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MANAGEMENT OF CHRONIC MEDIAL ELBOW INSTABILITY. LITERATURE REVIEW

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SUMMARY
Traumatic injury to the medial collateral ligament (MCL) of the elbow typically results from either an acute or chronic process. Valgus instability more typically is a manifestation of chronic overuse of the elbow. Athletes who participate in throwing activities compose the majority of patients who suffer from this condition – there are much more reports regarding the pitchers from American and Asian literature. The incidence of chronic medial elbow instability significantly increased last years, so did the number of primary and revision reconstructions performed for these athletes. The goal of this study is to evaluate elbow stability biomechanics, changings leading to chronic medial elbow instability and the methods of diagnosis and treatment of this relatively rare injury in Europe. This study is based on the literature review and concerns soft tissue pathologies, as no bony pathologies leading to chronic elbow instability are to be analysed.

Keywords: medial elbow instability, medial elbow collateral ligament tear.

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STRESZCZENIE
Uszkodzenie więzadła pobocznego przyśrodkowego łokcia jest zwykle wynikiem urazu lub procesu przewlekłego. Niestabilność przyśrodkowa łokcia (walgizacyjna) częściej powstaje w wyniku długotrwałego nadmiernego obciążenia. Większość pacjentów stanowią sportowcy tzw. „rzucający" – w dominującej części rzucający gracze w baseball opisywani w publikacjach pochodzących ze Stanów Zjednoczonych Ameryki lub Azji. Występowanie tej patologii, jak i liczba wykonywanych operacji naprawczych (zarówno pierwotnych i rewizyjnych) znacząco wzrosła w ostatnich latach. Celem poniższej pracy jest analiza mechanizmów stabilizacji łokcia, zmian patologicznych prowadzących do niestabilności oraz metod diagnostyki i leczenia tych uszkodzeń, których występowanie jest relatywnie rzadkie w Europie. Poniższa publikacja jest oparta na przeglądzie literatury i dotyczy tylko patologii tkanek miękkich, nie analizując kostnych przyczyn niestabilności przyśrodkowej łokcia.

Słowa kluczowe: niestabilność przyśrodkowa łokcia, uszkodzenie więzadła pobocznego przyśrodkowego łokcia

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Introduction

Anatomy and biomechanics

Elbow is the second most commonly dislocated joint in adults – its incidence was reported 6.1 in 100 000 per year in children and adults (Josefsson and Nilsson, 1986). Elbow stability can be functionally divided into static and dynamic components (Regan *et al.,* 1991). The static part is mainly provided by the congruency between the articulating surfaces, the anterior joint capsule, the medial and lateral collateral ligaments and the interosseous membrane. The dynamic stability includes the muscles crossing the elbow joint. The medial collateral ligament (MCL) complex is composed of 3 parts: the anterior bundle (AMCL), the posterior bundle (PMCL), and the transverse ligament (Cooper's ligament). The anterior bundle is the most well defined structure originating from the medial epicondyle and inserting on the sublime tubercle of the ulna (Regan *et al.,* 1991). The AMCL is divided in two functional components and is taut throughout the full range of motion because the components are alternatively tightening – the posterior part of the AMCL is taut from 80° (some authors report 60°) to full flexion, as the anterior part of the AMCL is taut in extension (some authors report from 30° to 90°) (de Haan *et al.,* 2011; Regan *et al.,* 1991; Dodson and Altchek, 2006). The AMCL is a stronger ligament than the PMCL and acts as the most important medial ligamentous stabilizer. The PMCL is a fan shaped structure that originates from the posterior epicondyle and inserts on the sublime tubercle proximal and posterior to the anterior bundle – it forms the floor of the cubital tunnel. The Cooper's ligament originates from the tip of the olecranon and inserts distally on the ulna. It is the least distinct anatomic structure and provides little stability to the elbow because it does not cross the joint (Regan *et al.,* 1991; de Haan *et al.,* 2011). Biomechanical studies have demonstrated that the anterior bundle is the primary constraint to valgus stress about the elbow, whereas bony anatomy provides primary elbow stability at less than 20° of flexion and more than 120° of flexion (Fuss, 1991; Callaway *et al.,* 1997; Hotchkiss and Weiland, 1987; Hechtman *et al.,* 1998; Lee and Rosenwasser, 1999). The primary constraints of the elbow are the anterior medial collateral ligament (AMCL), the lateral collateral ligament complex (LCLC) and the ulnohumeral joint. The secondary constraints are the radiohumeral joint, the common flexor-pronator tendon, the common extensor tendon and the capsule. None of "bone" based instability cases (fractures and/or malunions) is to be discussed in this review (de Haan *et al.,* 2011).

