Arch Orthop Trauma Surg (2014) 134:1641–1647
DOI 10.1007/s00402-014-2087-4

ORTHOPAEDIC SURGERY

Systematic diagnosis and therapy of lateral elbow pain with emphasis on elbow instability

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Received: 14 May 2014 / Published online: 30 September 2014

Abstract
Purpose In recalcitrant epicondylitis innumerable operative techniques have been published, nevertheless a certain percentage of patients remains symptomatic after operative treatment. We developed an individual, systematic diagnostic pathway including arthroscopic assessment of elbow stability to identify the optimal and respectively less invasive therapy.
Methods We so far included 40 patients with recalcitrant lateral epicondylitis (mean age 46 ± 11). 5 patients had previous surgery. In all patients, we did an elbow arthroscopy and a systematic arthroscopic stability testing. 25 patients were treated exclusively arthroscopically once instability was excluded. In 13 patients with slight instability, we did an open debridement of the lateral tendon complex and local refixation. Two patients with severe instability were treated with open debridement and additional stabilization of the LUCL with a trizeps graft. With a minimum follow-up of 1 year, we assessed the DASH score and subjective patient satisfaction.
Results Mean follow-up was 24 ± 12 months, mean duration of symptoms before surgery was 19 ± 18 months. The mean DASH score at follow-up was 22 ± 19.36 patients reported symptoms improvement, 34 patients would repeat surgery given the same situation; in 30 cases, patients expectations had been fulfilled. We did not observe any intraoperative complications or infections. One patient developed joint stiffness requiring reoperation.
Conclusion Using a systematic diagnostic pathway including assessment of elbow stability and consecutive individualized, respectively, less invasive surgical procedure we acquired high patients satisfaction and good clinical outcome with a low complication rate.
Level of evidence Level III.

Keywords Lateral epicondylitis · Elbow instability · Elbow arthroscopy · Lateral elbow pain · Radioulnar plica

Introduction

Lateral epicondylitis was first described as "lawn tennis arm" and "writers' cramp" at the end of the nineteenth century [32, 40]. Today, 1–3 % of the adult population suffers from this affliction [2, 15, 48]. Patients comprise both sexes, aged mainly between 40 and 50 years. Over 80 % of all patients treated conservatively or without specific therapy are symptom-free within 1 year. The number of patients requiring surgical treatment is given as between 4 and 11 % [7, 16, 35, 48].

Lateral epicondylitis does not present with a uniform etiology, but rather can have diverse causes [10, 15, 50]. Today, the main cause is ascribed to degenerative changes in the attachment of the extensor carpi radialis brevis tendon (ECRB) [10, 35, 50].

For a differential diagnosis, consideration must be given to impingement of a radial plica or chondromalacia in the radial compartment, instability, as well as compression of the peripheral branches of the radial nerve and blocked vertebrae. Instabilities can develop primarily through the degeneration of the lateral tendon complex, e.g. due to

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overuse, and secondarily after cortisone injections, surgical removal of the lateral capsular ligament complex, or following injury [8, 20, 28, 50].

The anatomical role of the individual lateral tendinous and ligamentous structures in stabilizing the elbow has been well examined and described [12, 13].

In addition, arthroscopic diagnosis and treatment are becoming increasingly important with regard to lateral epicondylitis [3, 4, 29–31, 37, 38, 42].

Since the beginning of the twentieth century, diverse techniques such as percutaneous, arthroscopic, and open surgeries have been described and developed to treat cases with unsuccessful conservative therapy outcomes [3, 5, 6, 10, 11, 18, 21, 23, 24, 31, 33, 35, 37, 39, 49, 51, 52].

At this time, there are no conclusive results showing which surgical method is most effective in treating lateral epicondylitis. This is mainly due to a lack of high quality studies and the use of no consistent outcome measures [31]. In addition, none of the studies performed preoperative patient selection to treat each patient with an individualized treatment program. In studies comparing different surgical techniques as well as in the numerous treatment control studies, patients with lateral epicondylitis were treated without any further differentiation, using the surgical technique preferred by the surgeon [18, 31, 38, 44]. Especially so far no differentiation was made concerning the possible role of micro instability of the elbow in developing lateral epicondylitis.

