Wrist arthroscopy in children and adolescents: a single surgeon experience of thirty-four cases

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Abstract

Purpose The purpose of this study was to report our experience of wrist arthroscopy in children and adolescents with chronic wrist pain in a retrospective single surgeon series. Therefore, technical differences or obstacles compared to standard wrist arthroscopy in adults, and complications were highlighted.

Methods A retrospective data review of all patients undergoing wrist arthroscopy between 2002 and 2011 was performed. The basic inclusion criteria was chronic, therapy refractory wrist pain for more than three months in children and adolescents aged 18 years and younger. In total, 34 arthroscopies in 27 girls and six boys were reviewed. The mean age at time of arthroscopic exploration was 14.6 years (range, 9.8–17.9 years).

Results A total of 28 wrists showed a triangular fibrocartilage complex (TFCC) tear (82.4%). In 26 of 34 (76.5%) inspected wrist joints additional pathologies besides TFCC tears were documented. As a consequence, 14 arthroscopic TFCC resections, two arthroscopic TFCC repairs and seven open resection arthroplasties were performed. Other concomitant procedures (e.g. ulna shortening)

were performed in 25 patients (26 wrists) because of predisposing malformations. No intraoperative or postoperative complications related to the arthroscopies were observed. No relevant technical differences to wrist arthroscopy in adults were experienced apart from cases of major anatomical malformations.

Conclusions Wrist arthroscopy has been shown to be a safe procedure to detect and treat paediatric wrist disorders. Nevertheless, we believe that this procedure should only be carried out by well-trained, experienced hand surgeons.

Introduction

Wrist arthroscopy has become an accepted and established therapeutic procedure in recent decades [1–3]. Besides diagnostic exploration, several techniques to restore integrity of the joint have been described [4, 5]. As the majority of wrist disorders are caused by traumatic or degenerative conditions, most studies primarily focus on trauma sequelae such as triangular fibrocartilage complex (TFCC) tears or intra-articular ligament disruptions [6–8]. The arthroscopy procedure has proved to be efficient, showing a lack of benefit in only 5% [9].

In contrast, wrist arthroscopy in children and adolescents has not been well described in the current literature. As summarised by Siparsky and Kocher, it is not a commonly practised treatment modality [10]. In paediatric and adolescent patients, successful healing may in many cases occur non-operatively. As a consequence, few studies have evaluated wrist arthroscopy and its complications in an immature population. Most series include a very limited number of patients. Alt et al. and Huracek et al. retrospectively reviewed results after arthroscopy of three and ten children, respectively [4, 11]. The largest series to date was published

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by Earp et al. including 32 children with chronic wrist pain [12].

The purpose of this study was to report our experience of wrist arthroscopy in children and adolescents with chronic wrist pain in a retrospective single surgeon series. Therefore, intraoperative findings, technical differences or obstacles compared to standard wrist arthroscopy in adults, and complications were highlighted.

Patients and methods

We conducted a retrospective data review of patients undergoing wrist arthroscopy between 2002 and 2011 with respect to diagnosis, intraoperative findings, types of operations and procedures performed, and complications. All patients were referred to our paediatric hand department by family physicians, paediatricians or orthopaedic surgeons because of chronic wrist pain. Those without any evidence of fracture were at first treated conservatively. They received either oral analgesics in standard dosage, activity modification, splintage, physical therapy or occupational therapy. Only patients aged 18 years and younger, who continued to experience significant pain or relevant functional impairment after several months of conservative treatment, were included in the study. The basic inclusion criteria for wrist arthroscopy in our study population was chronic, therapy refractory wrist pain for more than three months. These patients were re-examined by the treating surgeon and admitted for diagnostic wrist arthroscopy. All patients undergoing wrist arthroscopy after the age of 18 years were excluded from this study, as were those who had any hand/wrist operations prior to arthroscopy. Anteroposterior radiographs of the wrist in neutral position and in pronation, and MRI were obtained in all cases before arthroscopy. All patients were operated upon by the senior author. Complications were further classified according to Goslings and Gouma as follows: zero (no harm), 1 (temporary disadvantage, no [re-]operation), 2 (recovery after [re-]operation), 3 ([probably] permanent damage/disability), 4 (death), 5 (unclear due to untimely death) [13].

