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Ulnar Impaction Syndrome: A case series investigating the appropriate diagnosis, management, and post-operative considerations

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Ulnar sided wrist pain is a common site for upper extremity disability. Ulnar impaction syndrome results in a spectrum of triangular fibrocartilage complex (TFCC) injuries and associated lunate, triquetrum, and ligamentous damage. Patients commonly present with insidious ulnar sided wrist pain and clicking, and a history of trauma or repetitive axial loading and rotation. In this case series, three patients presented to a sports chiropractor for evaluation and were subsequently diagnosed with ulnar impaction syndrome. Treatment strategies consist of conservative management, arthroscopic debridement or repair, arthroscopic wafer procedure, or ulnar shortening osteotomy. For the athlete, intervention should be

Une douleur cubitale du poignet est une manifestation courante d'un handicap de membres supérieurs. Le syndrome d'impaction cubitale entraîne une série de lésions du complexe fibrocartilagineux triangulaire (TFCC) et des lésions connexes de l'os semi-lunaire, du cartilage aryténoïde et des ligaments. Les patients souffrent habituellement d'une douleur insidieuse au poignet du côté cubital et de craquements de l'articulation, ainsi que de traumatismes ou de compressions et rotations axiales répétées. Dans cette série de cas, trois patients se présentant à un chiropraticien de sport pour une évaluation ont ensuite reçu un diagnostic du syndrome d'impaction cubitale. Les stratégies thérapeutiques comportent le traitement conservateur, le débridement ou la réparation arthroscopique, la résection arthroscopique de la partie distale, ou l'ostéotomie de raccourcissement cubital. Pour l'athlète, l'intervention doit être adaptée et

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individualized and sport-specific, considering athletic priorities, healing potential, return to play, and long-term health concerns.

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KEY WORDS: ulnar impaction, abutment, TFCC injury, athlete(s), management, chiropractic

indiquée pour son sport en tenant des priorités du sport, du potentiel de guérison, de la possibilité du retour au jeu et des problèmes de santé à long terme.

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MOTS CLÉS : impaction cubitale, soutien, lésions TFCC, athlète, traitement, chiropratique

Introduction

Hand and wrist injuries are common among athletes. Current literature reviews suggest a rate of 3-9% of all sports injuries involve the hand or wrist, with 25-50% recognized as overuse injuries.[1,2] Ulnar impaction syndrome, or ulnocarpal abutment, is a common degenerative condition causing ulnar-sided wrist pain.[3] Biomechanical changes causing excessive loading across the ulnocarpal joint are responsible for a spectrum of pathological changes involving the triangular fibrocartilage complex (TFCC) and articular surfaces of the ulnar head, lunate, and triquetrum.[4,5,6]

Ulnar-sided wrist stability is enhanced via the TFCC, an arrangement of ligaments and fibrocartilage originating from the sigmoid notch on ulnar border of the radius and inserting into the base of the ulnar styloid and fovea of the ulnar head.[7] It continues distally into the lunate, triquetrum, hamate, and base of fifth metacarpal, and connects with the ulnolunate and ulnotriquetral ligaments and extensor carpi ulnaris (ECU) tendon subsheath.[7,8] The lunotriquetral ligament, a weak intrinsic ligament of the wrist, is also commonly disrupted with progressive degenerative ulnocarpal impaction.[2,9] The TFCC is composed of a rich peripheral arterial supply at the outer 10-40% of the articular disc, and a near avascular central triangular articular disc lying between the ulnar head, lunate, and triquetrum.[7,10] The arterial supply of the TFCC guides subsequent treatment options, as the central and radial portions of the TFCC have significantly limited healing ability following injury.

The TFCC is responsible for stability across the distal radioulnar joint (DRUJ). Palmer and Werner (1981) demonstrated ulnar neutral wrists transfer approximately 18% of the total load applied, with the radiocarpal joint transferring 82% of the total load. A direct relationship between increasing ulnar length and increased force transmission across the TFCC exists. A positive variance of 2mm will increase the ulnocarpal load to approximately 40%.[3,11] Increased dorsal tilt due to previous injury of the radius can additionally increase the ulnar load to 65% of total load transferred.[11] Further, thinning of the articular disc has been shown to accompany increased ulnar variance, increasing risk of TFCC wear and perforation.[12] Although most commonly associated with congenital or acquired positive ulnar variance, ulnar impaction can also occur in ulnar neutral or negative ulnar variance wrists.[5,13,14] Dynamic variance can present with maximal grip and pronation, directly implicating athletes performing power-gripping tasks associated with axial loading and rotation.[15] Immature athletes under these demands are at a heightened risk for premature physeal arrest of the distal radius, and subsequent ulnar impaction.[4] The diagnosis relies heavily on clinical examination and secondary radiographic studies, and has been classified based on pathoanatomical change resulting from progressive deterioration of the TFCC, as well as degenerative changes within the dome of the ulnar head, lunate, triquetrum, and lunotriquetral ligament (LTIL).[11,15]

This case series illustrates the appropriate diagnosis and management of three patients presenting to a sports chiropractor with ulnar sided wrist pain. The report outlines pathophysiological changes occurring with ulnar impaction syndrome, and demonstrates the effective management strategies available based on individual considerations concerning healing, return to play, and long-term health.

