Preventable Repeat Wrist Arthroscopies: Analysis of the Indications for 133 Cases

Steffen Löw, MD¹ Christian K. Spies, MD² Frank Unglaub, MD² Jörg van Schoonhoven, MD³
Karl-Josef Prommersberger, MD³ Marion Mühldorfer-Fodor, MD³

¹ Section of Hand Surgery, Division of Trauma and Orthopedic Surgery, Caritas Krankenhaus, Bad Mergentheim, Germany

² Department of Hand Surgery, Vulpius Klinik, Bad Rappenau, Germany

³ Clinic for Hand Surgery, Rhön Klinikum AG, Bad Neustadt a.d. Saale, Germany

Address for correspondence Steffen Löw, MD, Section of Hand Surgery, Division of Trauma and Orthopedic Surgery, Caritas Krankenhaus, Uhlandstraße 7, 97980 Bad Mergentheim, Germany (e-mail: steffen_loew@hotmail.com).

J Wrist Surg 2017;6:33–38.

Abstract

Keywords

- cartilage lesions
- chondromalacia
- photo and video documentation
- scapholunate ligament
- triangular fibrocartilage complex
- revision wrist arthroscopy

Background Frequently, patients undergo repeated wrist arthroscopies for single wrist problems.

Purpose The purposes of this study were to assess the indications for repeat wrist arthroscopies and to identify potentially preventable procedures.

Methods For this retrospective, two-center study, the electronic patient records were examined for patients, who underwent repeat wrist arthroscopy in a 5-year period. The cases were sorted by the underlying pathologies and the causes that necessitated repeat arthroscopies.

Results Ulnar-sided wrist pain accounted for 100 (77%) of all 133 revision arthroscopies: 67 of which due to suspected ulnar triangular fibrocartilage complex (TFCC) avulsions, 33 due to ulnar impaction syndromes. Cartilage was reassessed in 22 (17%) wrists. Thereby, insufficient preoperative diagnostics necessitated pure diagnostic before therapeutic arthroscopy in 49 (37%) wrists: 48 of which for TFCC pathologies, one for a scapholunate (SL) ligament lesion. The uncertainty of diagnosis despite previous arthroscopy necessitated 18 (14%) revision arthroscopies: 15 for ulnar TFCC avulsions, 1 for a central TFCC lesion, 2 to reevaluate the SL ligament. Inadequate photo or video documentation of the cartilage necessitated arthroscopic reassessment in 16 (12%) wrists.

Conclusion In this series, two out of three revision arthroscopies could potentially have been prevented. Inadequate preoperative diagnostics with the lack of reliable preoperative diagnoses necessitated pure diagnostic arthroscopies for ulnar-sided wrist pain. However, even arthroscopically, the diagnosis of ulnar TFCC avulsions or SL ligament lesions is not trivial. Surgical skills and experience are necessary to detect such lesions. Finally, adequate photo or video documentation may prevent repeated arthroscopic diagnostic procedures.

Level of Evidence Level IV.

received
March 1, 2016
accepted
April 28, 2016
published online
June 1, 2016

Copyright © 2017 by Thieme Medical Publishers, Inc., 333 Seventh Avenue, New York, NY 10001, USA.
Tel: +1(212) 584-4662.

DOI <http://dx.doi.org/10.1055/s-0036-1584311>.
ISSN 2163-3916.

Wrist arthroscopy is said to be the gold standard for the diagnosis of various wrist disorders. However, it is our experience that arthroscopies occasionally have to be repeated before planning or performing definitive procedures. One reason for this may be that the interpretation of cartilage lesions¹ and the interpretation of findings with respect to intra-articular ligament lesions differs among surgeons.² On the other hand, insufficient photo or video documentation impedes others from reproducing what was diagnosed during arthroscopy.^{3–6} Therefore, for those who perform definitive treatment, repeat arthroscopy serves to get an own idea of the wrists' status. Studies reporting on the incidence and causes for revision arthroscopies in larger joints are numerous.^{7–11} However, only one study on revision wrist arthroscopy is available, reporting on a small cohort of 16 patients.¹²

The purpose of this study was to evaluate the indications and reasons for revision wrist arthroscopies in a larger cohort. The authors analyzed the different reasons to address the question if these cases included potentially preventable arthroscopic procedures.