The purpose of the current study was to better define and understand the role of elbow microinstability in lateral elbow pain. Instability was tested with a new arthroscopic instability test. In addition, we aspired to provide patients with an individually tailored treatment plan which considered the multifactorial causes of pain, provided the best possible clinical results and resulted in the least possible surgical trauma.

Methods

To date, we have carried out follow-up examinations for 40 patients who received surgical treatment for lateral epicondylitis in our clinic between 5/2007 and 2/2009. Patients with radial tunnel syndrome or blocked thoracic or lumbar vertebrae were excluded from the study preoperatively. Before being referred to our clinic, all patients had undergone at least 6 months of conservative treatment without success. The mean duration of preoperative symptoms was 19 ± 18 months.

All patients underwent a standardized clinical examination including localization of pain and testing for macroinstability before operation. Preoperative examination also included the radiological depiction of the elbow in two planes and MRI diagnostics.

Average age at the time of surgery was 46 ± 11 years. In 30 cases, the dominant elbow was symptomatic. 14 patients reported working in a career requiring physical labor. 22 patients had received a local injection therapy before surgery; however, it was not possible in all cases to determine which substance was used for injection therapy. 5 patients had previously undergone surgery; one had undergone arthroscopic surgery, and 4 received an open denervation according to Wilhelm.

Every patient underwent an elbow arthroscopy including standardized arthroscopic testing for instability following an open procedure according to the arthroscopic findings.

With a minimum follow-up of 1 year we assessed the DASH score and subjective patients satisfaction.

Surgical technique

With the patient under anesthesia collateral ligament stability was tested as well as rotatory instability using the lateral pivot-shift test. Surgery was done in a prone position with an upper-arm tourniquet at 250 mmHg. The joint was insufflated with 25 ml of sterile saline through the posterolateral portal. After inserting an inflow cannula through the anterolateral portal, arthroscopy of the elbow was initiated through the high posterolateral portal. After inspecting the dorsal and ulnar recess, the dorsal humeroradial section of the joint was imaged and, with visual feedback, the deep posterolateral portal was established. Arthroscopic stability evaluation of the humeroradial, humeroulnar, and radioulnar joint sections was subsequently carried out according to the procedure first described by Geyer [20]. The dehiscence of each joint section was determined by inserting a trocar with a defined diameter. Dehiscence up to 3 mm represented no instability, up to 3–6 mm slight instability, and >6 mm severe instability (Fig. 1).

After completing the stability test, the ventral joint section was imaged via the anterolateral portal and the anteromedial portal was established. After changing the position of the camera to the ulnar view, the radial capsule was examined for changes.

Once instability was excluded (Group A), a purely-arthroscopic treatment was performed, including determination of intraarticular pathologies and subsequent partial synovectomy and plica resection. Where necessary, surgical measures to treat cartilage damage or the careful debridement of the origin of the M. extensor carpi radialis brevis were also performed.

On presentation of slight instability (Group B), we also carried out arthroscopic measures to address the

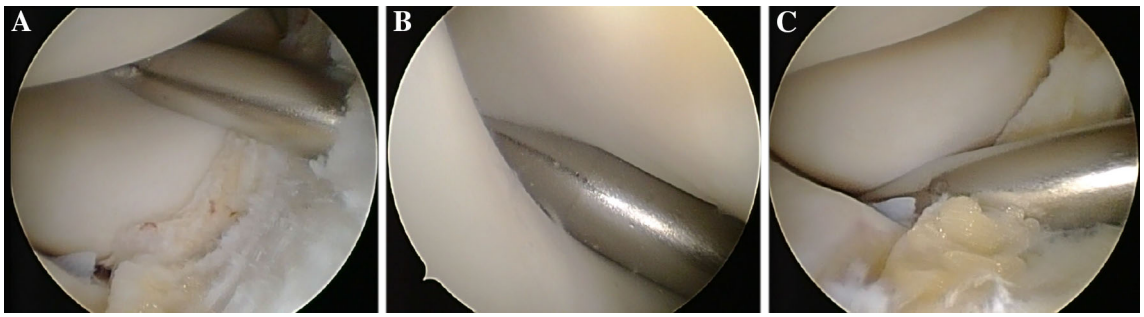

Fig. 1 Arthroscopic stability evaluation left elbow: **a** humeroradial joint section, **b** humeroulnar joint section, **c** radioulnar joint section

intraarticular pathologies. We subsequently changed to an open procedure to detach the lateral tendon complex (extensor carpi radialis muscle, extensor digitorum muscle and proximal origin of the ulnar collateral ligament), and debride the bone and tendon complex. Then stabilizing refixation was performed on the lateral epicondylus using a modified "double-row-technique".

