European Journal of Orthopaedic Surgery & Traumatology (2019) 29:785–792
https://doi.org/10.1007/s00590-019-02374-x

ORIGINAL ARTICLE • ELBOW - TRAUMA

Ligaments injuries check-up and assessment of their healing potential in simple posterolateral elbow dislocation: about 25 cases

Eric Abehsera[1,2] · Elvire Guerre[2] · Pauline Duriez[1] · Mazen El Rafei[3] · Christian Fontaine[2] · Christophe Chantelot[1]

Received: 9 August 2018 / Accepted: 4 January 2019 / Published online: 16 January 2019

Abstract

Introduction Elbow dislocation can lead to instability and stiffness of the elbow. The main goal of this study was to list the initial elbow ligaments injuries caused by simple posterolateral elbow dislocations. The secondary goals were to assess ligament healing 2 months after the initial dislocation, to research a correlation between ligaments injuries and clinical course, and to search for predictive factors of instability.

Patients and methods Patients who had simple posterolateral elbow dislocation for the first time between January 2015 and May 2016 were included. Each patient had an MRI scan of their traumatised elbow on the day of the dislocation and then again 2 months later. The assessment was performed thanks to a clinical examination and calculation of functional recovery scores. The Mann–Whitney *U* test was used to research a correlation between the healing of ligaments injuries and clinical course.

Results Twenty-five patients were included in the study. The initial MRI scans showed 70% and 54% ligament rupture, respectively, for the anterior band (ant MCL) and the posterior band (post MCL) of the medial collateral ligament (MCL), as well as 79% for the ulnar (ULCL) and 50% for the radial (RLCL) lateral collateral ligaments. The healing rate 2 months after dislocation was fairly low from 18% for the ULCL up to 41% for the anterior band of the MCL. No correlation was found between the ligament healing noticeable on MRI scans and clinical course. No elbow instability was diagnosed during the 4-month follow-up.

Conclusion Elbow dislocation is particularly damaging for ligaments. There is no predominance on medial or lateral ligament for rupture. The low healing rate 2 months after the initial dislocation could be explained by performing a follow-up MRI scan too early.

Keywords Elbow · Dislocation · Ligaments · Instability

Introduction

Elbow dislocations are fairly rare with a 6.1/100,000 per year incidence rate [1] concerning especially men of the second decade [2]. There are two types of dislocations: simple dislocations and complex ones which are made of one or multiple associated fractures [3], respectively, in 74% and 26% of the cases. Studies of simple elbow dislocations and their complications, such as posterolateral rotatory instability [4], have been conducted.

So far no prospective study has ever classified systematically ligament injuries caused by these dislocations via MRI data, but these lesions have been studied retrospectively [5, 6]. The main goal of this study was to list the initial elbow ligaments injuries caused by simple posterolateral elbow dislocations via MRI data. The secondary goals were to assess ligament healing 2 months after the initial dislocation, to research a correlation between ligaments injuries and clinical course, and to search for instability predictive factors at medium and long term. Finally, based on many reports about elbow dislocations arising from initial acute valgus load, we

✉ Eric Abehsera
eric.abehsera@hotmail.fr

1 Service de Chirurgie Orthopédique et Traumatologique, CHRU de Lille, Avenue du Professeur Emile Laine, Lille, France

2 Service d'Orthopédie B, Chirurgie de la Main et Membre Supérieur, CHRU de Lille, Avenue du Professeur Emile Laine, Lille, France

3 Service d'Imagerie de l'Appareil Locomoteur, CHRU de Lille, Avenue du Professeur Emile Laine, Lille, France

hypothesised that every patients could have a high-grade medial injury but without necessarily any associated injury of the lateral ligaments.

Methods

A prospective, epidemiological, observational, monocentre study was conducted.

(1) Clinical aspects

The reduction was performed on the day of the dislocation by the senior surgeon on call through external handling via a plexus nerve block. Then, elbow-testing was carried in extension and supination, or pronation in case of redislocation. Finally, we assessed valgus and varus ligament laxity. The patient's elbow was immobilised with a brachio-antebrachio-palmar plaster cast for 3 weeks. Each patient had a follow-up consultation at 1 and 3 weeks after the initial dislocation. A clinical examination was performed at 2 and 4 months after the initial dislocation. Calculations of two scores, Quick Disabilities of the Arm, Shoulder and Hand (QDASH) [7] and Mayo Elbow Performance Scores (MEPS) [8], were performed at 2 and 4 months. Clinical assessment of elbow instability was undertaken with the same method:

- Searching for signs of pain, apprehension, trigger ligament
- Valgus and varus laxity assessment
- Searching for a rotary instability via the "pivot-shift test" or via the "chair sign test" starting from 2 months after the initial dislocation
- Range of motion measurements in order to search for joint stiffness.

