Knee Surg Sports Traumatol Arthrosc (2017) 25:2264–2270
DOI 10.1007/s00167-017-4531-9

ELBOW

Arthroscopic R-LCL plication for symptomatic minor instability of the lateral elbow (SMILE)

Paolo Arrigoni[1,2] · Davide Cucchi[1,2] · Riccardo D'Ambrosi[3] · Alessandra Menon[3] · Alberto Aliprandi[4] · Pietro Randelli[1,2]

Received: 15 December 2016 / Accepted: 20 March 2017 / Published online: 23 March 2017
© European Society of Sports Traumatology, Knee Surgery, Arthroscopy (ESSKA) 2017

Abstract

Purpose Minor instability has been proposed as a possible aetiology of lateral elbow pain. This study presents the results of the arthroscopic plication of the radial component of the lateral collateral ligament (R-LCL) to reduce minor instability of the lateral elbow.

Methods Twenty-seven patients with recalcitrant lateral epicondylitis who had failed conservative therapy and who had no previous trauma or overt instability, were included. R-LCL plication was performed in the presence of at least one sign of lateral ligamentous patholaxity and one intra-articular abnormal finding. Single-assessment numeric evaluation (SANE), Oxford Elbow Score (OES), quick-DASH (Disabilities of the Arm, Shoulder, Hand), patient satisfaction and post-operative range of motion were evaluated.

Results SANE improved from a median of 30 [2–40] points pre-operatively to 90 [80–100] at final follow-up ($p < 0.0001$), and 96.3% patients obtained good or excellent subjective results. Post-operative median quickDASH was 9.1 [0–25] points and OES 42 [34–48]. Median post-operative flexion was 145°, and extension was 0°. Post-operative flexion was restrained in seven patients and extension in eight patients; 59% of patients reached full ROM at final follow-up.

Conclusions R-LCL plication produces subjective satisfaction and positive clinical results in patients presenting with a symptomatic minor instability of the lateral elbow (SMILE) at 2-year median follow-up. A slight limitation in range of motion is a possible undesired consequence of this intervention.

Level of evidence Retrospective case series, Level IV.

Keywords Elbow arthroscopy · Lateral elbow pain · Lateral epicondylitis · Elbow instability · Laxity · Capsular plication

Introduction

Lateral epicondylitis is generally considered to be an extra-articular condition involving degeneration and tendinosis of the common extensor origin, with the extensor carpi radialis brevis (ECRB) being the most commonly affected tendon [19, 52].

Five to 10% of patients with persistent symptoms may require surgical treatment [55]. The arthroscopic approach to the elbow joint has demonstrated the presence of potentially pathological intra-articular findings associated with ECRB tendinopathy [3, 7, 9, 30, 45, 56].

The presence of laxity signs within the lateral compartment of the elbow, in conjunction with these intra-articular abnormalities, supports the existence of a symptomatic minor instability of the lateral elbow (SMILE). A novel technique to plicate the radial component of the lateral collateral ligament (R-LCL) and reduce the lateral laxity has been introduced at our institution. In contrast to previously described techniques, this treatment is focussed towards the

✉ Davide Cucchi
d.cucchi@gmail.com

[1] Dipartimento di Scienze Biomediche per la Salute, Università degli Studi di Milano, Via Mangiagalli 31, 20133 Milan, Italy

[2] U.O. Ortopedia II, IRCCS Policlinico San Donato, Piazza Malan 1, 20097 San Donato Milanese, Milan, Italy

[3] IRCCS Policlinico San Donato, Piazza Malan 1, 20097 San Donato Milanese, Milan, Italy

[4] Servizio di Radiologia, IRCCS Policlinico San Donato, Piazza Malan 1, 20097, San Donato Milanese, Milan, Italy

treatment of a symptomatic minor instability of the elbow rather than a major instability.

The aim of this study is to describe the technique and to present the clinical results at mid-term follow-up.

Materials and methods

Twenty-seven patients enrolled between February 2009 and June 2015 were retrospectively evaluated; no controls were considered for this study.

Patients between 20 and 65 years of age with lateral elbow pain recalcitrant to at least 6 months of conservative treatment (including: ice; non-steroidal anti-inflammatory drugs; stretching; steroid injections and physical therapy) were included. Patients were excluded if there was a previous history of trauma or signs of overt elbow instability such as a positive posterolateral drawer, posterolateral pivot shift or varus/valgus stress tests. Patients were also excluded if there were any radiographic or magnetic resonance imaging (MRI) features of trauma or arthritis. All patients underwent a pre-operative clinical examination and a single-assessment numeric evaluation (SANE) was administered.