Methods

We retrospectively collected all electronic patient records from July 2005 to June 2015 at two hand surgery centers and scanned for patients who underwent repeat wrist arthroscopies. The identified cases were reviewed to discern the underlying indications that had led to the repetition of the arthroscopies. The patients' ages and sex were noted as well as the time interval between the two arthroscopies. It was also noted whether the previous arthroscopy was performed at the same institution or at a different one. The cases were sorted by the pathology (septic or aseptic arthritis; chondrocalcinosis; synovitis) and by the main afflicted intra-articular structure (peripheral and central part of the triangular fibrocartilage complex (TFCC); scapholunate (SL) ligament; cartilage) for which arthroscopy was indicated. The cases were additionally sorted by the causes that necessitated repeat arthroscopies (insufficient preoperative diagnostics; insufficient documentation at primary arthroscopy; uncertainty of diagnosis despite previous arthroscopy; the progress of the underlying disease; recurrent symptoms after primary successful treatment). The data were presented in a descriptive manner. The discussion focused on the question whether some of the repeat arthroscopies could potentially have been avoided.

Results

In the examined 5-year period, institution 1 performed 2,850 arthroscopies and institution 2 performed 290 arthroscopies. Repeated procedures accounted for 4.2 and 4.1%, respectively, of all arthroscopies. Index arthroscopies were performed by surgeons of different levels of experience, all revision procedures at both institutions were performed by senior hand surgeons. ►Table 1 lists the identified patients for both hand surgery centers. ►Fig. 1 illustrates the underlying pathologies and the main afflicted intra-articular structures, for which

repeat arthroscopies were indicated. ►Fig. 2 illustrates the different causes for the repeat arthroscopies, which were identified according to the patients' records.

Peripheral Part of the TFCC

The two institutions performed 67 repeat arthroscopies for the diagnosis of suspected ulnar TFCC avulsion and its treatment. Of these, 15 were performed to reevaluate the ulnar TFCC attachment, as the previous arthroscopies' diagnoses did not match the findings of the clinical or magnetic resonance imaging (MRI) examination. The initial diagnosis was confirmed by repeat arthroscopies in seven patients. In six patients, ulnar avulsion was diagnosed, whereas at the initial procedure the TFCC was rated as intact. In two further patients, the previously diagnosed ulnar TFCC avulsion could not be confirmed at the repeat arthroscopy. In 43 patients, 44 repeat arthroscopies were performed to reattach the previously diagnosed ulnar avulsion. Early reattachment (meaning 14 days after initial arthroscopy) was performed in 19 wrists after the discussion of treatment options for the previously diagnosed lesion. In 25 further wrists, reattachment was performed for persistent complaints (meaning 8 months) following the arthroscopic debridement of the ulnar lesion. In eight patients, repeat arthroscopies were performed a mean of 18 months (range, 5–33 months) after initially successful reattachment with alleviation of pain, with four patients reporting having suffered a new trauma.

Central Part of the TFCC

Overall, 35 repeated arthroscopies in 31 patients were performed for ulnar-sided wrist pain due to an ulnar impaction syndrome. Nine of which were previously treated in other institutions. In 17 patients, repeated debridement of the TFCC

Table 1 Patient data and number of repeat wrist arthroscopies

	Hand surgery center 1	Hand surgery center 2
Number of patients	102	9
Mean age, y, range	40.1 (17–74)	40.7 (19–69)
Sex	51 men/51 women	3 men/6 women
Affected wrists	61x right	4x right
	40x left	4x left
	1x both	1x both
Total number of repeat arthroscopies	121	12
	Thereof	
One repeat arthroscopy	84	8
Two repeat arthroscopies	17	2
Three repeat arthroscopies	1	–

Fig. 1 Underlying pathologies and main afflicted intra-articular structures, for which repeat arthroscopies were indicated. Three quarters of all revision arthroscopies were indicated for pathologies of the TFCC, with 22 further procedures for the reassessment of the cartilage, mostly in the context of a scapholunate ligament lesion. TFCC, triangular fibrocartilage complex.