Finally, we conducted a telephone survey of all patients to obtain data after a long period since the initial dislocation. Patients were asked to give information about returning to work, resuming sports activities and persistent symptoms. The Mann–Whitney *U* nonparametric test was used to research a correlation between the ligament injuries healing and clinical course at 4 months. Any clinical signs of posterolateral elbow rotatory instability were also researched 2 and 4 months after the initial dislocation via the Wilcoxon signed-rank test.

(2) Radiological aspects

The initial X-rays were performed before and after reduction, and each patient had an MRI scan of their traumatised elbow on the day of the dislocation after reduction and under plexus nerve block and then again 2 months later. Each patient gave his oral consent after reduction for our follow-up protocol. The position of the elbow in the MRI scanner was from − 30° to − 10° of extension.

The MRI scan of the elbow provided an early ligament check-up. The device used was a General Electric ® 1.5 Tesla extremity MRI. T1, T2 and T2 fat saturation sequences were systematically performed. The MRI resolution enabled ligaments injuries to be classified regarding their localisations [9] (Figs. 1, 2, 3, 4):

- medial collateral ligament (MCL): anterior band (ant MCL), and posterior band (post MCL)
- lateral collateral ligament (LCL), radial band (RLCL), ulnar band (ULCL), annular ligament.

All of the MRI scan reports were performed by the same osteoarticular radiologist who did not get any information about the clinical examinations of the elbows. As there was

Fig. 1 Radial band of lateral collateral ligament, lateral view

Fig. 2 Ulnar band of lateral collateral ligament, lateral view

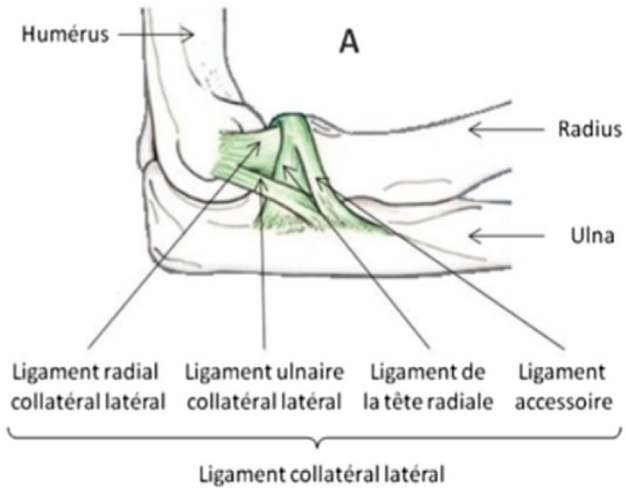

Fig. 3 Drawing of lateral collateral ligament (P. Laronde), Ligament collatéral latéral = lateral collateral ligament, Ligament radial collatéral latéral = radial band of lateral collateral ligament, Ligament ulnaire collatéral lateral = ulnar band of lateral collateral ligament, Ligament de la tête radiale = annular ligament, Ligament accessoire = accessory ligament

not any specific classification for elbow ligaments injuries, these were graded as usually by our university hospital osteoarticular team via a classification derived from knee ligaments injuries [10]:

- Stage 1: periligamentous infiltration, continuous ligament (Fig. 5)
- Stage 2: intra- and periligamentous infiltration, continuous ligament (Fig. 6)
- Grade 3: tearing of the ligament

  → a: partial (Fig. 7)
  → b: complete (Fig. 8)

Fig. 4 Radial band of lateral collateral ligament

(3) Statistical analysis

Two months after the initial dislocation, we assessed ligament healing in order to classify it on a binary mode: «healed» or «not healed». Criteria were defined with the osteoarticular radiologists team. Ligaments were considered to be healed if they at least regained a partial continuity after rupture or if they regained their full continuity after partial tearing. In the other cases, ligaments were reported as «not healed».