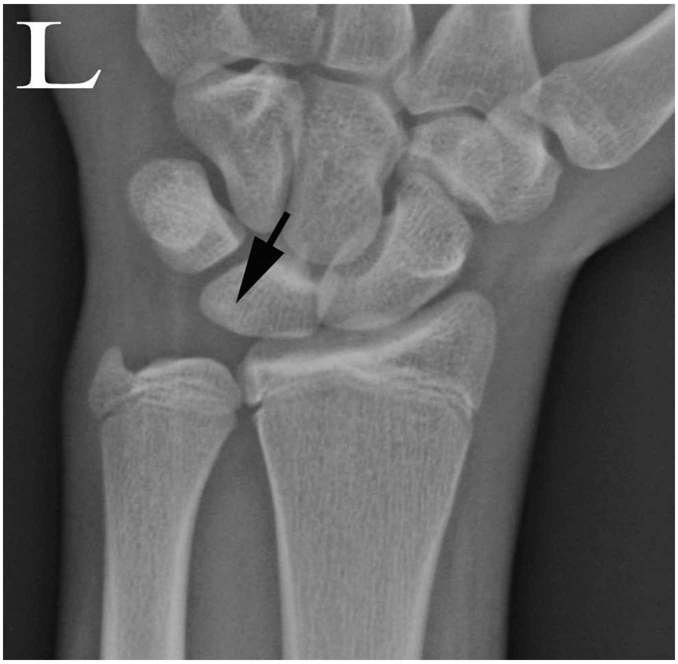


Figure 1.
Radiographic imaging from case 1 revealing sclerosis with indentation of the ulnar side of the proximal articular margin on the lunate.

Case Series

Case 1

A seventeen year old student and competitive boxer presented to a sports chiropractor with a 6-month complaint of left sided wrist pain. The pain had come on progressively and he related it to "over-exertion/over training". Specifically the patient's complaint was aggravated by punching, standard push-ups and plyometric push ups repeatedly in training. In addition, tournaments with multiple fights in a few days also aggravated his complaint. The patient had seen his family doctor who diagnosed a sprain and prescribed the anti-inflammatory arthrotec and rest. The patient only used the medication for a short period and found minimal improvement. At the time of presentation the patient had been on 3 months relative rest excluding push ups and punching bag from his training. He did not complain of clicking or locking and had no difficulties with activities of daily living such as opening jars, doors etc. The patient stated his intention was not to come for treatment but a second opinion on why a sprain would take so long to heal.

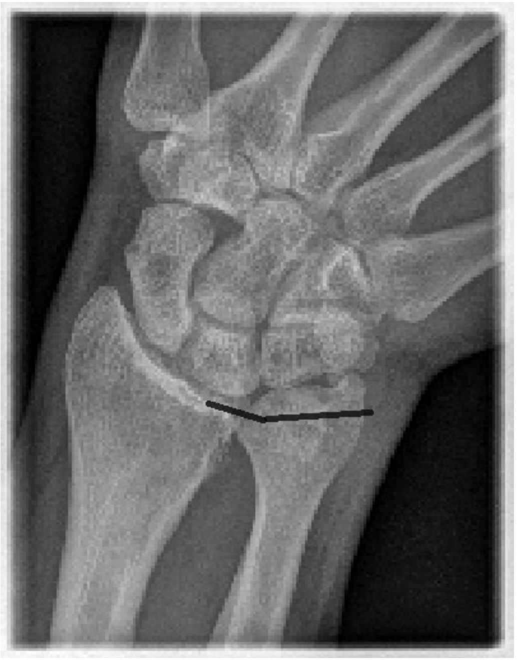
Upon physical examination active, passive and resisted wrist range of motions were unremarkable for pain or deficits. Specific palpation over the distal ulna, pisiform, lunate and triquetrum were positive producing a jump sign. An attempt to do push-ups during the exam also caused the patient significant pain. Joint line palpation of the TFCC appeared to be less tender than bony palpation and ulno-carpal stress test was unremarkable.

Radiographs were ordered for the left wrist due to the positive exam findings despite three months of prolonged rest. The differential diagnosis included chronic ulnar impaction syndrome, ulnar styloid impaction, growth plate injury, and TFCC injury.

Radiographs shown in Figure 1 revealed neutral ulnar variance, and sclerosis with indentation of the ulnar side of the proximal articular margin of the left lunate, consistent with ulno-lunate impaction syndrome.

The patient was advised to continue his relative rest in training while referral to a sports medicine physician was initiated to consider further advanced imaging and management options. Further imaging was necessary for additional confounding factors such as TFCC injury or growth plate injury. The MRI showed intermediate to high signal on the T2 fat saturated sequence at the distal insertion of the triangular ligament on the ulnar styloid. A tiny partial tear of the TFCC 1-2mm could not be completely excluded. There was mild increased signal across the epiphyseal plate of the distal ulna. This could indicate a subtle Salter type 1 or 5 non-displaced fracture. Therefore continued relative rest and monitoring was indicated. The patient was encouraged to keep working out at his club but to specifically rest from punching the bag, sparring with opponents and to avoid push ups or other exercises where the hands and wrists become weight bearing.