Surgical technique

Wrist arthroscopy was performed in the supine position under general or regional anaesthesia. The forearm was fixed in an elevated position using a “Chinese hand” and bags with 2–3 kg were used for extension of the radiocarpal joint (Fig. 1). A tourniquet at 250 mmHg was used to obtain a bloodless operative field. After needle instillation of saline solution into the radiocarpal joint, standard 3/4 and 6R ports were used. Transverse skin incisions were

Fig. 1 Preoperative arm positioning and fixation with the “Chinese hand” allows the best possible approach to the wrist joint for application of arthroscopy portals

enlarged by blunt dissection using a mosquito clamp. We prefer a transverse skin incision over longitudinal to improve cosmesis. An additional 6U port was used when there were manipulation difficulties of the TFCC due to anatomical malformation (e.g. Madelung deformity). Whenever necessary, a mid-carpal arthroscopy was performed via two ports distal to the 3/4 and 6R port. Mannitol was primarily used in order to enhance the use of coagulation devices. A 2.3-mm arthroscope with 30° visual angle was used for all arthroscopies. After inspection of the radiocarpal joint and ulnocarpal compartment, TFCC tears were classified according to Palmer's classification and treated by resection arthroplasty [14]. Concomitant operative procedures were performed in the same session depending on the underlying radiological and pathological findings.

Results

Demographic findings

Thirty-four arthroscopies in 27 girls and six boys were performed; one girl underwent an arthroscopy on both wrists for bilateral Madelung deformity. The mean age at

first visit in our clinic was 14.3 years (range, 9.2–17.9 years). Mean age at time of arthroscopic exploration of the affected wrist joint was 14.6 years (range, 9.8–17.9 years). Mean duration between first clinical examination at our department and arthroscopy was 4.4 months (range, 0.2–17.2 months). Left and right sides were affected in 23 and 11 cases, respectively. Twenty patients (61%) associated their wrist pain with an injury.

Intraoperative findings

Arthroscopy revealed an intact TFCC in six wrist joints (17.6%) whereas a total of 28 wrists showed TFCC tears (82.4%) (Table 1). Twenty tears were classified according to Palmer type 1 (traumatic tear; 58.9%), and the remaining eight tears according to Palmer type 2 (degenerative tear; 23.5%). In 26 of 34 (76.5%) inspected wrist joints additional pathologies were documented (Table 2). Major and minor synovitis were found in three and 12 joints, respectively (Fig. 2). Scapholunate (SL) lesions or laxity were found in five and two cases, respectively. A total of two ganglia were found. Chondromalacia of the lunate was found in two cases, whereas chondromalacia of scaphoid was found in one case. One patient showed a general chondropathia of the entire wrist joint. Other obvious findings were a combined scapholunate-lunotriquetral (SL/LT) lesion ($n=1$), midcarpal instability ($n=1$), a wide open distal radio-ulnar joint (DRUJ; $n=1$), and villonodular tissue ($n=1$).

Surgical procedures

Arthroscopic TFCC resection arthroplasty was performed in 14 cases. Open resection arthroplasty was necessary in seven cases due to compromising anatomy. In two cases, arthroscopic TFCC repair using an inside-out technique, was performed. In one patient with a high-grade Madelung deformity TFCC repair was unsuccessful and open resection arthroplasty was required. Other concomitant procedures

Table 2 Coexisting pathologies

Pathology	<i>n</i>
Major synovitis	3
Minor synovitis	12
SL-lesion	5
SL-laxity	2
SL-LT-lesion	1
Ganglion	2
Chondromalacia	
Lunate	2
Scaphoid	1
General	1
Midcarpal instability	1
Open DRUJ	1
Villous tissue	1
Total	32

SL scapholunate, LT lunotriquetral, DRUJ distal radio-ulnar joint

were performed in 25 patients (26 wrists) for predisposing malformations (Table 3).

Complications

No intra-operative complications related to the arthroscopies (e.g. arthroscope breakage) were observed in this study. There were no cases of neurovascular complications, cartilage or ligament injury, infection or complications related to traction and arm positioning. In contrast to arthroscopy, three complications associated with the concomitant procedures were observed. They included: non-union of the radius after dome-shaped osteotomy ($n=1$; grade 2), wound infection ($n=1$; grade 2) and rupture of the extensor pollicis brevis tendon ($n=1$; grade 2). Complete consolidation and healing was achieved in all three patients after revision surgery.