The presence of the following three signs of laxity was evaluated at elbow arthroscopy: the Annular Drive Through (ADT); the Loose Collar Sign (LCS); the R-LCL pull-up sign (RPS).

The annular drive through (ADT) is performed by pushing the radial head anteriorly with the surgeon's thumb from posteriorly, while looking with the scope in the posterolateral portal. If this manoeuvre allows enough space for a 4.2-mm shaver to slide between the radial head and the annular ligament with no or minimal resistance through the soft spot portal, the ADT is considered positive (Fig. 1).

A positive loose collar sign (LCS) indicates a characteristic annular ligament that at 90° of flexion lies low respect to the radial head, so that the radial neck is clearly exposed under the cartilaginous portion when observed from the anteromedial portal (Fig. 2).

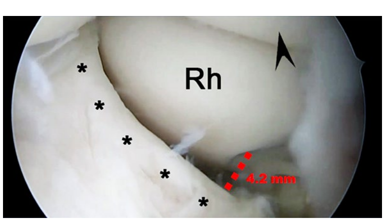

Fig. 1 Annular drive through (ADT) of a 4.2-mm shaver between the radial head (*Rh*) and the annular ligament (*asterisks*). *Right elbow* posterolateral view; *arrowhead* capitellum

The R-LCL pull-up sign (RPS) is performed while looking from the anteromedial portal, introducing a grasper via the anterolateral portal and pulling the R-LCL to the lateral side of the capitellum. If a vertical (distal to proximal) translation of 1 linear centimetre is possible, the sign is considered positive (Fig. 3).

Other pathologic findings were also considered, including: synovitis anterior to the radial head; anterolateral capsular tears; chondropathy of either the radial head or the lateral portion of the capitellum (CLAC lesion). Patients, who had at least one of the previous signs of minor instability in addition to one or more intra-articular associated lesions, were considered eligible for R-LCL plication (Fig. 4).

Similar to a previously described technique [4], a dedicated spade-drill was introduced via the proximal anterolateral portal under direct visual control from the anteromedial portal and after drilling, a bioabsorbable suture anchor was inserted high and lateral in the anterolateral aspect of the capitellum at the capsular insertion (Fig. 5). Sutures were passed into the R-LCL, either using an

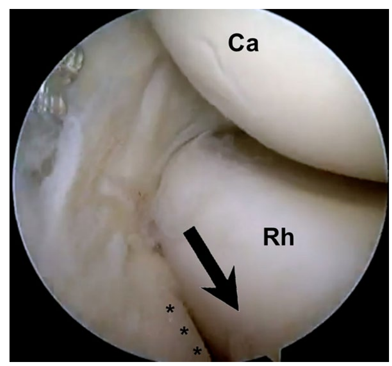

Fig. 2 Loose collar sign (LCS). Radial neck exposure under the cartilaginous portion (*arrow*) may be associated with annular ligament redundancy and laxity (*asterisks*). *Right elbow* anteromedial view; *Ca* capitellum, *Rh* radial head

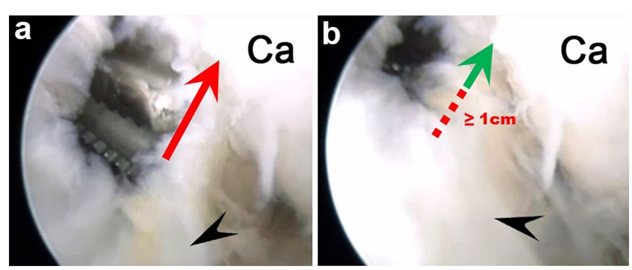

Fig. 3 R-LCL pull-up sign (RPS). The lax R-LCL (*arrowhead*) can easily be grasped (**a**) and reduced to the humerus or translated more than 1 cm with (**b**) a grasper or introduced via the anterolateral portal. *Right elbow* anteromedial 30° arthroscopic view; *Ca* capitellum