was performed for symptoms that persisted despite previous arthroscopic treatment. Of these, 14 patients underwent additional ulna shortening. Seven further patients have received ulna shortening 3 to 7 years earlier, which had alleviated the pain in each patient for a while. In three patients, repeat arthroscopies revealed one central and two radial perforations, which were not present at initial arthroscopies 6 and 7 weeks, respectively, and 2 years earlier. TFCC debridement was added by ulna shortening in one of these patients, which alleviated his ulnar-sided wrist pain. Two further patients underwent central TFCC resection at the second arthroscopy, whereas, initially, only a synovectomy was performed due to the lack of a perforation. Two other patients refused ulna shortening. Instead, each of these patients underwent two repeat arthroscopic TFCC debridements with the relieve of their ulnar-sided wrist pain for some months. Due to recurrent symptoms, they finally consented to ulna shortening osteotomies. One patient was referred, as the referring surgeon was not able to access the joint.

Cartilage

A total of 22 patients underwent repeat arthroscopy for cartilage reevaluation. Of these, 10 patients were previously

Fig. 2 The different causes for repeat arthroscopies, which were identified according to the patients' records. Two-thirds of all revision arthroscopies could potentially have been prevented by the proper use of modern magnetic resonance imaging techniques, by a sophisticated process for examining the joint, and, finally, by the adequate documentation of arthroscopic findings.

treated at different institutions. In 13 of these patients, a SL ligament tear was the underlying lesion. The findings at the time of the repeat arthroscopy determined whether SL ligament reconstruction or a salvage procedure was to be initiated. In 16 of the 22 patients, insufficient photo or video documentation of the arthroscopic findings was suspected for uncertainty concerning the integrity of the cartilage. The remaining six patients were reassessed for chondromalacia, which was expected due to the natural course of the underlying pathology (distal radius fractures; Kienböck disease; SL ligament lesion; rheumatoid arthritis; septic arthritis).

Scapholunate Ligament

Three patients underwent repeated arthroscopies for suspected SL ligament lesion. In one of these patients, repeat arthroscopy revealed a complete SL ligament lesion, which had not been noted by the surgeon during the primary arthroscopy at another institution. In another patient, repeat arthroscopy revealed a complete SL rupture, whereas during the initial procedure 3 years earlier, only first-degree ligament lesion had been diagnosed. In the third patient, a partial SL ligament lesion had been unexpectedly diagnosed at the time of the initial arthroscopy. Further treatment was discussed with the patient before providing definitive treatment, which consisted of arthroscopic debridement and carpal transfixation and was performed 2 weeks later.

Septic Arthritis

Three patients were treated for septic arthritis. Institution 1 repeated arthroscopic irrigation after 5 days each in two cases. According to the house treatment regimen for septic arthritis, external fixators were additionally applied. Institution 2 treated one patient for septic arthritis with two arthroscopies on two consecutive days.

Aseptic arthritis

Three patients were arthroscopically treated for severe recurrent synovitis. Two of these were caused by chondrocalcinosis. One of these patients underwent repeat arthroscopy after 18 days for persistent swelling and tenderness. The other patient underwent three arthroscopic synovectomies after time-intervals of 5 years and 3 months, respectively. In him, chondrocalcinosis led to the destruction of both the SL and the lunotriquetral ligament, as well as of the TFCC. The third patient had recurrent rheumatic synovitis. Two previous arthroscopies were performed at different institutions 5 and 16 months before. The procedure included an extensive synovectomy of the radiocarpal and midcarpal joints, the debridement of a Mannerfelt cyst, and the debridement of a massive central TFCC lesion.

Discussion

The purposes of this study were to assess the indications for repeat wrist arthroscopies and to identify potentially preventable cases.