Results

Patients who had simple acute posterolateral elbow dislocation for the first time between January 2015 and May 2016 were included. Non-included patients were minors,

Fig. 5 RLCL injury, stage 1

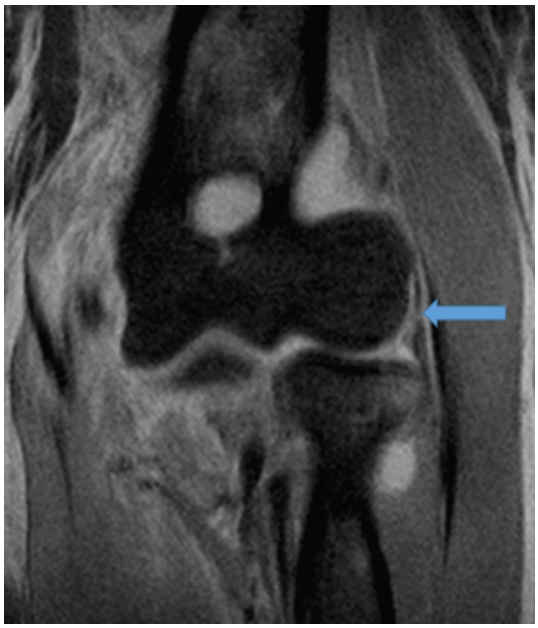

Fig. 7 RLCL injury, stage 3a

Fig. 6 Ant MCL injury, stage 2

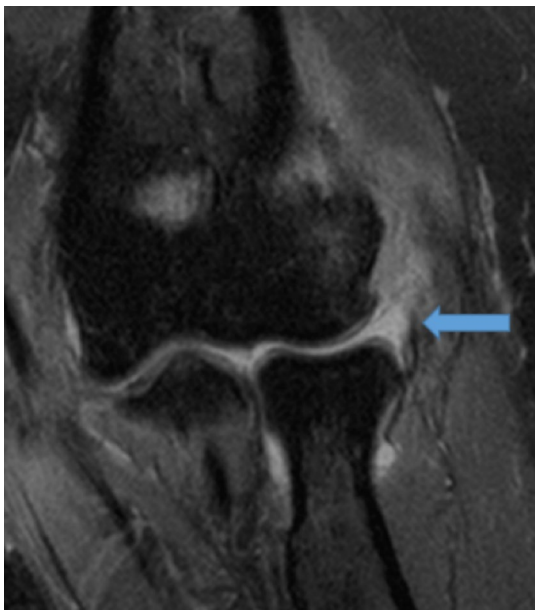

Fig. 8 RLCL injury, stage 3b

polytaumatised and those who had a type of fracture needing any specific surgical or orthopaedic treatment. From January 2015 to May 2016, 25 patients were included in the study. There were 17 men (68%) and 8 women (32%), aged from 18 to 62 years old.

The mean age was 38.4 (SD 11.7). The elbow dislocation occurred on the dominant hand side in 14 cases (56%). Four patients were lost to follow-up, but they all had an MRI scan on the day of the trauma. The patients' follow-up is shown in Fig. 9.

After reduction, most of the patients showed signs of valgus laxity (72%) during the clinical assessment of the elbow. Some showed signs of posterolateral instability (64%) when an axial valgus-supination constriction was

performed. One patient had his elbow redislocated in a range of motion starting from − 30° of extension.

The clinical scores results such as range of motion, QDASH and MEPS are reported in Tables 1 and 2. The clinical result of MEPS at 4 months was excellent (MEPS > 90) for 16 patients, good (MEPS = 75–89) for 4 patients and middle (MEPS = 60–74) for 1 patient.

After a 14.7 months (5 months SD) period of time, we reported on the last telephone survey:

- A 47-day mean for returning to work, a 117-day mean for resuming sports activities
- Two patients with similar symptoms to posterolateral rotatory elbow instability.

Table 1 Loss of range of motion (in °) in comparison with the contralateral side at 3 weeks, 2 months, 4 months

	3 weeks	2 months	4 months
Flexion	39° (12°) (20°–50°)	22° (20°) (0°–50°)	10° (14°) (0°–50°)
Extension	40° (15°) (5°–70°)	11° (15°) (0°–50°)	5° (8°) (0°–35°)
Pronation	14° (13°) (0°–50°)	3° (8°) (0°–20°)	0° (0°–10°)
Supination	19° (18°) (0°–55°)	1° (4°) (0°–15°)	2° (5°) (0°–20°)

One of them described "true sensations of dislocation", and the other one reported "subjective elbow instability sensations". Only one of the two patients attended the follow-up