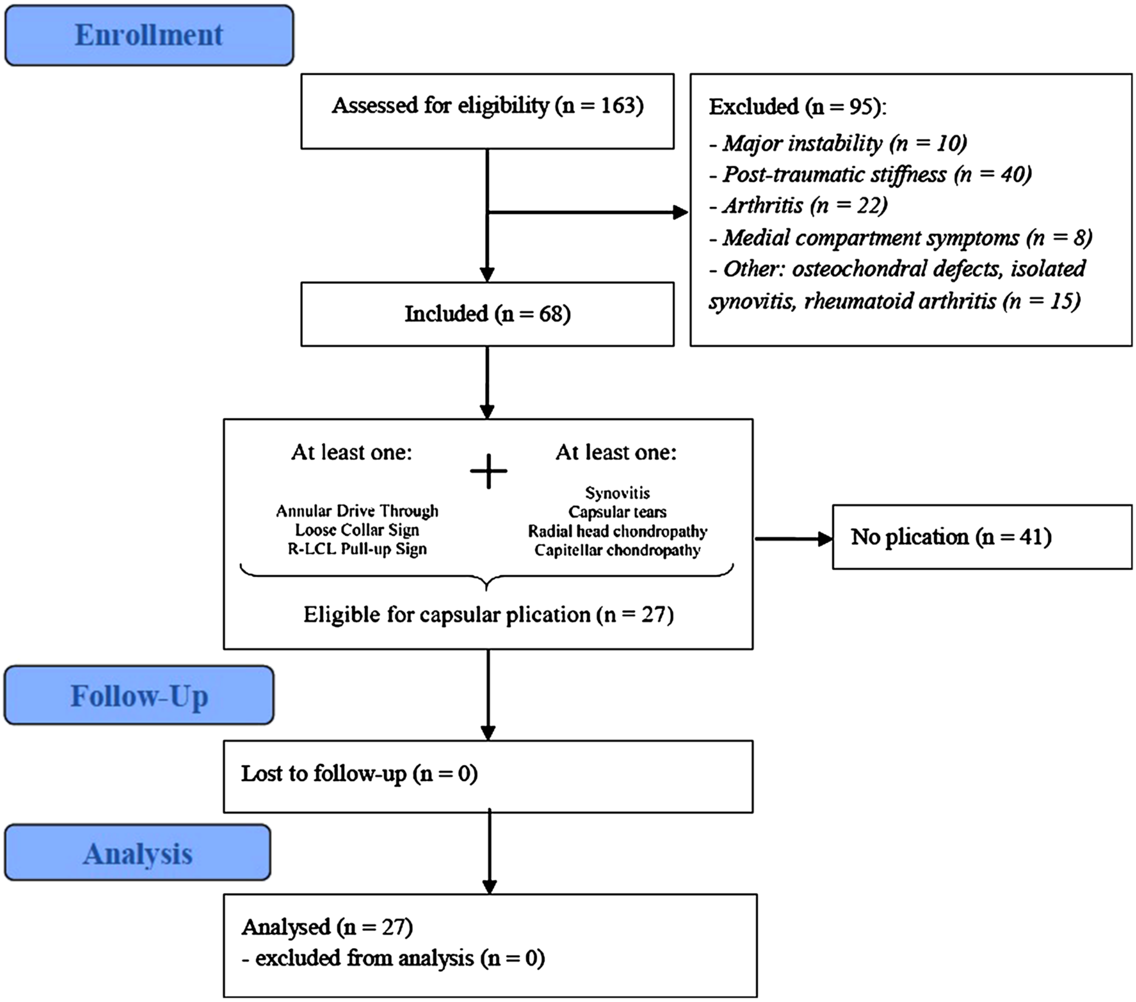

Fig. 4 Study flow chart

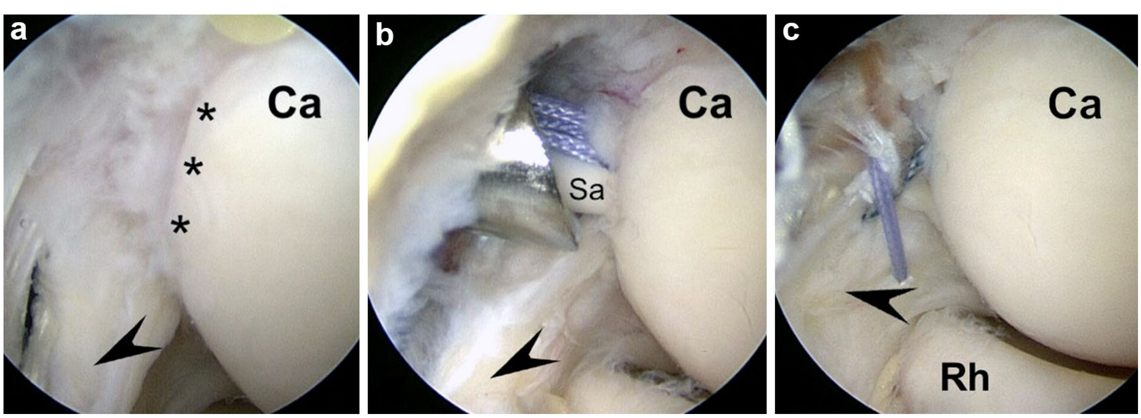

Fig. 5 Insertion of a suture anchor for R-LCL plication. **a** A limited capsulotomy anterior and proximal to the R-LCL (*arrowhead*) is performed and the lateral aspect of the capitellum is prepared (*asterisks*). **b** A dedicated bioabsorbable suture anchor is inserted through the anterolateral portal at the level of the R-LCL insertion on the capitellum. The axis of anchor insertion is approximatively 45° respect to the intercondilar line. **c** Standard sliding knots are used to secure and the R-LCL (*arrowhead*) back to the bone. *Right elbow*, anteromedial 30° arthroscopic view; *Ca* capitellum, *Sa* suture anchor, *Rh* radial head