Following eight months of relative rest the patient returned to his sports physician and his exam findings had returned to normal. He had recently initiated a return to full training including punching the bag and sparring. His case will require some additional clinical monitoring to determine if his wrist will handle full training and competition. Continued rest from push ups with the wrist extended position is recommended with a focus on allowing recovery following aggressive work outs or competition.



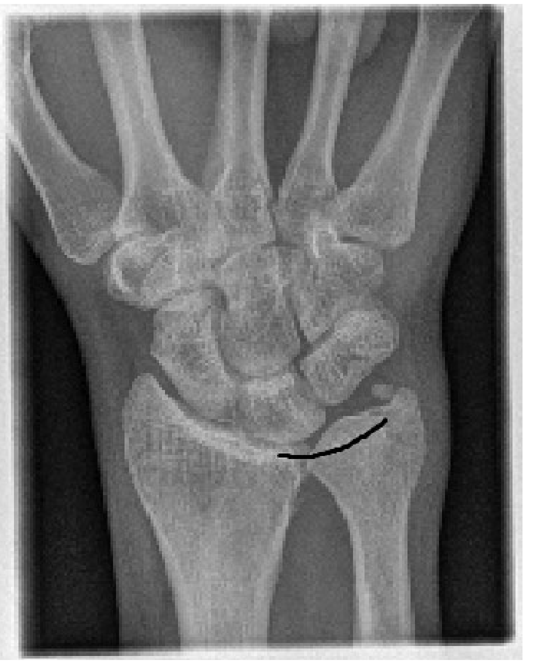
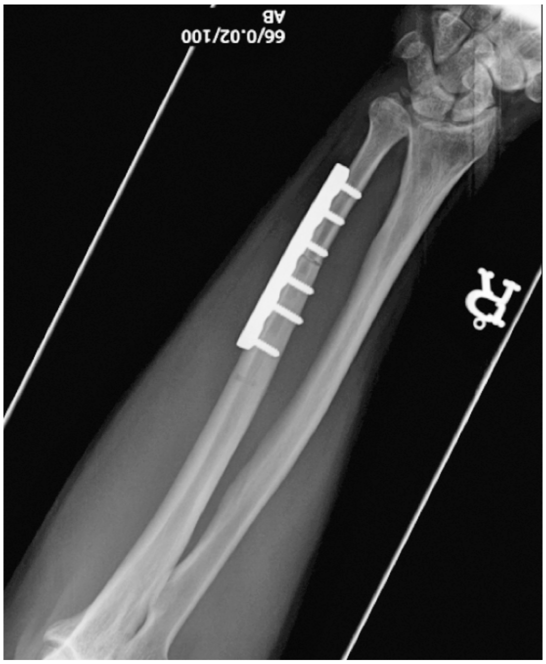


Figure 2 and 3:
Wrist ulnar deviation and PA views reveal positive ulnar variance of 5mm with incongruity of the DRUJ, as a sequela of previous distal radius fracture. An ossicle is also noted at the ulnar styloid process.

Case 2

A 26-year-old male chiropractic student presented to a chiropractor with a complaint of developing right wrist pain and stiffness following initiation of Mixed Martial Arts classes over a four-month period. The primary complaint was increased pain following repetitive punching at a stationary bag, and had increased in intensity over this period. Opening doors and weight bearing in extended positions would also aggravate his complaint. The pain was between 3/10 at rest and 8/10 when aggravated. The patient reported relief with rest. Previous trauma included a distal radius growth plate fracture and distal ulna fracture from a fall on an outstretched arm at the age of 13 years, in which the patient did not note long-term deficits. He also reported a history as a card dealer four years prior, where he occasionally experienced sharp ulnar sided pain while dealing. Further, two years prior to assessment, he received radiographic evaluation from his medical doctor, which was described to be unremarkable. During the current examination, minor swelling was noted at the distal radioulnar joint. Active, passive, and resisted wrist ranges of motion revealed discomfort during all movements involving extension, supination, and pronation. Upper limb closed-chain exercises were challenging, with the patient reporting apprehension during these exercises. The chiropractor requested radiographic imaging of the wrist, revealing a positive ulnar variance of 5mm with incongruity of the distal radioulnar joint, resulting from the previous radius fracture (Figure 2 and 3). The patient was referred for subsequent orthopaedic evaluation, where the surgeon suggested a right ulnar osteotomy shortening and TFCC debridement procedure (Figure 4 and 5). Following the operation, a splint was utilized for five days, after which gentle active and passive wrist range of motion exercises commenced. After a few weeks, gentle grip strength exercises at various wrist flexion and extension angles were used to replenish hypothenar atrophy resulting from the injury. Five months following the procedure, the patient