In the event of severe instability (Group C), after completing the arthroscopic procedure, the lateral tendon complex was also detached, and stabilization was achieved using an autologous triceps tendon transplant along the ulnar collateral ligament.

Postoperatively, the arthroscopic group (Group A) received functional follow-up treatment.

Group B received a plaster cast for 2 weeks, followed by an elbow orthosis until the end of week 4. Concurrently, guided motions limited to 0°–0°–90° were permitted.

The group that received triceps tendon reconstruction (Group C) was also immobilized in a plaster cast for 2 weeks followed by an elbow orthosis with limited motion (0°–0°–90°) until the end of week 6.

At the follow-up examination, the DASH score (range 0–100) as well as the subjective patient satisfaction and improvement in percent were recorded.

Statistics

Data were presented as mean (SD). Differences were analysed using unpaired Student's *t* tests. Statistical significance was defined for overall alpha error at the 0.05 level. All *P* levels were two sided.

Analysis of data was made with GraphPad Prism® Software.

Results

Of the 40 patients examined, 25 had no instability, 13 had a slight instability, and 2 had severe instability.

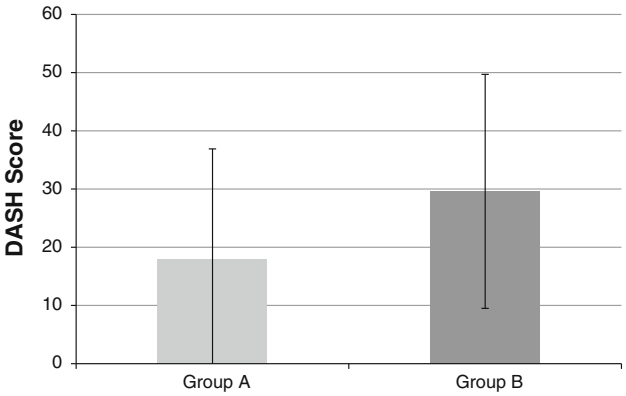

Fig. 2 DASH score for the subgroups (mean ± SD)

With regard to intraarticular pathologies, we found a more or less pronounced radial plica in all cases. In 13 cases, we found chondromalacia in the lateral compartment, and in 3 cases we found free intraarticular joint bodies.

Synovitis was found in 25 cases. Mean follow-up was 24 ± 12 months. The mean DASH score for all 40 patients at follow-up was 22 ± 19. For the subgroups the DASH score was 18 ± 18.9 for Group A and 29.6 ± 20.1 for Group B (Fig. 2).

36 patients (90 %) reported an improvement in their symptoms. 34 (85 %) patients said they would have the same procedure carried out again in the same situation. In 30 (75 %) of the cases, the operation fulfilled the patients' expectations. In Group A ($n = 25$), 23 (92 %) patients reported an improvement in their symptoms. 23 (92 %) said they would have the same procedure carried out again in the same situation.

In Group B ($n = 13$), 10 (77 %) patients reported an improvement (1× no response). 11 (85 %) would repeat the operation in the same situation.

The reported improvement in symptoms (in %) are shown in Fig. 3. Due to the low number of patients in

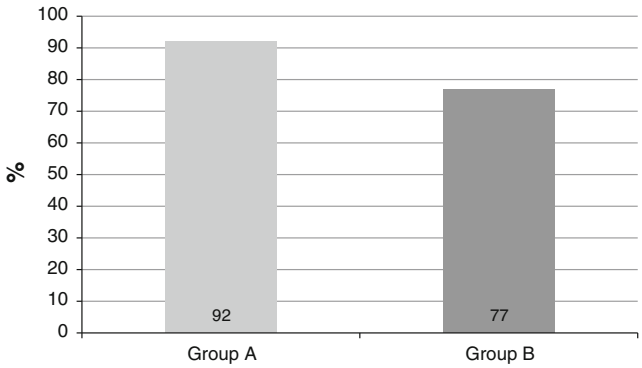

Fig. 3 Patients reporting of improvement of symptoms (mean in %)

Group C with triceps tendon reconstruction, the individual results are listed in Table 1.