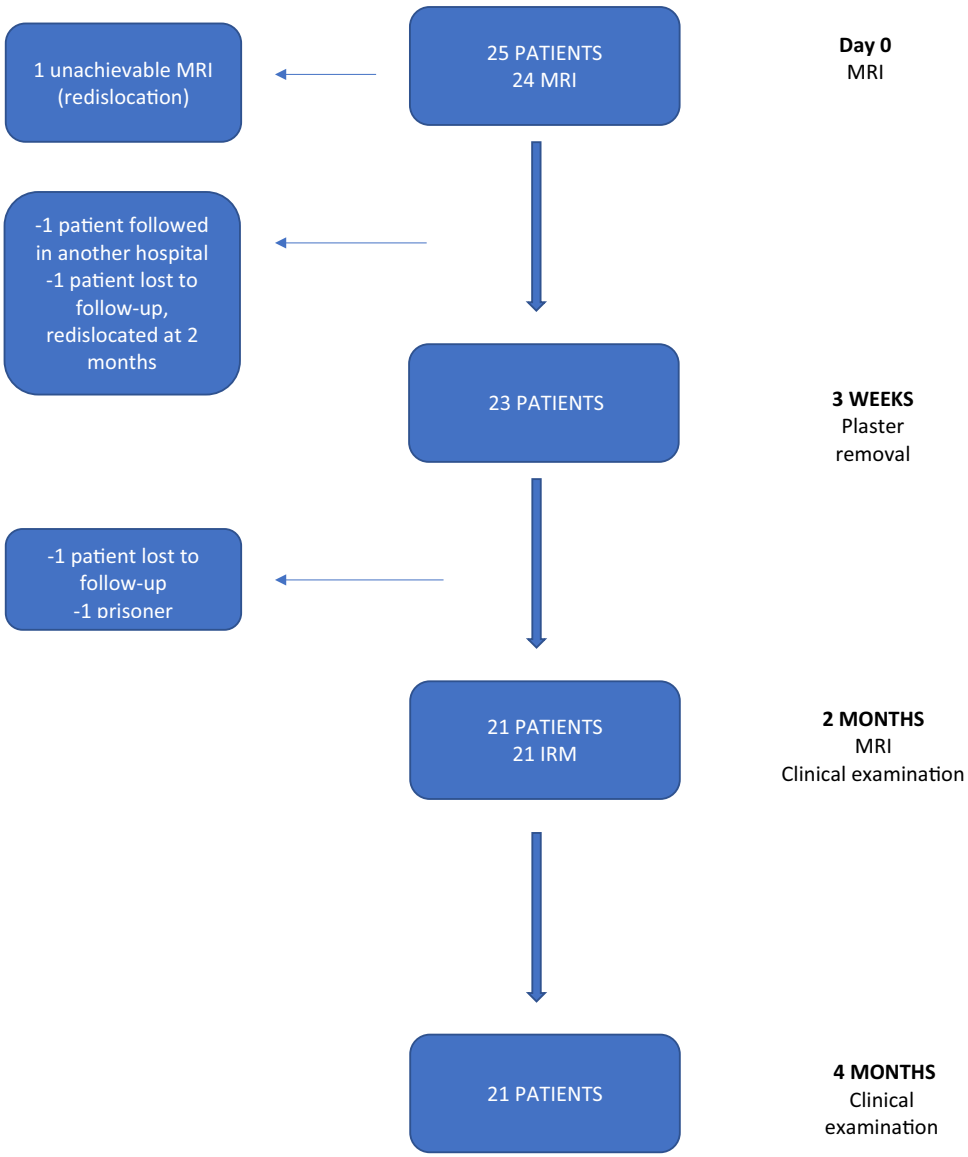

Fig. 9 Patients follow-up

Table 2 QDASH and MEPS scores at 2 and 4 months

QDASH 2 months	QDASH 4 months	MEPS 2 months	MEPS 4 months
24 (11) (7–50)	9 (7) (0–23)	83 (10) (60–100)	96 (6) (70–100)

Table 4 MRI scans analysis after 2 months of ligament healing

	LCM		LCL		
	Ant LCM	Post LCM	RLCL	ULCL	Ann Lig
Healed	7 (41%)	6 (30%)	4 (24%)	4 (19%)	3 (50%)
Not healed	10 (59%)	14 (70%)	13 (76%)	18 (81%)	3 (50%)

consultation. Faced with obvious signs of instability including a positive lateral pivot-shift test associated with MRI scans showing lack of healing of the ULCL, a ligamentoplasty was performed 2 months afterwards. This surgical procedure managed to stabilise the elbow joint.