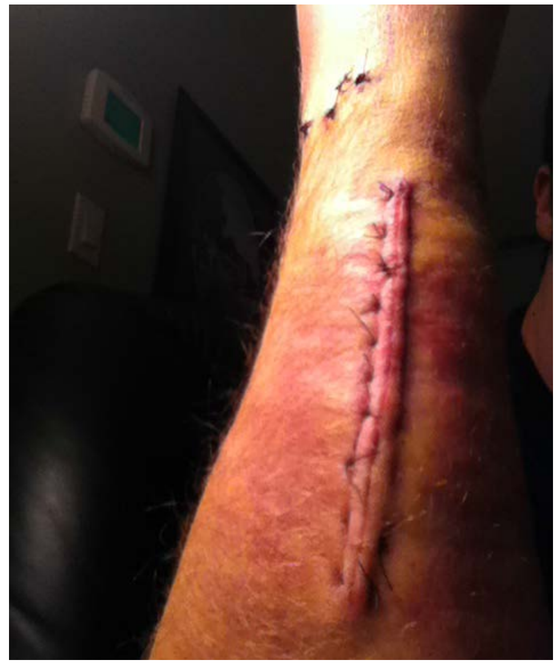
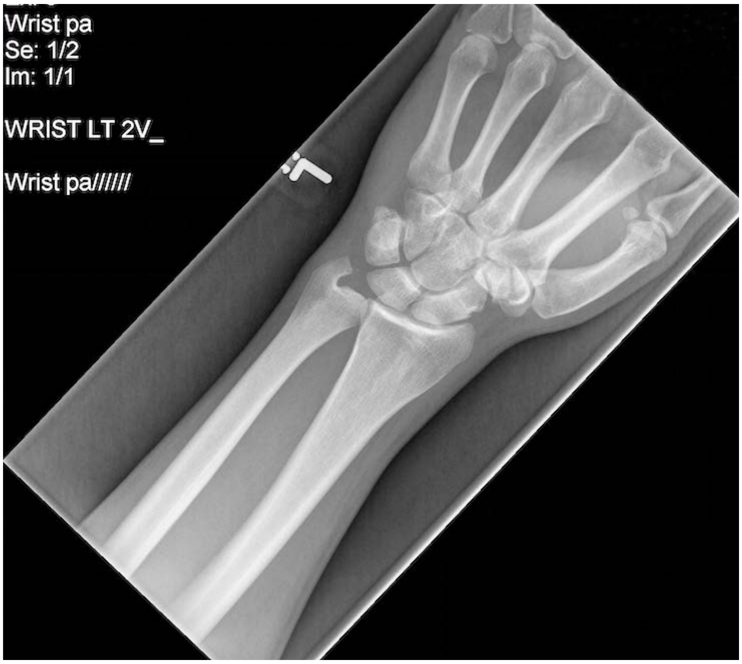


Figure 4 and 5:
Demonstrates successful ulnar osteotomy procedure, with ulnar variance decreased to neutral, and osteotomy procedure further increasing stability of the DRUJ joint.

reported mild ulnar sided wrist pain, when initiating his chiropractic career. Acupuncture (TH-4), with needle insertion on the dorsal ulnar aspect of extensor digitorum, relieved this complaint. Currently, 30 months following the operation, this pain has only recurred once and was again relieved with simple acupuncture therapy. Current limitations include minor restrictions in active and passive supination. There is occasional clicking near the TFCC and remaining apprehension during closed chain upper limb exercises with an extended wrist, such as planks and push-ups. The patient currently maintains working on shoulder centration exercises while maintaining quadruped position, with varying center of gravity. Concurrent grip strength exercises, Turkish get-ups, and Farmer carries are also significant positive influences in the rehabilitation process.

Case 3

A 27-year-old male chiropractic student presented to a chiropractor with 10 days of moderate to severe left ulnar sided wrist pain, which started when catching a rolling ground ball during a baseball game. The patient rated the pain at 9/10 following this incident, and could not use his left hand in the shower when attempting to wash hair. At presentation, the pain had decreased to 2/10, with increases in intensity following tobacco farming. He had a long history of tobacco farming, which consists of repetitive ulnar deviation, long days of physical work, and heavy lifting. He also reported an active history of hockey, volleyball, and golf, with repetitive minor wrist sprains bilaterally. Upon physical examination, no visible bruising or scarring was evident. Digital palpation of the distal left ulna and ulnar collateral ligament was very painful. Ranges of motion were full and pain free; except for ulnar deviation limited 50% due to increased pain at the ulnar aspect of the wrist. Grip strength was unremarkable. The patient was sent for radiographic studies and diagnostic ultrasound, in order to examine the integrity of the dis-