Table 1 TFCC tears according to Palmer

Type of tear	Wrists (<i>n</i>)
No tear	6
Traumatic tears	
1B	11
1C	2
1D	7
Degenerative tears	
2A	3
2B	1
2C	4
Total ^a	34

TFCC triangular fibrocartilage complex

^a No type 1A and 2D among tears

Fig. 2 Arthroscopy revealing heavy synovitis in the ulnocarpal compartment of a patient with Madelung deformity who suffered from severe pain for several months (asterisk)

Discussion

This study showed that wrist arthroscopy is a safe and reliable diagnostic and therapeutic tool in children and adolescents with chronic wrist pain. No relevant technical

differences compared to wrist arthroscopy in adults were experienced apart from cases of predisposing major anatomical malformations.

Wrist arthroscopy and its various techniques are described in detail in many scientific articles. Although the

Table 3 Overview of surgical procedures and complications

Case	Sex	Side	Injury	Surgery		Complications ^a
				TFCC	Concomitant procedures	
1	F	L	No	None	Dome-shaped osteotomy	Loss of correction (radius) + non-union (2)
2	F	L	Yes	Open resection	Dome-shaped osteotomy	
	F	R	Yes	Asc resection ^b	None	Superficial infection (2)
3	F	L	Yes	None	CMC1 repair, radius + ulna shortening	
4	M	R	Yes	None	None	
5	F	L	No	Open resection	Dome-shaped osteotomy	
6	F	L	No	None	Wrist denervation, shrinking palmar ligaments, open ligament repair	Rupture extensor-Pollicis-Brevis tendon (2)
7	M	L	No	None	PE	
8	F	L	No	Open resection	Dome-shaped osteotomy	
9	F	L	No	Open resection	Dome-shaped osteotomy, synovectomy, epiphysiodesis distal radius + ulna	
10	F	R	Yes	Open resection	Wrist denervation, open radiotriquetal ligament repair, Ulna shortening, DRUJ arthroplasty	
11	F	L	Yes	Asc resection	Synovectomy, CMC1 ligament repair + DRUJ revision	
12	F	R	Yes	Asc resection	Synovectomy	
13	M	L	Yes	None	Shrinking palmar ligaments	
14	F	R	Yes	None	Capsuloplasty	
15	F	R	Yes	None	Capsuloplasty	
16	F	R	No	Asc resection	None	
17	F	L	Yes	Asc resection	Dome-shaped osteotomy, ulna shortening	
18	F	R	Yes	Asc resection	None	
19	F	R	No	Asc resection	Ulna shortening	
20	F	L	No	None	Arthrography, synovectomy, PE	
21	F	L	No	Open resection	Open PE	
22	M	L	No	None	Arthrography, synovectomy, debridement	
23	F	L	Yes	Asc resection	None	
24	M	L	Yes	Open resection	DRUJ revision	
25	F	L	No	None	Synovectomy	
26	F	R	Yes	Asc resection	Dome-shaped osteotomy + ulna correction	
27	F	L	Yes	Repair	None	
28	M	L	Yes	Asc resection	None	
29	F	L	Yes	Asc resection	None	
30	F	R	No	Asc resection	Dome-shaped osteotomy, failed TFCC repair	
31	F	L	Yes	Asc resection	Ganglion resection	
32	F	L	Yes	Repair	Ulna shortening	
33	F	L	Yes	Asc resection	Ganglion resection	

M male, *F* female, *R* right, *L* left, *TFCC* triangular fibrocartilage complex

^a Numbers in brackets indicates grade of complication according to Goslings and Gouma [13]

^b Asc resection indicates arthroscopic resection of the TFCC

vast majority of wrist arthroscopies are performed in adults, some indications for arthroscopic exploration of the adolescent wrist joint definitely exist. Wrist pain in children and adolescents is often caused by injuries that show spontaneous healing without any operative treatment. Nevertheless, surgical intervention is indicated in cases of major wrist injury [15, 16]. In addition, other uncommon disorders and predispositions can lead to chronic pain which needs further diagnostic investigation. Patients with deformities and malformations of the upper extremity represent a major part of the study population (Fig. 3). Only patients with chronic pain after a minimum of three months of conservative treatment were admitted for arthroscopy. For all of our patients standard arthroscopic equipment, which is regularly used for wrist arthroscopy in adults, was preferred by the treating surgeon. We tested a smaller arthroscope (1.9 mm) in the first five paediatric patients prior to this study. Contrary to expectations, we did not experience any advantage because of a reduced visual field and high fragility of the small device. Since then we have used a 2.3-mm arthroscope. Concerning surgical approach via 6R and 3/4 ports, no difficulties or differences to arthroscopy of adult wrists were experienced. Twenty-three of 33 patients (70%) were older than 14 years at the time of intervention. These children exhibited conditions of anatomy similar to adult patients. However, some wrists still remained vulnerable due to female wrist configuration and ligamentous laxity. Hence, arthroscopy should be carried out with special caution in any immature patient with arthroscope diameter of maximum 2.3 mm. In contrast to normal joint conditions, wrist geometry of patients showing Madelung deformity was significantly altered (Fig. 4). Due to the V-shaped carpus, an additional 6U port had to be used in most cases of TFCC manipulation. Thus, feasibility of arthroscopic TFCC repair and resection were clearly