The results for patients with prior surgical interventions are depicted in detail in Table 2.

The DASH score for the entire group correlated significantly to the subjective improvement of symptoms ($P < 0.0001$).

There was no correlation between the postoperative DASH score or the preoperative duration of symptoms ($P = 0.1257$) and the patients' age ($P = 0.9832$).

In addition, no significant differences were found between the clinical results for male and female patients.

The four patients who reported their postoperative improvement as 0 % were considered "failures". Two of these patients were in the arthroscopically-treated Group A, and two treated by arthroscopy and open detachment and refixation of the lateral tendon complex (Group B).

The individual DASH scores for these four patients were 66, 49, 45, and 40. Two patients had received surgery previously (1× arthroscopic, 1× OP according to Wilhelm). Two patients reported heavy physical labor at work.

One of these patients reported that the preoperative symptoms no longer existed but that a new point of pain had developed.

Another patient had been admitted to the hospital prior to this operation to treat a somatoform pain disorder. This patient also reported discomfort at multiple locations.

No intraoperative complications occurred in any of the groups.

We observed no postoperative infections, wound healing disorders or nerve lesions.

Postoperative joint stiffness occurred in one case, which led to surgical arthroscopic intervention and subsequently to a satisfactory result.

Discussion

Since the first clinical description of lateral epicondylitis, numerous publications have reported on its pathogenesis as well as on conservative and surgical treatments.

Hohmann described detachment of the extensor aponeurosis as early as 1927 [25].

Further studies have identified degenerative changes in the ECRB tendon as the main cause of discomfort and addressed this pathology with open, arthroscopic, and percutaneous surgery [10, 11, 17–19, 22, 24, 31, 35–37, 49, 50].

Altogether, mostly good clinical outcomes are reported for the surgical procedures. In their detailed review of clinical results, with a synopsis of all postoperative follow-up studies, Walz et al. [50] report 80 % good to excellent results, independent of surgical procedure. However, they

Table 1 Results of patients with triceps tendon reconstruction (Group C)

Age	Gender	Months p.op.	DASH p.op.	Same procedure again	Improvement in symptoms (%)	Prior surgery
51	Male	16	13	No	50	Yes
65	Female	12	25	Yes	80	Yes

Table 2 Results of patients with prior surgical interventions (1× arthroscopic surgery, 4× open denervation according to Wilhelm)

Age	Gender	Months p.op.	DASH p.op.	Same procedure again	Improvement in symptoms (%)	Local tissue refixation	Triceps transplant
47	Female	17	66	No	0	X	
41	Female	20	30	Yes	30	X	
47	Male	14	40	No	0	X	
65	Female	12	25	Yes	80		X
51	Male	16	13	No	50		X

also described failure rates that are doubtless familiar to all physicians from clinical practice. Previous studies report a failure rate following surgical treatment, usually defined as no clinical improvement, of between 3 and 20 % [4, 35, 37, 47].

Although arthroscopic treatment of lateral epicondylitis is becoming increasingly important, it is also still controversial.

When interpreting the results it is important to note that it is difficult to compare our study with those previously published, as none of the previous studies implemented consistent and directly comparable outcome scores or assessment criteria [31].

Over 72–99 % good to very good results are reported after carrying out an arthroscopic release and addressing accompanying intraarticular pathologies [31]. However, Peart et al. [38] also report 21 % merely satisfactory results and a 7 % failure rate. Tseng et al. [46] report good results in 9 out of 11 patients; however, they also report a complication rate of 33 %. Baker [3, 4] found good and very good results in 37 out of 39 patients, with only slight deterioration at the long-term follow-up examination. These altogether variable results can be attributed to the difficulty of identifying the extraarticularly-located ECRB attachment arthroscopically [14]. Two direct-comparison studies of patients treated with open and arthroscopic lateral ECRB release showed similar clinical results [38, 43]. Significant, high quality treatment comparison studies, however, have yet to be published [9, 31].