Etiology

Traumatic injury to the MCL typically results from either an acute or chronic process. MCL injury secondary to an acute elbow dislocation has been reported as high as 100% (Josefsson *et al.,* 1987). Rarely, however, these patients develop symptomatic valgus instability, probably because there is minimal valgus stress applied to the elbow during normal activities of daily living. Eygendaal *et al.* (2000) reported persistent medial instability on dynamic radiographs with valgus loads in 59% of examined cases after an average of 9 years after a simple dislocation. Magnetic resonance imaging revealed 42% of these cases with medial instability on dynamic radiographs had a rupture of the medial collateral ligament. Nevertheless, no recurrent elbow dislocations were noted. Cho *et al.* (2015) reported 7 cases of acute valgus instability after a single trauma episode without dislocation – all patients were operated on from 3 to 10 days after the injury – the repair of torn structures were performed. According to literature valgus instability more typically is a manifestation of chronic overuse of the elbow. Athletes who participate in overhead – particularly throwing activities compose the majority of patients who suffer from this condition – there are much more reports regarding the throwers from American and Asian reports, as baseball is less common sport in Europe. Throwing places high stresses on the MCL, which can lead to microtearing, attenuation and finally rupture. This leads to abnormal valgus rotation of the elbow and instability – elbow becomes subluxated in valgus during extension, leading to lateral radiocapitellar compression and extension overload within the posterior compartment – the repeated impaction of the posteromedial olecranon in the olecranon fossa can cause osteophyte formation. This phenomenon has been termed valgus extension over-load (Miller and 3rd, 1994).

Aim

This study is based on the literature review and concerns soft tissue pathologies, as no bony pathologies leading to chronic elbow instability are to be analysed.

Material, methods and results

Patient's evaluation

Patients with chronic valgus instability complain of medial elbow pain that is exacerbated with throwing. Another sign of instability may be a feeling of the elbow "giving-way" whilst axial loading. It is important to remember these patients can also suffer from medial epicondylitis and traction injuries to the ulnar nerve (Grace and Field, 2008). Instability examination should be done with lax collateral ligaments, which means flexion (from 10° to 90°) and pronation of the forearm for valgus testing of the MCL. Several clinical tests are proposed to evaluate medial elbow stability (de Haan *et al.,* 2011). The moving valgus stress test described by O'Driscoll *et al.* (2005) was reported to be the most accurate in predicting medial ulnar collateral ligament injury The elbow is brought through range of motion while the examiner applies a valgus force. A positive result is noted when the patient experiences pain between 70° and 120° when flexing and extending the elbow while applying valgus force (O'Driscoll *et al.,* 2005). The "milking" test is performed by having the patient reach with the contralateral hand under the affected elbow and grasps the ipsilateral thumb. A valgus force is applied by the patient with the elbow flexed, and medial elbow pain with this maneuver indicates a positive result (Veltri DM, O'Brien SJ, 1994). To perform the static valgus stress test the examiner places the patients distal forearm under his axilla and applies a valgus load to the elbow in 30° of flexion while palpating the medial collateral ligament (Dodson and Altchek, 2006). Finally, the valgus extension overload test can be used to help detect the presence of chronic posteromedial compartment degeneration as a result of long standing valgus instability. The examiner stabilizes the humerus with one hand, with the other hand applies a valgus force while quickly maximally extending the elbow. A positive test causes pain and is indicative of posteromedial compartment overload (Dodson and Altchek, 2006).

Radiologic diagnostics

The initial diagnostics should include routine anterior – posterior (AP) and lateral radiographs. Posteromedial osteophytes, loose bodies, and other pathologic changes of the elbow can be seen on plain radiographs. Stress radiographs could be useful to compare to contralateral shoulder. Magnetic resonance imaging (MRI) scan (itself or arthrography) is very helpful in distinguishing partial tears from complete ones and can show recognizable patterns of acute or chronic injury of the MCL. Ultrasound is useful tool to evaluate dynamic ligaments insufficiency (Dodson and Altchek, 2006).

