fractures.[7] In our case, therefore, surgical treatment was indicated since the patient had been symptomatic for 6 months. The purpose of the surgery was to improve the biological environment of the fracture site and to control its stability against the extension stress in the posterior aspect of the medial column.

The posterior medial approach was useful because the fracture line was visualized on the posterior aspect of the medial column and the ulnar nerve was easily accessible. The posterior medial approach was also the most appropriate approach to avoid iatrogenic injury to the superficial anterior forearm muscle attachments. In the medial column, the entire medullary cavity had been replaced by osteosclerosis, and there was no cancellous bone. This condition means that the blood supply necessary for the healing of the fracture is very poor. Débridement of surrounding the fracture site between the medial column and the distal diaphysis using a drill was an important procedure to induce fresh bleeding, but the removal of the osteosclerotic lesion and cortical bone created a large space into the medial column. Therefore, iliac bone grafting with monocortex was ultimately required to solve the mechanical and biological problems through intraoperative procedures. Although the use of cannulated cancellous screws was considered for the fixation of the grafted bone, plate fixation was favorable to buttress for tension side and preserve the grafted bone. As a result, bone healing was achieved in the stress fracture area of the medial column, and the player was able to return to play baseball 4 months after surgery without any symptoms in the iliac donor site.

To the best of our knowledge, this is the first report of surgical treatment for humeral medial column stress fractures. These stress fractures are a rare bone disorder and may be missed because of lack of common recognition. If there is an osteophyte on the posterior medial side of the olecranon, a stress fracture of the medial column should be suspected, and additional evaluation for tenderness and CT or MRI is recommended. This case report presents that surgical treatment for humeral medial column stress fractures may be one of the treatment strategies options.

Conclusion

This report documents our surgical treatment of humeral medial column stress fracture, for which only conservative treatment had been reported. In this case, débridement of the fracture site, use of bone graft, and compression plate fixation allowed the player to return to play baseball, and surgical treatment for this fracture was successfully accomplished.

Disclaimers:

Funding: No funding was disclosed by the author(s).
Conflicts of interest: The authors, their immediate families, and any research foundation with which they are affiliated have not received any financial payments or other benefits from any commercial entity related to the subject of this article.
Consent: Obtained.

Acknowledgments

The authors would like to thank Enago (www.enago.jp) for the English language review.

References

1. Ahmad CS, Lee TQ, ElAttrache NS. Biomechanical evaluation of a new ulnar collateral ligament reconstruction technique with interference screw fixation. Am J Sports Med 2003;31:332-7. https://doi.org/10.1177/03635465030310030201.
2. Ahmad CS, Park MC, ElAttrache NS. Elbow medial collateral ligament insufficiency alters posteromedial olecranon contact. Am J Sports Med 2004;32:1607-12. https://doi.org/10.1177/0363546503263149.
3. Chang EY, Fronek J, Chung B. Medial supracondylar stress fracture in an adolescent pitcher. Skeletal Radiol 2014;43:85-8. https://doi.org/10.1007/s00256-013-1707-3.
4. DiGiovine NM, Jobe FW, Pink M, Perry J. An electromyographic analysis of the upper extremity in pitching. J Shoulder Elbow Surg 1992;1:15-25.
5. Eygendaal D, Safran MR. Postero medial elbow problem in the adult athlete. Br J Sports Med 2006;40:430-4. https://doi.org/10.1136/bjsm.2005.025437.
6. Fleisig GS, Andrews JR, Dillman CJ, Escamilla RF. Kinetics of baseball pitching with implications about injury mechanisms. Am J Sports Med 1995;23:233-9.
7. Furushima K, Itoh Y, Iwabu S, Yamamoto Y, Koga R, Shimizu M. Classification of olecranon stress fractures in baseball players. Am J Sports Med 2014;42:1343-51. https://doi.org/10.1177/036354651428099.
8. Hoshika S, Nimura A, Yamaguchi R, Nasu H, Yamaguchi K, Sugaya H, et al. Medial elbow anatomy: a paradigm shift for UCL injury prevention and management. Clin Anat 2019;32:379-89. https://doi.org/10.1002/ca.23322.
9. Iwamoto J, Takeda T. Stress fractures in athletes: review of 196 cases. J Orhtop Sci 2003;8:273-8. https://doi.org/10.1007/s10776-002-0632-5.
10. Kimball JP, Glowczewskie F, Wright TW. Intraosseous blood supply to the distal humerus. J Hand Surg Am 2007;32:642-6. https://doi.org/10.1016/j.jhsa.2007.02.019.
11. Molenaars RJ, Medina GIS, Eygendaal D, Oh LS. Injured vs. uninjured elbow opening on clinical stress radiographs and its relationship to ulnar collateral ligament injury severity in throwers. J Shoulder Elbow Surg 2020;29:982-8. https://doi.org/10.1016/j.jse.2020.01.068.
12. O'Holleran JD, Altchek DW. The thrower's elbow: arthroscopic treatment of valgus extension overload syndrome. HSSJ 2006;2:83-93. https://doi.org/10.1007/s11420-005-51246.
13. Orava S, Puranen J, Ala-Ketola L. Stress fractures caused by physical exercise. Acta Orthop Scand 1978;49:19-27.
14. Park JY, Yoo HY, Chung SW, Lee SJ, Kim NR, Ki SY, et al. Valgus extension overload syndrome in adolescent baseball players: Clinical characteristic and surgical outcomes. J Shoulder Elbow Surg 2016;25:2048-56. https://doi.org/10.1016/j.jse.2016.09.007.
15. Suzuki K, Minami A, Suenaga N, Kondoh M. Oblique stress fracture of the olecranon in baseball pitchers. J Shoulder Elbow Surg 1997;6:491-4.
16. Werner SL, Fleisig GS, Dilman CJ, Andrews JR. Biomechanics of the elbow during baseball pitching. J Orthop Sports Phys Ther 1993;17:274-8.
17. Wilson FD, Andrews JR, Blackburn TA, McCluskey G. Valgus extension overload in the pitching elbow. Am J Sports Med 1983;11:83-8.