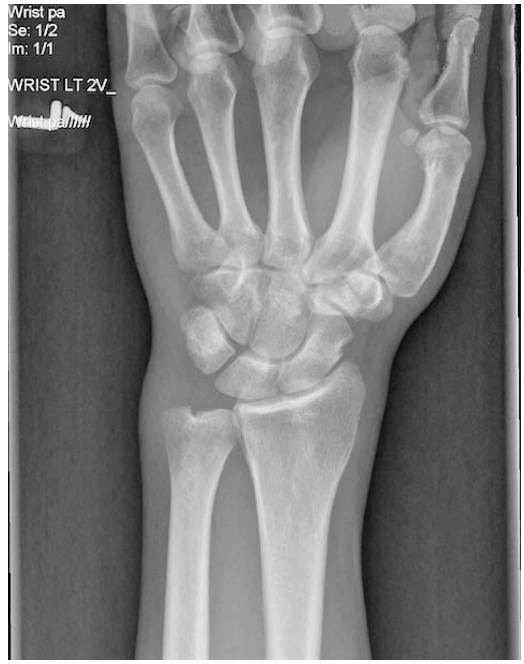


Figure 6 and 7:
PA left wrist (Figure 6) demonstrates presence of ulnar styloid fracture and ulnar styloid impaction syndrome, with ulceration and cyst formation depicted within the triquetrum pre-operative. PA left wrist (Figure 7) demonstrates imaging following subsequent ulnar styloidectomy.

tal radioulnar joint, ulnar collateral ligament and TFCC. Diagnostic ultrasound was unremarkable. Radiographs demonstrated a fracture of the ulnar styloid and signs of subchondral cyst formation within the triquetrum (Figure 6 and 7), consistent with ulnar impaction. At this time, the patient was referred to an orthopaedic surgeon, and a subsequent ulnar styloidectomy was performed, removing fractured pieces under anesthesia and shaving the ulnar styloid. The wrist was then casted for three weeks. Mild atrophy globally and severe stiffness was present throughout the wrist following casting, and the patient re-visited the chiropractic clinic, presenting with moderate swelling, tenderness, and redness at the excision site (approximately 4cm in length). Supination and pronation was decreased 50%, with flexion and extension decreased by 25%. The patient was treated with Graston Technique (GT)®, microcurrent, myofascial release techniques, and active and passive range of motion strengthening three times a week for eight weeks. At follow-up, he reported 90% strength and range of motion globally, and was able to resume normal working duties with only mild to moderate discomfort. The patient received intermittent GT® on scar tissue and passive range of motion exercises for another month, when he then returned to full working duties with great success. At 42 months follow-up, the patient is a working chiropractor, reporting no pain, and full strength and range of motion of his left wrist and arm. While exercising in a loaded closed-chain position, he focuses on maintaining neutral wrist position.

Discussion

Ulnar sided wrist pain is a common cause of upper extremity disability, a host site for many traumatic and chronic degenerative conditions.[16] Ulnar impaction syndrome is a progressive degenerative condition, most commonly resulting from repetitive abutment of a lengthened ulna, with the TFCC, lunate, triquetrum, and lunotriquetral ligament. The relative length of the ulna compared to

Table 1
*Palmer and Werner Classification of traumatic and degenerative conditions of the TFCC *L-T: lunotriquetral ligament*

Class I: Traumatic	
A	Central perforation
B	Medial avulsion (ulnar attachment) with or without distal ulnar fracture
C	Distal avulsion (carpal attachment)
D	Lateral avulsion (radial attachment) with or without sigmoid notch fracture
Class II: Degenerative (Ulnocarpal Impaction Syndrome)	
A	TFCC wear
B	TFCC wear + lunate and/or ulnar chondromalacia
C	TFCC perforation + lunate and/or ulnar chondromalacia
D	TFCC perforation + lunate and/or ulnar chondromalacia + L-T* ligament perforation
E	TFCC perforation + lunate and/or ulnar chondromalacia + L-T* ligament perforation + ulnocarpal arthritis

the radius is expressed as ulnar variance, where neutral variance is dictated by a difference of less than 1mm from the radius.[17] Although a wide distribution occurs within the population, developmental positive ulnar variance is cited to be relatively more common in Asian and black populations than Caucasians.[16, 18] Athletic events requiring repetitive compression and rotation demands on the upper extremity may also predispose a patient to ulnar impaction via traumatic development.[19] Distal radius fractures are the most frequent occurring fracture in children under 16 years of age[20], with shortening of radial length greater than 5mm considered to lead to long-term functional impairment[20, 21]. This was certainly involved in the development of ulnar impaction in case 2. Authors have reported TFCC tears in 43-80% of patients following distal radius fractures, with majority of peripheral TFCC tears demonstrating DRUJ instability.[22,23] Post-traumatic shortening of the radius following distal radial fractures is associated with lengthening of a previously asymptomatic, long, or beaked ulnar styloid; resulting in concomitant impaction of the ulnar styloid on the proximal aspect of the triquetrum and ulnar-side of the lunate.[14] This is referred to as ulnar styloid impaction syndrome, and may be present alone, or in combination with ulnar impaction syndrome, and commonly developing with repetitive ulnar deviation and dorsal flexion.[14] This was noted within the third case of this case series, likely due to repetitive rotational demands during tobacco farming. Further, in absence of distal radius fractures, submitting an immature wrist to prolonged compression and repetitive microtrauma has demonstrated premature arrest of radial growth plate and subsequent ulnar overgrowth.[17, 24-26] Our first case highlighted the need for appropriate prolonged rest periods in the adolescent athlete.