Treatment

Non-operative treatment based on 6 to 12 weeks of rest followed by strengthening physiotherapy program should be attempted, particularly in non-throwing athletes and in patients with moderate physical activity.

However it is to remember that conservative treatment of MCL injuries in baseball players was successful in only 42% (Rettig *et al.,* 2001). Podesta *et al.* reported enhancing results in patients with PRP injection for partial medial ligament tears (Podesta *et al.,* 2013). The indication for surgery is based on the patients' subjective symptoms – mainly the inability to continue sport (or heavy manual work) due to refractory medial elbow pain. Dodson and Altchek reported their indications for surgery in throwing athletes were based on following findings: a history of medial elbow pain in the region of the MCL whilst throwing, evidence of MCL injury on MRI and pain that is preventing the patient from an acceptable level of competition (Dodson and Altchek, 2006). It is to notice the indications for surgery are based on patient's complaints confirmed by some clinical and radiological findings rather than any available method of instability evaluation. Many authors recommend starting the procedure with a diagnostic arthroscopy to confirm the valgus instability and to remove loose bodies and some osteophytes in posterior compartment if present (Dodson and Altchek, 2006; Field and Altchek, 1996). After this step the proper reconstruction procedure is started.

Surgical technique

Many surgical techniques were proposed to reconstruct the medial elbow stability. The original Jobe procedure offered good to excellent results for 63% of overhead throwing athletes (Jobe *et al.,* 1986). A palmaris tendon autograft was placed through drill holes at the medial epicondyle and ulna in a figure-of-eight fashion and sutured to itself. The surgical approach involved transection of the flexor/pronator muscle group and routine transposition of the ulnar nerve. Patients returned to sport after 12 to 18 months, but a relatively large number of postoperative complications were reported – with ulnar nerve problems being particularly common (Jobe *et al.,* 1986). Conway *et al.* reported the success rate of 68% but still complications related to ulnar nerve were present in 21% of patients. A revision procedure of the ulnar nerve was performed in 58% of these patients (Conway *et al.,* 1992). Smith *et al.* described a more limited approach, which involved splitting the flexor-pronator muscle group instead of dividing it completely from the medial epicondyle. Using this technique, it was unnecessary to transpose the ulnar nerve routinely (Smith *et al.,* 1996). Thompson *et al.* reduced the complication rate and improved the success rate to 93% using this modified technique. The authors recommended come back to sport activity from 12 to 18 months after surgery (Thompson *et al.,* 2001). Also Azar *et al.* reported 81% of good to excellent results after this modification. They also succeeded to quicken the postoperative recovery time with a return to sport after average 9.8 months. The complication rate was 8.8% (Azar *et al.,* 2000). Rohrbough *et al.* proposed the docking technique – only one primary tunnel in the ulna and one in the medial epicondyle of the humerus were drilled (Rohrbough *et al.,* 2002). The graft was passed initially through the ulnar tunnel from anterior to posterior, than the posterior limb of the graft was placed into the humeral tunnel. After the graft length was determined, the suture was placed into this limb and excess graft was removed. The graft was passed into the blind-ended main tunnel of the epicondyle. Two smaller accessory tunnels were used to pass suture limbs – this allowed the graft to be secured with appropriate tension tied over bony bridge with the elbow in supination and slight varus stress applied. Rohrbough *et al*reported a 92% success rate with athletes returning to sport in average 12 months (Rohrbough *et al.,* 2002). More recently, single drill holes located in the isometric and anatomic location of the AMCL on the medial epicondyle and ulna were proposed to simplify the procedure and to lower the risk of the ulnar nerve. Ahmad *et al.* in their laboratory cadaveric study reported good initial strength (95% of the intact elbow) using a single-strand reconstruction of the central fibers of the AMCL with single isometric drill holes in both the medial epicondyle and ulna and graft fixation with the interference screws (Ahmad *et al.,* 2003). There are some biomechanical studies comparing the methods of graft fixation, however the results are inconsistent. Armstrong *et al.* reported a biomechanical comparison of 4 MCL reconstruction techniques: figure-8 reconstruction (Jobe's technique), docking technique, endobutton fixation and the interference metal screw technique (Armstrong *et al.,* 2005). The peak load to failure of the MCL reconstructions was inferior compared with the intact ligament (142.5+/− 39.4 N). The interference screw technique (41.0 +/− 16.0 N) was inferior to the docking technique (53.0 9.5 N) and the endobutton (52.5 +/− 10.4 N) in means of peak load. A figure-8 tehchnique seemed to be the weakest with a load of falure of (33.3 +/− 7.1 N). Authors also found it difficult to introduce the interference screw in the ulna without damaging the graft – it was cut by the screw threads, possibly the metal screws were too hard (Armstrong *et al.,* 2005). Furukawa *et al.* compared the docking technique with the interference metal screw technique with the use of a palmaris longus graft versus a GraftJacket (modified dermal allograft tissue) graft (Furukawa *et al.,* 2007). With the use of a palmaris longus graft the results for the docking technique and interference screw technique were comparable. Large *et al.* compared the interference metal screw technique with figure-8 technique and found the latter to be superior for reconstruction stiffness (Large *et al.,* 2007). McAdams *et al*compared the interference bioabsorbable screw technique with the docking technique after cyclic loading (McAdams *et al.,* 2007). The interference screw reconstruction was significantly stiffer than the docking technique. Kodde *et al.* reported clinical results in 20 patients operated on using the bioabsorbable (5.5 mm) interference screws. They reported Mayo Elbow Performance Index (MEPI) score improved from 82 to 91 points, 6 patients (30%) quit the sport activities because of reasons unrelated to the elbow surgery. 18 patients reported excellent results on the Conway scale (Kodde *et al.,* 2012).