This study has several limitations aside from its retrospective design. The study only focuses on the reasons and indications for revision arthroscopies and does not provide

the clinical results thereof. Due to space limitation in this article, the patients' symptoms and clinical examination findings could not be presented. Diagnoses at repeat arthroscopies were only made by one expert, but not confirmed by another. Nevertheless, this should not influence the conclusions of this study. Furthermore, the two participating institutions may tend to indicate the same procedures in the same situations, as the surgeons from both institutions share the same background in medical education. This leads to the particular selection of cases and indications, which does not necessarily reflect the situation for the whole community of hand surgeons.

In this series, the TFCC appears to be the main afflicted intra-articular structure that necessitated repeat arthroscopy. It accounted for three out of four repeat arthroscopies in the two participating institutions. Thereby, the peripheral part of the TFCC played a major role. Half of all repeat arthroscopies in both institutions were indicated for reattachment of an ulnarly avulsed TFCC. Previous arthroscopy, thereby, acted as a pure diagnostic procedure. One might expect that preoperative MRI reliably depicts ulnar TFCC avulsions, so that reattachment can typically be planned in a single procedure. Indeed, highly sophisticated MRI techniques facilitate accurate diagnosis.^{13–15} However, the MRIs that we are faced with in daily practice do not always meet the required quality criteria. Wrist curls and contrast media are not consequently used, and radiologists are not always experienced in medical imaging for wrist pathologies.^{15–17} Therefore, Hahn et al¹⁶ did not recommend the general use of MRI in the diagnosis of ulnar-sided wrist pain. In this context, and with respect to considerations of cost-effectiveness, it is questionable, whether a diagnosis has to be compelled by MRI before arthroscopy, when a TFCC pathology is suspected on clinical examination. If an ulnar avulsion is unexpectedly detected during the arthroscopy of a wrist, with a stable distal radioulnar joint (DRUJ), then simple ulnar TFCC debridement is considered as an effective alternative to its prompt reattachment. Cardenas-Montemayor et al¹⁸ reported 87% excellent and good results according to the modified Mayo wrist score with a significant reduction in pain. Their results are therefore in line with the studies on TFCC reattachment. TFCC reattachment is generally recommended in cases of foveal detachment, since this is accompanied by DRUJ instability. Atzei et al reported 83.3% excellent and good results following arthroscopic repair.¹⁹ Morimoto achieved 91.3% excellent and good results using a palmar open approach.²⁰ However, the clinical assessment of DRUJ instability, is not trivial as it is influenced by the patients' compliance and by the examiners' experience.¹⁵ All the same, the arthroscopic diagnosis of an isolated foveal detachment is demanding, and misdiagnosis is not uncommon. This is further illustrated by the present study, since 15 of the 133 repeated arthroscopies were performed to reassess the foveal TFCC attachment. Nakamura et al²¹ recommended DRUJ arthroscopy, which facilitates the direct visualization of the foveal attachment of the radioulnar ligaments as well as the assessment of the integrity of the DRUJ itself. However, Yamamoto et al²² found that the foveal insertion of the TFCC and the sigmoid notch could be visualized only in 57 and 69%, respectively. Due to these technical difficulties, other authors do not recommend DRUJ

arthroscopy as a routine procedure.²³ Instead, Unglaub et al²⁴ proposed the push-off needle test as an additive tool to the standard hook test²⁵ to diagnose foveal TFCC detachment.

The central part of the TFCC accounted for another fourth of all repeated arthroscopies (35 out of 133). Of these, 29 were necessary for recurrent or persistent ulnar-sided wrist pain due to an ulnar impaction syndrome. The arthroscopies were preceded, accompanied or eventually followed by ulna shortening osteotomies. In this context, Tatebe et al²⁶ proved the healing potential of the central TFCC portion in half of their patients, who underwent ulna shortening followed by revision arthroscopy. This is somewhat surprising, since the central part of the TFCC is known to be avascular.¹⁵ Nevertheless, this explains recurrence of symptoms despite the reduction of ulnar loading by ulna shortening.