outside-in shuttling technique with a percutaneous needle, or by using a suture retriever via the anterolateral portal. Care was taken to pass the sutures beyond a level anterior to the mid-point of the radial head and approximately 0.5 cm proximal to the radiocapitellar joint line. Sutures were then retrieved from the anterolateral portal and a standard sliding knot was performed, ensuring that it lay extra-articularly. Debridement of any synovitis or chondral irregularity was then performed and a re-assessment for any residual sign of laxity then undertaken.

All patients underwent a pre-operative clinical examination and SANE was administrated by asking the patient to self-evaluate the affected elbow between 0 (minimum) and 100 (maximum).

All surgery was undertaken by a single surgeon (P.A.) with expertise in the field of arthroscopic elbow surgery. At final follow-up, range of motion (ROM), Oxford Elbow Score (OES), quickDASH (Disabilities of the Arm, Shoulder, Hand) and SANE questionnaires were collected from each patient, by two blinded assessors (D.C., R.D).

Institutional approval of the study protocol was obtained by the Ospedale San Raffaele Ethic Committee (70/INT/2016)

Statistical analysis

Statistical analysis (A.M.) was performed using GraphPad Prism v 6.0 software (GraphPad Software Inc.). Continuous variables were expressed as the mean ± standard deviation (SD) or medians and first and third quartiles [Q1–Q3] as appropriate, while the dichotomous variables are expressed in numbers of patients and frequencies. The Shapiro–Wilk normality test was used to evaluate the normal distribution of the sample. Differences between pre- and post-operative SANE score were analysed with an unpaired Wilcoxon matched-pairs signed rank test. A sample size of 25 was considered sufficient to evaluate a difference in post- to pre-operative SANE greater than 0.5 SD units with a power >80% and significance level set at 5%.

Results

All of the 27 patients who underwent R-LCL plication, with a mean age of 45.5 (±9.1) years, were available at a median follow-up of 2.1 [1.2–4.8] (mean 3.1) years (Fig. 4). The right elbow was involved in 20 patients. Positive signs of laxity were negated intra-operatively in all patients at the end of the procedure. Median SANE improved from 30 [2–40] points pre-operatively to 90 [80–100] at final follow-up ($p < 0.0001$) and 26 patients (96.3%) obtained good or excellent subjective results. Post-operative median quickDASH was 9.1 [0–25] points and OES 42 [34–48] out of a maximum of 48 points (Fig. 6). Median post-operative flexion was 145° [135°–145°] (mean 141.1°) and extension was 0° [0° to −20°] (mean −7.7°). Post-operative ROM restriction was documented in seven patients for flexion in eight for extension; 16 patients (59%) reached full ROM at final follow-up.

Discussion

The most relevant finding of this study is that R-LCL plication provides patient satisfaction and positive clinical results in patients presenting with a SMILE condition at more than 2 years of median follow-up.

ECRB debridement or release through open, percutaneous and arthroscopic approaches is generally considered the gold standard surgical treatment for recalcitrant lateral epicondylitis. However, success rates ranging between 65 and 95% suggest that these approaches may not precisely address the underlying pathologic process [8–10, 35, 37, 38, 50].

The idea of elbow instability resulting from progressive ligamentous elongation has already been postulated. Specific sporting mechanisms have been associated with ligamentous incompetence, as in the case of pitcher's elbow (valgus instability), posterolateral rotatory instability and varus posteromedial rotatory instability for