The incidence of intraarticular pathologies reported in current studies varies considerably between max. 5 % [34] to up to 69 % [4]. In an MRI study, Husarik et al. [26] found a posterolateral plica in 98 % of his cases. Our patient cohort all showed more-or-less pronounced intraarticular radial plica, which were addressed surgically. In combination with the denervation of the extensor attachment and after excluding instability without additional comprehensive release, 92 % of the patients experienced an improvement of their symptoms.

Only a few authors discuss instability as a possible cause of lateral epicondylitis [20]. However, several, mainly American, publications on pitcher's elbow have shown that a primary or secondary instability combined with specific loads can lead to lateral epicondylitis as well as changes in the cartilage in the lateral joint compartment [1, 27, 28, 41, 45].

Our patients were examined arthroscopically for instability, and when confirmed, patients were treated both for the instability and the debridement of the ECRB tendon. In a direct comparison, the results for patients with instability were not as good as the solely arthroscopically-treated group without instability. This could be ascribed to a more severe underlying disease, as defined by instability caused by degenerative changes. Patients with tendon degeneration following cortisone injections are also reported to have worse results. The prospective analysis of Dash scores may be helpful to determine which of the patients with instabilities were in clinically worse conditions prior to surgery.

Furthermore, in some cases it is difficult to assign the arthroscopic measured stability to a specific group. Potentially, in our group of instable classified elbows, open stabilization surgery using triceps tendon replacement should have been indicated more often. With regard to the failure rate in our population, psychological interaction cannot be excluded for two of the four patients. This has been described as an independent prediction factor for a poor outcome and is also well known in daily clinical practice [10]. The other two patients who failed to respond to treatment had received surgery previously and so began in a more-compromised condition than the others.

In summary, we conclude that good outcomes can be expected for lateral epicondylitis patients once instability is excluded using the described selection criteria, with purely arthroscopic treatment and without extended open debridement of the extensors.

Through improvement of the stability measurement procedure and analyzation and filtering of negative predictive factors, we hope to further optimize treatment and clinical outcome of those epicondylitis patients classified with concomitant elbow instability.

Nevertheless further studies amongst other including a control group are needed to better understand and strengthen the role of instability in lateral elbow pain.

Conflict of interest The authors declare that they have no conflict of interest.

References

1. Ahmad CS, ElAttrache NS (2009) Arthroscopy in the throwing athlete. In: Morrey BF, Sanchez-Sotelo J (eds) The elbow and its disorders. Saunders Elsevier, Philadelphia, pp 287–595
2. Allander E (1974) Prevalence, incidence, and remission rates of some common rheumatic diseases or syndromes. Scand J Rheumatol 3(3):145–153
3. Baker CL Jr, Baker CL 3rd (2008) Long-term follow-up of arthroscopic treatment of lateral epicondylitis. Am J Sports Med 36(2):254–260. doi:10.1177/0363546507311599
4. Baker CL Jr, Murphy KP, Gottlob CA, Curd DT (2000) Arthroscopic classification and treatment of lateral epicondylitis: two-year clinical results. J Shoulder Elbow Surg 9(6):475–482. doi:10.1067/mse.2000.108533
5. Baumgard SH, Schwartz DR (1982) Percutaneous release of the epicondylar muscles for humeral epicondylitis. Am J Sports Med 10(4):233–236
6. Bosworth DM (1965) Surgical treatment of tennis elbow; a follow-up study. J Bone Joint Surg Am 47(8):1533–1536
7. Boyd HB, McLeod AC Jr (1973) Tennis elbow. J Bone Joint Surg Am 55(6):1183–1187