In five further patients with clinically diagnosed ulnar impaction syndrome, only ulnar synovectomy was performed during the initial procedure, since from the radiocarpal view the TFCC was found to be intact. Persistent ulnocarpal pain forced repeat arthroscopy, during which three of these patients demonstrated a centrally located tear. Analogous to these findings, Jang et al¹² reported on six patients who necessitated revision wrist arthroscopy for persistent ulnar-sided pain due to ulnar impaction. During the initial procedures, three Palmer type 1A and three type 1C lesions²⁷ were debrided, respectively, repaired, whereas during secondary procedures the patients' diagnoses were revised to one Palmer type 2B, three type 2C, and two type 2D lesions. This means that, until revision surgery, two central lesions developed in addition to the initially diagnosed three traumatic-like lesions. As we know that degenerative changes begin at the proximal surface of the TFCC,^{28,29} the radiocarpal arthroscopic view may not be sufficient to diagnose an ulnar impaction syndrome. In these cases, additional DRUJ arthroscopy would detect early-degenerative changes.^{21,29} Abe and Tominaga³⁰ reported on two patients, in whom they diagnosed tears and fibrillations of the TFCC within the DRUJ without radiocarpal tears. TFCC debridement relieved both patients' symptoms. In this context, the two other central TFCC resections in the current study were performed despite the lack of a central perforation. Unfortunately, a "normal" MRI is not able to depict such degenerative TFCC changes reliably.¹⁶ If, instead, preoperative MRIs could be done in a sophisticated manner and by an experienced radiologist,¹³ then the central TFCC resection could be planned to decompress the ulnocarpal joint during the initial arthroscopy, even in spite of the lack of a complete perforation.

Insufficient photo and video documentation of the arthroscopically diagnosed cartilage lesions led to revision arthroscopy in 16 additional patients. Cartilage assessment already differs among surgeons, when they scope the same patients one-by-one,¹ the quality of assessment diminishes further by inadequate documentation. Löw et al⁶ have examined the interobserver diagnoses based on video documents of different lengths. In their study, surgeons rated twice as many false-positive cartilage lesions when viewing short videos compared with when viewing long video sequences. Consequently, they suggested documenting a radiocarpal joint for a minimum of 60 seconds, whereas the video of a midcarpal joint should last a minimum of 45 seconds.

Repeated arthroscopic cartilage assessment was mostly indicated in association with a SL ligament lesion. The reassessment of the ligament itself accounted for three patients only, and only one of these constitutes a misdiagnosis during a previous arthroscopy. Jang et al¹² reported on four patients whom they diagnosed with a dynamic SL ligament injury, whereas the initially scoping surgeon had described only Palmer type 1A TFCC lesions. They found that the probe could be inserted or even turned in between the scaphoid and lunate from midcarpal and they treated this by thermal shrinkage. As a result, the pain level reduced from 8.1 to 3.1. However, the overall results were poor, and all four patients needed subsequent salvage procedures. This illustrates that the interpretation of SL ligament findings differs among surgeons. Whereas the classification of Geissler et al³¹ is widely accepted, some surgeons doubt that the insertion of the probe in between the two bones from midcarpal constitutes a relevant SL ligament lesion.⁴

Repeat arthroscopic irrigation and debridement for aseptic or septic arthritis finally accounted for seven patients. With respect to septic arthritis, institution 1 repeated arthroscopies for persistent clinical signs of infection, whereas institution 2 performed repeat arthroscopy the next day according to the house treatment regimen for septic arthritis. Sammer and Shin³² retrospectively compared open and arthroscopic treatment for septic arthritis of the wrist. When only the wrists were affected, all arthroscopically treated patients could be treated with a single procedure, whereas six out of seven openly treated patients needed more than one operation. This benefit was not found, when infection affected multiple sites. The study illustrates the effectiveness of arthroscopic treatment. Repeat arthroscopy can be discussed, therefore, and may be indicated by the patients' clinical course. Correspondingly, for the hip joint, one single arthroscopic irrigation was shown to be effective.³³

Among the 133 revision arthroscopies, two out of three could potentially have been prevented. Some pure diagnostic arthroscopic procedures for ulnar-sided wrist pain could be omitted by the proper use of available modern MRI techniques. However, even with the so-called gold standard arthroscopy, the diagnosis of ulnar TFCC avulsions or SL ligament lesions is not trivial. Surgical skills and experience are necessary to detect such lesions. Finally, arthroscopic findings have to be documented adequately to prevent repeated arthroscopic diagnostic procedures.