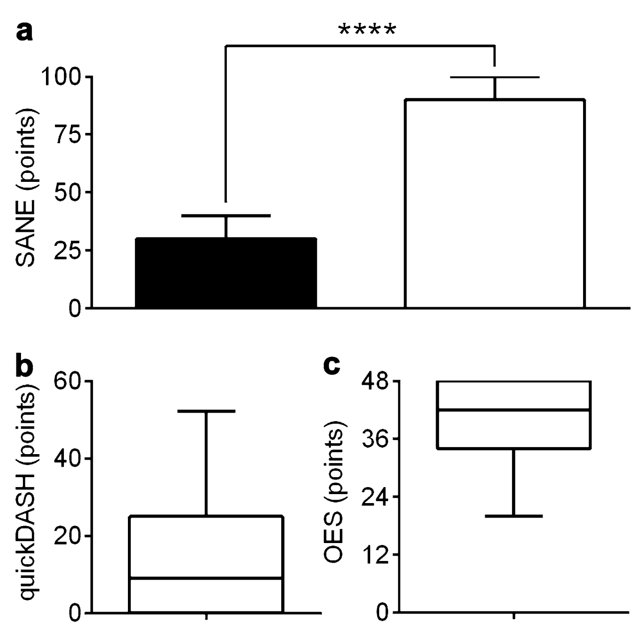

Fig. 6 Functional results in the study population. **a** SANE (single-assessment numeric evaluation); **b** OES (Oxford Elbow Score); **c** quickDASH (disabilities of the Arm, Shoulder, Hand). *Black* pre-operative value; *white* post-operative value; ****$p < 0.0001$

example [21, 26, 39, 42]. Few authors have suggested a minor instability condition with more subtle features most commonly presenting only with pain [31]. Intra-articular findings seen at arthroscopy have also been described previously during surgery performed for lateral epicondylitis [3, 30, 45, 47, 49, 54, 56]. The cumulative presence of intra-articular signs of patholaxity and minor elements of pathology has been correlated with clinical symptoms [6].

Knowledge of lateral elbow anatomy is pivotal while understanding the rationale of R-LCL plication [12]. Proximally, the lateral elbow capsule attaches along the articular margin of the elbow extending anteriorly above the coronoid and radial fossa, distally to the edge of the coronoid process, and laterally to the annular ligament. The capsule is taut anteriorly when the elbow is extended and posteriorly when the elbow is flexed and provides most of its stabilizing effects with the elbow extended [17, 25, 40]. The lateral collateral ligament (LCL) complex (Fig. 7) is a reinforcement of the lateral capsule and consists of three components, including the R-LCL, the ulnar band (U-LCL) and the annular ligament [14, 16, 39, 48, 57].

Several daily activities such as most desk jobs are performed with the shoulder in moderate abduction, pronation of the hand and 50–70° of elbow flexion. With time, this varus/pronation moment created by the hand and the forearm could lead to elongation of the R-LCL and annular ligament The ECRB proximal insertion is located just extra-capsular and parallel to R-LCL, in intimate association but easily distinguishable with the lateral collateral ligament [5, 16]. Within the SMILE theory, ECRB tendinopathy could be a consequence of R-LCL elongation, as this structure acts as an extra-articular secondary stabilizer resisting varus-pronation stresses. Strain on this ligament with the secondary bracing effect of ECRB activity provides the rationale for R-LCL plication. Future research will help to confirm this theory and investigate if the pathologic cascade is initiated extra-articularly (from ECRB) and subsequently becomes intra-articular (generating ligamentous laxity and associated lesions), or indeed the opposite. Proving one or the other origin could help to intervene conservatively in the very first symptomatic phase, avoiding progression of the symptoms.

The goal of R-LCL plication is to surgically constrain an intra-articular structure and to stabilize a joint compartment, as similarly described in other joints with satisfactory results [8–11]. Procedures aiming to reduce capsular volume to treat symptomatic instabilities have been described while performing shoulder arthroscopy for anterior, posterior and multidirectional instability [46]. Capsular plication has also been successful in treating minor instabilities of the shoulder [11, 13].

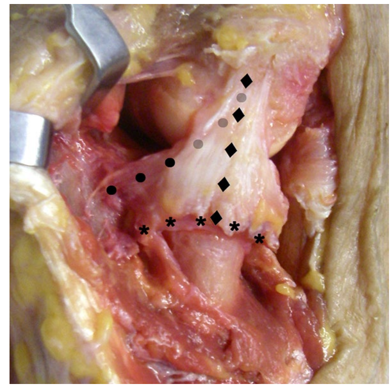

Fig. 7 Right elbow, anatomical study of the lateral collateral ligament complex. Three components can be distinguished: the radial band (R-LCL, *diamonds*), the ulnar band (U-LCL, *circles*) and the annular ligament (*asterisks*). Note the diamond shape of the R-LCL, which blends, in its distal part, with the annular ligament fibres

Cadaveric studies have shown that the LCL complex plays a role in posterolateral rotatory instability although references to LCL pathology occurring without trauma are scarce [41]. This is in contrast to the medial collateral ligament of the elbow, for which pathology related to elongation after a repetitive valgus stress has been widely described [2, 22, 37, 57]. The SMILE concept postulates a role for the R-LCL in the origin of atraumatic minor instability and pain of the lateral elbow.