Ulnar impaction syndrome results in progressive degeneration and increased abutment of the distal ulna or TFCC against the ulnar carpus. Although a precise incidence of TFCC injury is unknown; gymnasts, boxers, racquet and stick sports are said to report "fairly common" injury of TFCC.[10, 20] These athletes generally present with a history of axial loading on a pronated wrist, and pain provocation during wrist rotation. Particularly, the load bearing attributes of the TFCC increases susceptibility towards acute traumatic injury, as well as secondary degenerative concerns implicated with ulnar impaction[8]. In the second case, distal radius trauma in combination with load bearing activity were factors in the progression of TFCC degeneration, and such necessary debridement during osteotomy procedure. The TFCC is exposed to a spectrum of acute and degenerative pathoanatomical changes, as originally described in 1981 by Palmer and Werner (Table 1). This classification system reveals the progressive and additive nature of degenerative TFCC injuries, as increased impingement occurs between the ulnar head on the triquetrum and ulnar aspect of the lunate.[24] Traumatic injury of the TFCC usually affects the peripheral disc, whereas degenerative tears most commonly impact the central disc.[2] The first case also showed signs of a small tear using MRI but it could not be confirmed with this image alone.

A detailed history and focused physical examination are critical components for diagnosing TFCC injury due to ulnar impaction in the athlete. Chronic pain caused by repetitive loading of the wrist, with painful clicking or locking during pronation and supination are often present[8], pain is aggravated with activity, and generally relieved with rest. As opposed to acute events generally associated with class I traumatic TFCC tearing, athletes present with insidious, progressive pain limiting range of motion, grip strength, and performance.[4] The history of the patient in case 1 and 2 was very similar to this expected athletic presentation.

Many provocative manoeuvres have been described to help diagnose TFCC injury. Ranges of motion should be evaluated, with ulnar deviation and pronation often pain-producing. Gripping motion also elicits pain subsequent to TFCC injury and grip strength is usually decreased compared with the unaffected wrist.[8] Tenderness of the TFCC during palpation distal to the ulnar styloid and proximal to the pisiform, between the tendons of the ECU and flexor carpi ulnaris (FCU) indicates a positive ulnar fovea sign.[2] The ulnocarpal stress test, originally introduced by Nakamura (1991) involves combined dorsiflexion, axial loading, and ulnar deviation or rotation of the wrist. In the authors' original study, 33 of 45 patients with positive ulnocarpal stress tests demonstrated positive ulnar variance of 1mm or more on the affected wrist during standard posterior-anterior (PA) views. Further, class II TFCC lesions resulting from ulnocarpal impaction were confirmed in 19 patients, or 57.8% of those demonstrating positive ulnar variance. The majority of these patients suffered a spontaneous onset of pain, and were diagnosed with class IIB lesions involving TFCC wear with lunate and/or ulnar chondromalacia. However, positive ulnocarpal stress testing is sensitive for a variety of intra-articular ulnar wrist pathology[16], and is not specific for the diagnosis of ulnocarpal abutment syndrome[4, 24]. A positive supination lift test, with patient "lifting" examination table with palms flat on undersurface of table, can further suggest peripheral dorsal tear of the TFCC[2]. During a positive piano key sign, the athlete forcefully presses palms into examination table while the clinician observes for increased dorsal-palmer translation of DRUJ, which may suggest instability. Impairment of the articular disc and longitudinal instability of the DRUJ occur simultaneously and must be investigated.[12] Overall, a detailed history of spontaneous ulnar sided wrist pain combined with provocative testing should prompt the astute clinician to further radiologic evaluation, as the chiropractor promptly ordered in all of the above cases.

When expecting possible ulnar impaction syndrome, radiographic series include standard zero rotation posterior-anterior (PA) and lateral views. Although ulnar positive wrists will demonstrate ulnar impaction, ulnar neutral and negative wrists are also at risk due to dynamic variance, in which forearm pronation and forceful gripping have been shown to increase ulnar variance.[15, 27] Therefore, in addition, a pronated grip PA view is often performed to best demonstrate increased ulnar variance. This is critical as the presence of ulnar variance impacts future treatment decisions for the athlete, and an accurate diagnosis can prompt appropriate management considerations, including further imaging. Conventional radiographs can detect the presence of positive ulnar variance, ulceration or cyst formation within the ulnar base of the lunate and/or triquetrum, and joint incongruency of the DRUJ.[16, 24] Further, the presence of a prominent ulnar styloid must be noted as this may affect surgical treatment, with wafer resections incapable of resolving ulnar styloid-carpal impaction.[4] MRI can be helpful to further detect radiologically occult lesions. MRI has reported 72-100% sensitivity, 90% specificity, and 92% localization capability of TFCC tears[28, 29], however detection of peripheral tears and experience of interpreting radiologist significantly influence the ability to detect and localize TFCC injuries[30]. Softening, fibrillation, or partial thickness defects within the articular cartilage are more difficult to detect, as well as degeneration within the lunotriquetral ligament.[14] The gold standard imaging for localizing TFCC injuries is considered to be wrist arthroscopy, which serves as treatment at time of diagnosis, and reports 88-100% sensitivity.[8,16,24] Arthroscopy also provides detailed information regarding ligamentous lesion size if present, while distinguishing partial and complete tears of the TFCC.[14, 24]