Ethical Review Committee

An ethical review committee statement was not solicited, since this is just a study on the patients' electronic records.

Conflict of Interest

None.

Location of the Work/Involved Institutions

1. Section of Hand Surgery, Division of Trauma and Orthopedic Surgery, Caritas Krankenhaus, Uhlandstraße 7, 97980 Bad Mergentheim, Germany.
2. Clinic for Hand Surgery, Rhön Klinikum AG, Salzburger Leite 1, 97616 Bad Neustadt a.d. Saale, Germany.

References

- 1 Spahn G, Klinger HM, Baums M, Pinkepank U, Hofmann GO. Reliability in arthroscopic grading of cartilage lesions: results of a prospective blinded study for evaluation of inter-observer reliability. *Arch Orthop Trauma Surg* 2011;131(3):377–381
- 2 Löw S, Herold D, Mühldorfer-Fodor M, Pillukat T. The effect of labeling photo documents in wrist arthroscopies on intra- and interobserver reliability. *Arch Orthop Trauma Surg* 2012;132(12):1813–1818
- 3 Löw S, Prommersberger KJ, Pillukat T, van Schoonhoven J. Intra- and interobserver reliability of digitally photodocumented findings in wrist arthroscopy [in German]. *Handchir Mikrochir Plast Chir* 2010;42(5):287–292
- 4 Löw S, Pillukat T, Prommersberger KJ, van Schoonhoven J. The effect of additional video documentation to photo documentation in wrist arthroscopies on intra- and interobserver reliability. *Arch Orthop Trauma Surg* 2013;133(3):433–438
- 5 Löw S, Herold A, Eingartner C. Standard wrist arthroscopy: technique and documentation [in German]. *Oper Orthop Traumatol* 2014;26(6):539–546
- 6 Löw S, Erne H, Schütz A, Eingartner C, Spies CK. The required minimum length of video sequences for obtaining a reliable interobserver diagnosis in wrist arthroscopies. *Arch Orthop Trauma Surg* 2015;135(12):1771–1777
- 7 Abouali JA, Hatzantoni K, Holtby R, Veillette C, Theodoropoulos J. Revision arthroscopic Bankart repair. *Arthroscopy* 2013;29(9):1572–1578
- 8 Cvetanovich GL, Harris JD, Erickson BJ, Bach BR Jr, Bush-Joseph CA, Nho SJ. Revision Hip Arthroscopy: A Systematic Review of Diagnoses, Operative Findings, and Outcomes. *Arthroscopy* 2015;31(7):1382–1390
- 9 Sardana V, Philippon MJ, de Sa D, et al. Revision Hip Arthroscopy Indications and Outcomes: A Systematic Review. *Arthroscopy* 2015;31(10):2047–2055
- 10 Shamsudin A, Lam PH, Peters K, Rubenis I, Hackett L, Murrell GA. Revision versus primary arthroscopic rotator cuff repair: a 2-year analysis of outcomes in 360 patients. *Am J Sports Med* 2015;43(3):557–564
- 11 Shin JJ, Mascarenhas R, Patel AV, et al. Clinical outcomes following revision anterior shoulder arthroscopic capsulolabral stabilization. *Arch Orthop Trauma Surg* 2015;135(11):1553–1559
- 12 Jang E, Danoff JR, Rajfer RA, Rosenwasser MP. Revision wrist arthroscopy after failed primary arthroscopic treatment. *J Wrist Surg* 2014;3(1):30–36
- 13 Burns JE, Tanaka T, Ueno T, Nakamura T, Yoshioka H. Pitfalls that may mimic injuries of the triangular fibrocartilage and proximal intrinsic wrist ligaments at MR imaging. *Radiographics* 2011;31(1):63–78
- 14 Cody ME, Nakamura DT, Small KM, Yoshioka H. MR Imaging of the Triangular Fibrocartilage Complex. *Magn Reson Imaging Clin N Am* 2015;23(3):393–403
- 15 Kirchberger MC, Unglaub F, Mühldorfer-Fodor M, et al. Update TFCC: histology and pathology, classification, examination and diagnostics. *Arch Orthop Trauma Surg* 2015;135(3):427–437
- 16 Hahn P, Häusler A, Bruckner T, Unglaub F. Quality rating of MRI regarding TFCC lesions in the clinical practice [in German]. *Handchir Mikrochir Plast Chir* 2012;44(5):310–313
- 17 Andersson JK, Andernord D, Karlsson J, Fridén J. Efficacy of Magnetic Resonance Imaging and Clinical Tests in Diagnostics of Wrist Ligament Injuries: A Systematic Review. *Arthroscopy* 2015;31(10):2014–2020.e2
- 18 Cardenas-Montemayor E, Hartl JF, Wolf MB, et al. Subjective and objective results of arthroscopic debridement of ulnar-sided TFCC (Palmer type 1B) lesions with stable distal radio-ulnar joint. *Arch Orthop Trauma Surg* 2013;133(2):287–293
- 19 Atzei A, Luchetti R, Braidotti F. Arthroscopic foveal repair of the triangular fibrocartilage complex. *J Wrist Surg* 2015;4(1):22–30