Postoperative protocol

Usually most of the authors recommend 7 days of immobilization, than the elbow motion is allowed from 30° to 90° for 2 weeks and from 15° to 45° for next 2 weeks. The elbow is protected with a brace in this period (Rohrbough *et al.,* 2002; Kodde *et al.,* 2012; Dodson and Altchek, 2006). After 5 weeks the final range of motion is slowly restored and slow muscular strengthening is begun. As the graft remodeling takes up to 12 months it should be taken under consideration when allowing the patient to fully return to normal activity. Rehabilitation should be performed with a stable joint, which for valgus instability involves supination of the forearm. Active rather than passive mobilization should be stimulated to improve muscular stability (de Haan *et al.,* 2011).

Discussion

It is interesting to realize, that Ericson *et al.* reported an "epidemiology" of MCL reconstructions in pitchers in the USA (Erickson *et al.,* 2016). Conte *et al.* reported that 25% of major league and 15% of minor league pitchers confirmed history of ulnar collateral reconstruction (Conte *et al.,* 2015). Erickson *et al.* showed a significant increase in the number of reconstructions in major league pitchers from 2000 to 2012 (Erickson *et al.,* 2014).

Zaremski *et al.* found the younger athletes suffered from less severe MCL injuries than older athletes and non-operative treatment coud be a reliable option for them. However they reported the incidence of non-surgical ligament injuries in young athletes increased 12-folds from 2000 to 2016 (Zaremski *et al.,* 2017). The increased number of primary reconstruction in professional pitchers could be worry, but more important concern started to be the increased number of revisions. Wilson *et al.* reported that 15% professional players required at least one revision MCL reconstruction during their pitching career (Wilson *et al.,* 2015). As the results of primary reconstructions in professional pitchers are reliable, the results following revisions are not as encouraging. Marshall *et al.* and Liu *et al*reported worse results after revision surgery comparing to the results after primary surgery (Marshall *et al.,* 2015; Liu *et al.,* 2016). It is interesting that some studies also showed a small but regular decrease in velocity of throwing after the reconstruction (Jiang and Leland, 2014; Lansdown and Feeley, 2014). This might be the reason Erickson *et al.* suggested in their review study that MCL repair, particularly in younger patients with other lesions than midsubstance ligament injury, could benefit from a repair over reconstruction – it is potentially easier to revise the elbow after surgical repair rather than surgical reconstruction (Erickson *et al.,* 2017).

Conclusions

Chronic medial ulnar instability stays a challenge problem particularly for European surgeon, as the number of these problems in European patients is much lower, comparing to countries with large number of "pitching athletes". One should be aware of potential benefits of surgery for demanding patients; however the rate of return to high level varies from 50% to 95% (Conway *et al.* 1992; Koh *et al.* 2006).

The optimal technique for reconstruction of the MCL is still debatable. It is recommended to continue investigation in finding one repetitive technique to minimize the risk and improve outcomes.

Regardless surgical treatment an effort should be done to work on prevention protocol for risk sports' athletes.

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