Treatment

Athletes may benefit from earlier intervention in an effort to return to play more rapidly, or may delay intervention based on athletic aspirations and timing.[4] Individualized treatment plans must be formulated with the surgeon, including potential postponement of surgical options following the season when injury is not disabling. Early diagnosis and intervention have been claimed to reduce the risk of long-term disability and injury progression[2,6,8,31], with early arthroscopy and peripheral TFCC repair recommended for cases of DRUJ instability[10,20]. During the athletic season, treatment typically begins with modified activities, non-steroidal anti-inflammatories, bracing, and physical therapy to decrease patient symptomology, with corticosteroid injections offered if extended rest is not effective.[4] Park and colleagues[32] reported 57% of patients with TFCC injury to achieve resolution of symptoms following four weeks of immobilization. Although effective for the general population, immobilization alone will not address altered biomechanical concerns in the athlete. Ultimately, in order to decrease load experienced across the ulnocarpal joint, ulnar variance must be adjusted with surgical treatment. Arthroscopic options include TFCC debridement and/or repair, or arthroscopic wafer technique. Open procedures include the ulnar-shortening osteotomy (USO) and more advanced techniques in presence of significant ulnocarpal arthritis present within class IIE lesions.[4]

Arthroscopic debridement or repair may be appealing for midseason athletes secondary to benefit of shorter recovery time.[33, 34] Central tears are often debrided due to lack of blood supply, whereas peripheral TFCC injuries warrant repair based on adequate vascular supply and increased symptomology.[2] Type IA lesions, tears within the central articular disc, and type IIC lesions, associated with articular disc perforations, are therefore commonly treated with debridement. The success rates in the literature range from 66 to 87%.[19,33,35] Generally speaking, arthroscopic repair of peripheral tears involves increased immobilization and delayed rehabilitation as compared to central tears due to the influence TFCC function on DRUJ stability.[19] USO remains a successful secondary procedure for persistent pain following debridement or repair of TFCC.[19] Following arthroscopic debridement alone, patients are immobilized for one to two weeks prior to initiating limited range of motion.[19] Strengthening begins when near normal active range of motion is obtained. Return to modified play can occur as early as three weeks following intervention, where 80% strength and motion gains are advisable.[9,10,20,36] Some athletes may return to modified sport tasks within four to five weeks, with the exception of those involving high axial loading, such as gymnastics and boxing.[8] In a specific evaluation of 16 National Collegiate Athletic Association (NCAA) athletes with a required high level of wrist function, McAdams and colleagues[37] reported an average return to play of three months with significant improvements in DASH (Disabilities of the Arm, Shoulder and Hand). All patients underwent six weeks immobilization, followed by six weeks of progressive range of motion and strengthening exercises with full return to sport permitted at three months. The two athletes unable to return to sport at three months had associated ulnocarpal impaction and DRUJ instability. Long-term follow-up studies are needed in order to document the durability of arthroscopic procedures, as well as evaluate long-term outcomes as related to pain and grip strength. Athletes with ulnar impaction syndrome must also recognize further surgical intervention to address ulnocarpal impaction is likely necessary, with debridement failure at 13-60% in the ulnar positive wrist.[6,16,19,33]

Arthroscopic wafer procedures, originally described by Feldon and colleagues[38], can be performed in combination with debridement, or at a later date. This procedure can be performed in type IA, IIC, and IID TFCC injuries demonstrating less than 2mm ulnar positive variance, and without associated lunotriquetral instability.[4,19] Arthroscopic wafer procedures include partial excision of the distal dome of the ulna until fluoroscopy indicates -1 to -2mm variance.[6, 27] The articular surfaces of the lunate and triquetrum are also evaluated, with loose cartilage resected.[19] The athlete is generally splinted for two weeks following intervention, with in-sport splinting and gradual range of motion encouraged.[8,19] Gradual range of motion is dictated by patient comfort, with strengthening initiated at four weeks.[19] A large percentage of patients report symptom free eight weeks following surgery[27,34], although return to full activity has been reported from six weeks to seven months[6,27,39]. Wafer resections may be preferred over USO in patients with concern for non-union or hardware irritation.[19] Rare complications such as postoperative tendonitis, and inadequate ulnar head resection with overzealous debridement of TFCC, leading to DRUJ instability, have been reported within the literature.[19]