The choice of an all-arthroscopic technique is dictated by the reduced procedure-related morbidity, the possibility to visualise and diagnose every compartment of the elbow, and the capability of performing a dynamic evaluation of the laxity of articular and ligamentous structures before and after re-tensioning. An open procedure could also be considered, depending on the preference and experience of the surgeon. Traditional open techniques of ECRB release may work by generating a scarring process of R-LCL [8]. This could eventually lead to a similar functional result as plicating the R-LCL. Nevertheless, we believe that a procedure that plicates an existing ligament is more respectful to the anatomy compared with aiming to create a scar by detaching a tendon with the underlying ligament.

We did not consider laser-assisted capsulorrhaphy or arthroscopic thermal shrinkage because of the association with significant complications such as chondrolysis and thermal nerve injury that have been demonstrated in the management of shoulder instability [24, 28, 46].

Post-operative loss of extension was the most frequent adverse event encountered in our series, which partially explains the few unsatisfactory subjective final results. Reduction in joint movement and loss of strength have been extensively described as potential complication of arthroscopic treatment of joint instability; this adverse event may directly depend on the surgical procedure (non-anatomical repair or mechanical failure of the anchors) or on inadequate physiotherapy [1, 23, 27, 33]. However, loss of ROM is considered an acceptable drawback of a procedure which relieves pain and reduces instability [51, 53]. The vast majority of our patients at final follow-up had a minimal reduction in flexion or extension that was not subjectively considered as problematic. Future research will help us to modulate the amount of distal to proximal shift of R-LCL and eventually to limit the ROM loss though it is recognised even with percutaneous and arthroscopic ECRB releases a minor percentage of post-operative ROM loss occurs (1.9 and 1.1%, respectively). [44].

Defining the limits of this procedure is challenging and requires further study. Image-based diagnosis and classification of the intra-articular findings evaluated in this study in association with lateral elbow pain is challenging. Ultrasound examination is still considered the imaging gold standard even if ultrasound is limited in the evaluation of joint cartilage and capsule [15, 20, 32, 34, 43]. MRI is limited by the need for different arm positions and reconstructions to fully investigate anomalies. MRI arthrography and three-dimensional reconstruction may help increase the utility of MRI [18, 29, 36]. A detailed knowledge of the pathology and a precise clinical examination can improve imaging-based diagnostics and a specific question from the requesting surgeon may help focus the relevant investigation.

Limitations of this study include that it is a case series from a single surgeon without any control group. Given the lack of any suitable validated criteria, eligibility was determined through intra-articular assessment of findings and performance of tests in a standardised fashion by the primary author. The development of a standardised diagnostic algorithm will enable further refinement of the indications for this technique and to offer a reproducible and reliable treatment option for a selected subgroup of patients affected by recalcitrant elbow pain.

Conclusions

Arthroscopic R-LCL plication abolishes objective signs of laxity and leads to substantial improvements in subjective patient satisfaction and positive clinical outcomes at more than 2 years of median follow-up in patients presenting with symptomatic minor instability of the lateral elbow (SMILE). A well-tolerated limitation in range of motion is a possible consequence of this intervention.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflicts of interest relevant to this study.

Funding None.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent Informed consent was obtained from all individual participants included in the study.

References

1. Adams JE, King GJW, Steinmann SP, Cohen MS (2014) Elbow arthroscopy: indications, techniques, outcomes, and complications. J Am Acad Orthop Surg 22(12):810–818
2. Ahmad CS, ElAttrache NS (2004) Valgus extension overload syndrome and stress injury of the olecranon. Clin Sports Med 23(4):665–676
3. Antuna SA, O'Driscoll SW (2001) Snapping plicae associated with radiocapitellar chondromalacia. Arthroscopy 17(5):491–495
4. Arrigoni P, Fossati C, Zottarelli L, Brady PC, Cabitza P, Randelli P (2014) 70° frontal visualization of lateral compartment of the elbow allows extensor carpi radialis brevis tendon release with preservation of the radial lateral collateral ligament. Arthroscopy 30(1):29–35
5. Arrigoni P, D'Ambrosi R, Randelli P (2015) Arthroscopic treatment of annular drive through and radial lateral collateral ligament articular-side tear of the elbow. Arthrosc Tech 4:e647–e650
6. Arrigoni P, Cucchi D, D'Ambrosi R, Butt U, Safran MR, Denard P, Randelli P (2017) Intra-articular findings in symptomatic minor instability of the lateral elbow (SMILE). Knee Surg Sports Traumatol Arthrosc. doi:10.1007/s00167-017-4530-x
7. Baker CL, Cummings PD (1998) Arthroscopic managementof miscellaneous elbow disorders. Oper Tech Sports Med 6:16–21
8. Baker CL, Jones GL (1999) Arthroscopy of the elbow. Am J Sports Med 27(2):251–264
9. Baker CL, 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
10. Baumgard SH, Schwartz DR (1982) Percutaneous release of the epicondylar muscles for humeral epicondylitis. Am J Sports Med 10(4):233–236
11. Boileau P, Zumstein M, Balg F, Penington S, Bicknell RT (2011) The unstable painful shoulder (UPS) as a cause of pain from unrecognized anteroinferior instability in the young athlete. J Shoulder Elbow Surg 20(1):98–106
12. Bryce CD, Armstrong AD (2008) Anatomy and biomechanics of the elbow. Orthop Clin North Am 39(2):141–154
13. Castagna A, Nordenson U, Garofalo R, Karlsson J (2007) Minor shoulder instability. Arthroscopy 23(2):211–215
14. Ciaudo O, Guérin-Surville H (1980) Importance of damage to the medial fascia of the external lateral ligament (radial collateral ligament) in the mechanisms of luxations of the elbow. Study on the cadaver (author's transl). J Chir (Paris) 117(4):237–239