8. Bredella MA, Tirman PF, Fritz RC, Feller JF, Wischer TK, Genant HK (1999) MR imaging findings of lateral ulnar collateral ligament abnormalities in patients with lateral epicondylitis. AJR Am J Roentgenol 173(5):1379–1382. doi:10.2214/ajr.173.5.10541124
9. Buchbinder R, Green S, Bell S, Barnsley L, Smidt N, Assendelft WJ (2002) Surgery for lateral elbow pain. Cochrane Database Syst Rev (1):CD003525. doi:10.1002/14651858.CD003525
10. Calfee RP, Patel A, DaSilva MF, Akelman E (2008) Management of lateral epicondylitis: current concepts. J Am Acad Orthop Surg 16(1):19–29
11. Calvert PT, Allum RL, Macpherson IS, Bentley G (1985) Simple lateral release in treatment of tennis elbow. J R Soc Med 78(11):912–915
12. Charalambous CP, Stanley JK (2008) Posterolateral rotatory instability of the elbow. J Bone Joint Surg Br 90(3):272–279. doi:10.1302/0301-620X.90B3.19868
13. Cohen MS, Hastings H 2nd (1997) Rotatory instability of the elbow. The anatomy and role of the lateral stabilizers. J Bone Joint Surg Am 79(2):225–233
14. Cohen MS, Romeo AA, Hennigan SP, Gordon M (2008) Lateral epicondylitis: anatomic relationships of the extensor tendon origins and implications for arthroscopic treatment. J Shoulder Elbow Surg 17(6):954–960. doi:10.1016/j.jse.2008.02.021
15. Coombes BK, Bisset L, Vicenzino B (2009) A new integrative model of lateral epicondylalgia. Br J Sports Med 43(4):252–258. doi:10.1136/bjsm.2008.052738
16. Coonrad RW, Hooper WR (1973) Tennis elbow: its course, natural history, conservative and surgical management. J Bone Joint Surg Am 55(6):1177–1182
17. De Smedt T, de Jong A, Van Leemput W, Lieven D, Van Glabbeek F (2007) Lateral epicondylitis in tennis: update on aetiology, biomechanics and treatment. Br J Sports Med 41(11):816–819. doi:10.1136/bjsm.2007.036723
18. Dunkow PD, Jatti M, Muddu BN (2004) A comparison of open and percutaneous techniques in the surgical treatment of tennis elbow. J Bone Joint Surg Br 86(5):701–704
19. Garden R (1961) Tennis elbow. J Bone Jt Surg 43B:100
20. Geyer M (2009) Ligamentäre Ellbogeninstabilitäten. Orthopädie und Unfallchirurgie up2date 4(06):395–418
21. Goldberg EJ, Abraham E, Siegel I (1988) The surgical treatment of chronic lateral humeral epicondylitis by common extensor release. Clin Orthop Relat Res 233:208–212
22. Grewal R, MacDermid JC, Shah P, King GJ (2009) Functional outcome of arthroscopic extensor carpi radialis brevis tendon release in chronic lateral epicondylitis. J Hand Surg Am 34(5):849–857. doi:10.1016/j.jhsa.2009.02.006
23. Grifka J, Boenke S, Kramer J (1995) Endoscopic therapy in epicondylitis radialis humeri. Arthroscopy 11(6):743–748
24. Grundberg AB, Dobson JF (2000) Percutaneous release of the common extensor origin for tennis elbow. Clin Orthop Relat Res 376:137–140
25. Hohmann G (1933) Das Wesen und die Behandlung des sogenannten Tennisellenbogens. Münch Med Wochenschr 80:250–252
26. Husarik DB, Saupe N, Pfirrmann CW, Jost B, Hodler J, Zanetti M (2010) Ligaments and plicae of the elbow: normal MR imaging variability in 60 asymptomatic subjects. Radiology 257(1):185–194. doi:10.1148/radiol.10092163
27. S-S J (2009) Lateral collateral ligament insufficiency. In: Morrey BFS-SJ (ed) The elbow and its disorders. Saunders Elsevier, Philadelphia, pp 669–679
28. Kalainov DM, Cohen MS (2005) Posterolateral rotatory instability of the elbow in association with lateral epicondylitis. A report of three cases. J Bone Joint Surg Am 87(5):1120–1125. doi:10.2106/JBJS.D.02293
29. Kalainov DM, Makowiec RL, Cohen MS (2007) Arthroscopic tennis elbow release. Tech Hand Up Extrem Surg 11(1):2–7