USO are indicated when positive ulnar variance exceeds 2mm, with associated lunotriquetral instability, or the presence of ulnar styloid impaction.[4,14] This was indicated in case 1. Surgeons perform an oblique osteotomy at the distal ulna and complete fixation with a compression plate.[7] Historically, patients presenting with ulnar-positive and ulnar-neutral wrists suffering type IIA and IIB lesions of the TFCC are offered a USO to decrease the total load across the ulnar side of the wrist.[7] In type IID lesions, associated with lunotriquetral interosseous injury, USO is performed to increase stability via tightening of the extrinsic wrist ligaments.[40] Type IIE lesions are associated with ulnocarpal arthritis, in which wafer procedures and USO are contraindicated, requiring salvage procedures due to extensive damage and instability.[7] Multiple studies report improved pain, range of motion, and function following USO, with good to excellent results reported in 89-94% of patients.[41,42] Symptomology greater than six months prior to USO has been shown to dampen results, possibly secondary to irreversible pathological changes in the wrist.[41] Patients are immobilized for a week followed by casting for four to six weeks, with gentle forearm motion and grip strengthening encouraged immediately following surgery.[2,4] Passive range of motion begins as split is discontinued, with isometric strengthening initiating at eight to ten weeks, progressing to weight bearing and plyometrics.[2] Literature suggests that approximately 50% of patients may require hardware removal[6], causing further avoidance of contact sport and weight bearing. The patient in case 1 has not reported any concurrent hardware complaints at follow-up. The principal risk for non-union is reported at 0-5%, and is increased in the smoking population.[4,16] Baek and colleagues[43] investigated long-term results of USO in 36 patients, with excellent clinical outcomes in pain, range of motion, and function greater than five years postoperatively, even within 16% who demonstrated radiographic arthritic changes of the DRUJ. More recently, a retrospective case series of 33 patients following USO were assessed at average follow-up of 10 years, with 88% reporting satisfied to very satisfied with the procedure, accounting for 30% of patients who required hardware removal.[44]

A single prospective trial has investigated the effects of low-intensity pulsed ultrasound (LIPUS) on bone healing at osteotomy sites in 27 patients following forearm shortening for stimulating cellular biochemical events to promote bone formation.[45] Patients were randomized to LIPUS (1.5MHz and 30mW/cm^2) or without LIPUS (control), with the intervention group receiving daily 20-minute treatments at one week post-operatively until at least 12 weeks post-operatively. Cortical union represented with disappearance of interruption of cortex with callus formation, and endosteal union with obliteration of osteotomy line with endosteal callus were assessed. Although all osteotomies achieved complete union, the LUPUS group demonstrated shortened time to cortical union by 27% ($P = 0.012$) and endosteal union by 18% ($P = 0.019$), providing opportunity for earlier return to activity and work, with no complications identified. No differences in pain, range of motion, grip strength, or functional status occurred between groups at time of radiographic union. These findings support previous research on distal radius fractures and accelerated tibial fracture healing[46, 47], and should be considered post-operatively following ulnar osteotomies. Further randomized, prospective controls demonstrating reproducibility of results are important to determine the efficacy of such treatment for promoting early return to play in athletes undergoing ulnar osteotomies.

Studies evaluating the results of arthroscopic wafer procedure for ulnar impaction syndrome have shown similar favourable results as compared to USO.[19] Contstantine and colleagues[48] compared clinical outcomes of USO and wafer procedure, finding similar results in pain relief and wrist function, with USO requiring more revision procedures and delayed healing. Bernstein and colleagues[6] concluded that combined debridement and wafer procedure provided similar results to USO in 27 patients with statistical differences in complications rate, favouring the wafer procedure. Papapetropoulos and colleagues[49] prospectively reviewed data in 51 patients up to 24 months postoperatively, reporting no statistical significant difference in range of motion, grip strength, and DASH and VAS scores between USO and wafer procedure. Although larger prospective trials are needed, the best available evidence supports wafer resection to be an equally effective treatment for ulnar impaction as compared to USO, while avoiding potential hardware complications, repeat procedures, and delayed healing risks.[5]

Conclusions

Ulnar impaction syndrome is a common cause of a spectrum of pathoanatomical changes to the distal radioulnar joint (DRUJ). Scientific data regarding the treatment of peripheral TFCC lesions and ulnar impaction syndrome are limited to relatively small sample sizes, in which the distinction between traumatic and non-traumatic lesions is unclear.[22] More prospective randomized evidence is required comparing duration of symptoms, immobilization, debridement and arthroscopic or USO repair. The ideal intervention strategy in the future must not only minimize symptoms and reoccurrence with operative procedures, but also better evaluate post-operative conservative measures available for improved healing, and sports performance. Future research evaluating long-term outcomes following operative care and subsequent injury management is crucial.

When dealing with ulnar impaction syndrome in the athlete, the diagnosis, treatment, and rehabilitation regimen should be individualised and sport-specific, considering age of the athlete, athletic priorities, healing potential, return to play, and long-term health concerns and well-being. Early detection is critical for the athlete, and clinical findings such as locking and clicking, as well as previous fractures, must be evaluated by the sports chiropractor, warranting imaging and early orthopaedic referral. Limited research has investigated conservative management of TFCC injuries, specifically within the athletic population. In season injury management consists of cortisone injections and TFCC debridement in hopes of awaiting off-season required surgical procedures.

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