15. Clarke AW, Ahmad M, Curtis M, Connell DA (2010) Lateral elbow tendinopathy: correlation of ultrasound findings with pain and functional disability. Am J Sports Med 38(6):1209–1214
16. 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
17. Deutch SR, Olsen BS, Jensen SL, Tyrdal S, Sneppen O (2003) Ligamentous and capsular restraints to experimental posterior elbow joint dislocation. Scand J Med Sci Sports 13(5):311–316
18. Dewan AK, Chhabra AB, Khanna AJ, Anderson MW, Brunton LM (2013) MRI of the elbow: techniques and spectrum of disease: AAOS exhibit selection. J Bone Joint Surg Am 95(e99):1–13
19. Dines JS, Bedi A, Williams PN, Dodson CC, Ellenbecker TS, Altchek DW, Windler G, Dines DM (2015) Tennis injuries: epidemiology, pathophysiology, and treatment. J Am Acad Orthop Surg 23(3):181–189
20. Dones VC, Grimmer K, Thoirs K, Suarez CG, Luker J (2014) The diagnostic validity of musculoskeletal ultrasound in lateral epicondylalgia: a systematic review. BMC Med Imaging 14:10
21. Doornberg JN, Ring DC (2006) Fracture of the anteromedial facet of the coronoid process. J Bone Joint Surg Am 88(10):2216–2224
22. Dugas JR (2010) Valgus extension overload: diagnosis and treatment. Clin Sports Med 29(4):645–654
23. El-Gazzar Y, Baker CL, Baker CL (2013) Complications of elbow and wrist arthroscopy. Sports Med Arthrosc 21(2):80–88
24. Fenn P, Hersch J (2007) Posterior instability of the shoulder following thermal capsulorrhaphy for multidirectional instability. Arthroscopy 23(2):226.e1-4
25. Gallay SH, Richards RR, O'Driscoll SW (1993) Intraarticular capacity and compliance of stiff and normal elbows. Arthroscopy 9(1):9–13
26. Grana WA, Rashkin A (1980) Pitcher's elbow in adolescents. Am J Sports Med 8(5):333–336
27. El Hajj F, Hoteit M, Ouaknine M (2015) Elbow arthroscopy: an alternative to anteromedial portals. Orthop Traumatol Surg Res 101(4):411–414
28. Hawkins RJ, Krishnan SG, Karas SG, Noonan TJ, Horan MP (2007) Electrothermal arthroscopic shoulder capsulorrhaphy: a minimum 2-year follow-up. Am J Sports Med 35(9):1484–1488
29. Kijowski R, Tuite M, Sanford M (2005) Magnetic resonance imaging of the elbow. Part II: abnormalities of the ligaments, tendons, and nerves. Skeletal Radiol 34(1):1–18
30. Kim DH, Gambardella RA, Elattrache NS, Yocum LA, Jobe FW (2006) Arthroscopic treatment of posterolateral elbow impingement from lateral synovial plicae in throwing athletes and golfers. Am J Sports Med 34(3):438–444
31. Kniesel B, Huth J, Bauer G, Mauch F (2014) Systematic diagnosis and therapy of lateral elbow pain with emphasis on elbow instability. Arch Orthop Trauma Surg 134(12):1641–1647
32. Latham SK, Smith TO (2014) The diagnostic test accuracy of ultrasound for the detection of lateral epicondylitis: a systematic review and meta-analysis. Orthop Traumatol Surg Res 100(3):281–286
33. Leong NL, Cohen JR, Lord E, Wang JC, McAllister DR, Petrigliano FA (2015) Demographic trends and complication rates in arthroscopic elbow surgery. Arthroscopy 31(10):1928–1932
34. Levin D, Nazarian LN, Miller TT, O'Kane PL, Feld RI, Parker L, McShane JM (2005) Lateral epicondylitis of the elbow: US findings. Radiology 237(1):230–234
35. Lo MY, Safran MR (2007) Surgical treatment of lateral epicondylitis: a systematic review. Clin Orthop Relat Res 463:98–106
36. Magee T (2015) Accuracy of 3-T MR arthrography versus conventional 3-T MRI of elbow tendons and ligaments compared with surgery. AJR Am J Roentgenol 204:W70–W75