30. Lattermann C, Romeo AA, Anbari A, Meininger AK, McCarty LP, Cole BJ, Cohen MS (2010) Arthroscopic debridement of the extensor carpi radialis brevis for recalcitrant lateral epicondylitis. J Shoulder Elbow Surg 19(5):651–656. doi:10.1016/j.jse.2010.02.008
31. Lo MY, Safran MR (2007) Surgical treatment of lateral epicondylitis: a systematic review. Clin Orthop Relat Res 463:98–106. doi:10.1097/BLO.0b013e3181483dc4
32. Major H (1883) Lawn-tennis elbow. Br Med J 2:557
33. Merrell G, DaSilva MF (2009) Arthroscopic treatment of lateral epicondylitis. J Hand Surg Am 34(6):1130–1134. doi:10.1016/j.jhsa.2009.02.027
34. Nirschl RP, Alvarado GJ (2009) Tennis elbow tendinosis. In: Morrey BF, Sanchez-Sotelo J (eds) The elbow and its disorders. Saunders Elsevier, Philadelphia, pp 626–624
35. Nirschl RP, Pettrone FA (1979) Tennis elbow. The surgical treatment of lateral epicondylitis. J Bone Joint Surg Am 61(6A):832–839
36. Othman AM (2011) Arthroscopic versus percutaneous release of common extensor origin for treatment of chronic tennis elbow. Arch Orthop Trauma Surg 131(3):383–388. doi:10.1007/s00402-011-1260-2
37. Owens BD, Murphy KP, Kuklo TR (2001) Arthroscopic release for lateral epicondylitis. Arthroscopy 17(6):582–587. doi:10.1053/jars.2001.20098
38. Peart RE, Strickler SS, Schweitzer KM Jr (2004) Lateral epicondylitis: a comparative study of open and arthroscopic lateral release. Am J Orthop (Belle Mead NJ) 33(11):565–567
39. Pruzansky ME, Gantsoudes GD, Watters N (2009) Late surgical results of reattachment to bone in repair of chronic lateral epicondylitis. Am J Orthop (Belle Mead NJ) 38(6):295–299
40. Runge F (1873) Zur genese und behandlung des schreibekrampfes. Berl Klin Wochenschr 10:245–248
41. Safran M, Ahmad CS, Elattrache NS (2005) Ulnar collateral ligament of the elbow. Arthroscopy 21(11):1381–1395. doi:10.1016/j.arthro.2005.07.001
42. Smith AM, Castle JA, Ruch DS (2003) Arthroscopic resection of the common extensor origin: anatomic considerations. J Shoulder Elbow Surg 12(4):375–379. doi:10.1016/mse.2003.S1058274602868239
43. Stapleton T, Baker C (1996) Arthroscopic treatment of lateral epicondylitis: a clinical study. Arthroscopy 12(3):365–366
44. Szabo SJ, Savoie FH 3rd, Field LD, Ramsey JR, Hosemann CD (2006) Tendinosis of the extensor carpi radialis brevis: an evaluation of three methods of operative treatment. J Shoulder Elbow Surg 15(6):721–727. doi:10.1016/j.jse.2006.01.017
45. Timmerman LA, Andrews JR (1994) Undersurface tear of the ulnar collateral ligament in baseball players. A newly recognized lesion. Am J Sports Med 22(1):33–36
46. Tseng V (1994) Arthroscopic lateral release for treatment of tennis elbow. Arthroscopy 10:335–336
47. Verhaar J, Walenkamp G, Kester A, van Mameren H, van der Linden T (1993) Lateral extensor release for tennis elbow. A prospective long-term follow-up study. J Bone Joint Surg Am 75(7):1034–1043
48. Verhaar JA (1994) Tennis elbow. Anatomical, epidemiological and therapeutic aspects. Int Orthop 18(5):263–267
49. Wada T, Moriya T, Iba K, Ozasa Y, Sonoda T, Aoki M, Yamashita T (2009) Functional outcomes after arthroscopic treatment of lateral epicondylitis. J Orthop Sci 14(2):167–174. doi:10.1007/s00776-008-1304-9
50. Walz DM, Newman JS, Konin GP, Ross G (2010) Epicondylitis: pathogenesis, imaging, and treatment. Radiographics 30(1):167–184. doi:10.1148/rg.301095078

51. Wilhelm A (2000) Die Denervation zur Behandlung der therapieresistenten Epicondylitis humeri lateralis. Operative Orthopädie und Traumatologie 12(2):95–108

52. Wilhelm A (2009) Lateral epicondylitis review and current concepts. J Hand Surg Am 34(7):1358–1359 (author reply 1359–1360). doi:10.1016/j.jhsa.2009.06.007