- 20 Moritomo H. Open repair of the triangular fibrocartilage complex from palmar aspect. *J Wrist Surg* 2015;4(1):2–8
- 21 Nakamura T, Matsumura N, Iwamoto T, Sato K, Toyama Y. Arthroscopy of the distal radioulnar joint. *Handchir Mikrochir Plast Chir* 2014;46(5):295–299
- 22 Yamamoto M, Koh S, Tatebe M, et al. Arthroscopic visualisation of the distal radioulnar joint. *Hand Surg* 2008;13(3):133–138
- 23 Pillukat T, Fuhrmann R, Windolf J, van Schoonhoven J. Arthroscopy of the distal radioulnar joint [in German]. *Oper Orthop Traumatol* 2014;26(6):547–555
- 24 Unglaub F, Müller LP, Oppermann J, Hahn P, Spies CK. Push-off needle test for traumatic triangular fibrocartilage complex lesions. *J Hand Surg Am* 2014;39(7):1448–1449
- 25 Iwasaki N, Nishida K, Motomiya M, Funakoshi T, Minami A. Arthroscopic-assisted repair of avulsed triangular fibrocartilage complex to the fovea of the ulnar head: a 2- to 4-year follow-up study. *Arthroscopy* 2011;27(10):1371–1378
- 26 Tatebe M, Horii E, Nakao E, et al. Repair of the triangular fibrocartilage complex after ulnar-shortening osteotomy: second-look arthroscopy. *J Hand Surg Am* 2007;32(4):445–449
- 27 Palmer AK. Triangular fibrocartilage complex lesions: a classification. *J Hand Surg Am* 1989;14(4):594–606
- 28 Mikić ZD. Age changes in the triangular fibrocartilage of the wrist joint. *J Anat* 1978;126(Pt 2):367–384
- 29 Yamamoto M, Koh S, Tatebe M, et al. Importance of distal radio-ulnar joint arthroscopy for evaluating the triangular fibrocartilage complex. *J Orthop Sci* 2010;15(2):210–215
- 30 Abe Y, Tominaga Y. Ulnar-sided wrist pain due to isolated disk tear of triangular fibrocartilage complex within the distal radioulnar joint: two case reports. *Hand Surg* 2011;16(2):177–180
- 31 Geissler WB, Freeland AE, Savoie FH, McIntyre LW, Whipple TL. Intracarpal soft-tissue lesions associated with an intra-articular fracture of the distal end of the radius. *J Bone Joint Surg Am* 1996;78(3):357–365
- 32 Sammer DM, Shin AY. Comparison of arthroscopic and open treatment of septic arthritis of the wrist. Surgical technique. *J Bone Joint Surg Am* 2010;92(Suppl 1 Pt 1):107–113
- 33 de SA D, Cargnelli S, Catapano M, et al. Efficacy of Hip Arthroscopy for the Management of Septic Arthritis: A Systematic Review. *Arthroscopy* 2015;31(7):1358–1370