37. McAdams TR, Masters GW, Srivastava S (2005) The effect of arthroscopic sectioning of the lateral ligament complex of the elbow on posterolateral rotatory stability. J Shoulder Elbow Surg 14(3):298–301
38. Nirschl RP, Pettrone FA (1979) Tennis elbow. The surgical treatment of lateral epicondylitis. J Bone Joint Surg Am 61(6A):832–839
39. O'Driscoll SW, Bell DF, Morrey BF (1991) Posterolateral rotatory instability of the elbow. J Bone Joint Surg Am 73(3):440–446
40. O'Driscoll SW, Morrey BF, An KN (1990) Intraarticular pressure and capacity of the elbow. Arthroscopy 6(2):100–103
41. O'Driscoll SW, Spinner RJ, McKee MD, Kibler WB, Hastings H, Morrey BF, Kato H, Takayama S, Imatani J, Toh S, Graham HK (2001) Tardy posterolateral rotatory instability of the elbow due to cubitus varus. J Bone Joint Surg Am 83-A(9):1358–1369
42. Pollock JW, Brownhill J, Ferreira L, McDonald CP, Johnson J, King G (2009) The effect of anteromedial facet fractures of the coronoid and lateral collateral ligament injury on elbow stability and kinematics. J Bone Joint Surg Am 91(6):1448–1458
43. Poltawski L, Ali S, Jayaram V, Watson T (2012) Reliability of sonographic assessment of tendinopathy in tennis elbow. Skeletal Radiol 41(1):83–89
44. Pomerantz ML (2016) Complications of lateral epicondylar release. Orthop Clin North Am 47(2):445–469
45. Rajeev A, Pooley J (2015) Arthroscopic resection of humeroradial synovial plica for persistent lateral elbow pain. J Orthop Surg (Hong Kong) 23(1):11–14
46. Randelli P, Cucchi D, Butt U (2016) History of shoulder instability surgery. Knee Surg Sports Traumatol Arthrosc 24(2):305–329
47. Rhyou IH, Kim KW (2013) Is posterior synovial plica excision necessary for refractory lateral epicondylitis of the elbow? Clin Orthop Relat Res 471(1):284–290
48. Rhyou IH, Park MJ (2011) Dual reconstruction of the radial collateral ligament and lateral ulnar collateral ligament in posterolateral rotator instability of the elbow. Knee Surg Sports Traumatol Arthrosc 19(6):1009–1012
49. Ruch DS, Papadonikolakis A, Campolattaro RM (2006) The posterolateral plica: a cause of refractory lateral elbow pain. J Shoulder Elbow Surg 15(3):367–370
50. Savoie FH, VanSice W, O'Brien MJ (2010) Arthroscopic tennis elbow release. J Shoulder Elbow Surg 19(2 Suppl):31–36
51. Shafer BL, Mihata T, McGarry MH, Tibone JE, Lee TQ (2008) Effects of capsular plication and rotator interval closure in simulated multidirectional shoulder instability. J Bone Joint Surg Am 90(1):136
52. Sims SEG, Miller K, Elfar JC, Hammert WC (2014) Non-surgical treatment of lateral epicondylitis: a systematic review of randomized controlled trials. Hand (N Y) 9(4):419–446
53. Sodl JF, McGarry MH, Campbell ST, Tibone JE, Lee TQ (2016) Biomechanical effects of anterior capsular plication and rotator interval closure in simulated anterior shoulder instability. Knee Surg Sports Traumatol Arthrosc 24(2):365–373
54. Steinert AF, Goebel S, Rucker A, Barthel T (2010) Snapping elbow caused by hypertrophic synovial plica in the radiohumeral joint: a report of three cases and review of literature. Arch Orthop Trauma Surg 130(3):347–351
55. Taylor SA, Hannafin JA (2012) Evaluation and management of elbow tendinopathy. Sports Health 4(5):384–393
56. 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
57. Wegmann K, Burkhart KJ, Bingoel AS, Ries C, Neiss WF, Müller LP (2015) Anatomic relations between the lateral collateral ligament and the radial head: implications for arthroscopic resection of the synovial fold of the elbow. Knee Surg Sports Traumatol Arthrosc 23(11):3421–3425