Fig. 3 Arthroscopy in Madelung deformity showing the V-shaped carpus due to a sloping radial plateau (*asterisk*). Inspection of the palmar ligaments is substantially impaired due to the narrow radiocarpal joint despite regular fluid instillation

Fig. 4 Arthroscope insertion at the 3/4 port in a patient with Madelung deformity, showing typical palmar subluxation of the carpus with a prominent ulnar head

enhanced. Nevertheless, TFCC repair proved to be impossible in one high-grade Madelung patient, making an open resection arthroplasty inevitable. In our opinion, patients with minor anatomical variances such as ulna positive or negative variance, ulna hypoplasia (grade I) or post-traumatic lesions are no obstacle or contraindication for arthroscopy. In contrast, arthroscopic exploration of high-grade deformities (e.g. Madelung) tend to be much more demanding (Online Resource 1). Since 2009 our treatment strategy changed from TFCC resection arthroplasty in any case showing TFCC pathology to resection of the central part in case of central perforation, and TFCC refixation in case of avulsion from the ulnar styloid process (inside-out suture technique). However, we agree with Puhaindran et al. that wrist arthroscopy in particular should not be undertaken by inexperienced beginners [17].

In contrast to other studies focussing on wrist arthroscopy, no complications were observed in this retrospective analysis. Studies about wrist arthroscopy in paediatric populations are rare and thus no reports about complication

rates were found. Two studies summarised possible sources of complications not considering paediatric wrist joints [18, 19]. Other authors reported complication rates of arthroscopy in adults ranging from 1.6 to 5.3% [9, 20, 21]. Furthermore, Van Meir et al. did not encounter any complications or technical problems using volar portals in 28 wrist arthroscopies [22]. A report by Rocchi et al. revealed a higher complication rate of about 8.5% [23]. They reported four major complications (including 2× neurapraxia, haematoma, radial artery branch injury) in 47 arthroscopic ganglia resections. Other potential risk factors for serious complications are thermal ablation during wrist arthroscopy and use of a 6U port [24, 25]. None of them could be observed in this study. An additional 6U port was used in nine patients with Madelung deformity and shrinkage of palmar ligaments was performed in one patient only without any complications. Nevertheless, some difficulties related to the concomitant procedures in this study were found. They all could be sufficiently addressed by wound debridement and antibiotics, revision surgery with iliac crest interposition and abductor pollicis longus-tendon transfer in one case each. In our opinion, the tendon rupture was not related to the arthroscopy but caused by K-wire fixation of the radius after dome-shaped osteotomy. As tendon ruptures may occur after wrist arthroscopy, the literature is primarily reporting on ruptures of the extensor pollicis longus tendon. In our case, the extensor pollicis brevis tendon was affected which is more likely to be caused by one of the three K-wires for radius fixation. Additionally, symptoms of tendon insufficiency did not occur until 2.5 years after the arthroscopy.

Limitations of this study are (1) its retrospective design, (2) the relatively small sample size and (3) the heterogeneous population that necessitated different concomitant procedures other than arthroscopic exploration and TFCC resection. As a consequence, the technical feasibility of this procedure was reduced in cases with complex deformities, and complications may have remained undetected behind additional interventions. However, we believe that this variety represents the broad spectrum of paediatric wrist pathologies that can lead to chronic pain. Further prospective studies with larger cohorts are necessary to detect other infrequent complications.

Wrist arthroscopy is shown to be a safe procedure to detect and treat paediatric wrist disorders. Nevertheless, we believe that this procedure should only be carried out by well-trained, experienced hand surgeons.

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