The results of the initial ligament injuries visible on the MRI scans are reported in Table 3. The rate of complete tear of ligaments was fairly high, occurring mainly on the ant MCL (70%) and the ULCL (79%). The number of ligaments per elbow which had a complete tear of their bands was 4 for 6 patients (25%), 3 for 8 patients (33%), 2 for 8 patients (33%), 1 for 1 patient (4%) and 0 for 1 patient (4%). A low number of ligament injuries had healed within 2 months (Table 4): from 19% (ULCL) to 41% (ant MCL). Regarding clinical course, we reported one case of redislocation which occurred in a patient who initially had elbow instability starting from −20 to −30 degrees of extension. An external fixator was fitted to ensure stronger immobilisation. Twenty-one patients had a follow-up consultation at 2 and 4 months. No signs of posterolateral rotatory elbow instability were reported.

Regarding complications, three patients had paraesthesia in the ulnar nerve area, although this had disappeared by the 3-week follow-up consultation. One patient had paraesthesia in the median nerve area up to the second month of the follow-up. One case of elbow instability leading to redislocation occurred 1 week after the initial dislocation and had to be treated by an external fixator. One patient underwent a type 2 complex regional pain syndrome which was diagnosed after 4 months of follow-up. One patient had a severe stiffness of the elbow which required an arthrolysis 5 months after the initial dislocation.

We searched for a correlation between ligament healing visible on MRI scans and better clinical course. Patients were organised into two groups: the first with no healed ligament bands and the second with at least one healed ligament band. The assessment was performed on the range of motion via QDASH and MEPS, 4 months after the initial dislocation. No significant difference was found between the two groups.

Table 3 Initial ligaments injuries check-up via MRI scans

	MCL		LCL		
	Ant MCL	Post MCL	RLCL	ULCL	Ann Lig
Stage 1			1 (4%)		12 (50%)
Stage 2	4 (17%)	1 (4%)	4 (17%)		6 (25%)
Stage 3a	3 (13%)	10 (42%)	7 (29%)	5 (21%)	1 (4%)
Stage 3b	17 (70%)	13 (54%)	12 (50%)	19 (79%)	5 (21%)

Discussion

We reported a high percentage of ligament injuries, especially for ULCL and ant MCL. It is particularly interesting to note that in our study ULCL is the ligament with the higher rate of complete tear. At first glance, we could possibly think that the lateral side is simply the first one to tear in the process. But it seems actually to be in favour of the O'Driscoll model in which tearing of the ULCL, which often occurs after elbow dislocation, is responsible of posterolateral rotatory instability. A recent study [11] even highlighted that posterolateral rotatory instability only occurred when two lesions were associated: ULCL and posterior band of MCL. MRI remains the gold standard imaging for this type of ligament injury [12, 13]. The main innovation of this study was to perform a systematic imaging check-up immediately after elbow dislocation and then 2 months later. It was the first prospective study ever conducted on this matter. Rhyou et al. [5] analysed MRI scans from 15 patients with injuries caused by elbow dislocations. Injuries were reported from ulnar to radial areas. Ulnar tissues were more frequently injured. It was a retrospective analysis about patients who had elbow dislocations over the 6 years prior to the study. No data were provided about the indications for MRI scans. Without any standard protocol to follow regarding clinical indications for medical imaging, it calls into question the relevance of the MRI scans which were performed. The time period between the dislocation and the imaging was also unreported. We can make the same comments about Schreiber et al. [6] study which analysed 16 MRI scans of simple posterior dislocations. In our study, there was no significant difference between the number of complete tear of ligament bands in between the medial and lateral planes. No specific types of injury were found. However, our results differ from those of the two studies previously quoted as they both reported more frequent injuries in the ulnar area. This high rate of ULCL ruptures may indicate that ruptures

happen first on this type of ligament via a possible external rotative-axial constriction-valgus mechanism pattern.

The ligament healing rate at 2 months was particularly low. In 2016, Walper et al. [14] conducted a study which analysed the healing of MCL after surgical treatment by radial head prosthesis. Their period for analysis was longer with a mean of 76 months. The healing rate was 87% which is much higher than in our study. Based on these results, it seems that clinical healing and radiological features of healing are not synchronous. As no posterolateral rotatory instability and valgus instability were reported in our cases, we can say that there was a successful ligament healing process. A 2-month period prior to the medical imaging follow-up seems too short to observe a clear image of ligamentous continuity. The fibrous callus which builds up into the gap made by the ligament rupture is difficult to spot on MRI scans. The ligamentous continuity image seems to appear later. Therefore, it would be beneficial to perform MRI scans in a later period in order to assess the healing process of each ligament band again. The period of analysis attributed to our study may have been too short.

The clinical course was satisfactory in comparison with literature data, regarding huge case series such as De Haan one [15] reporting on eight studies [1, 3, 16–21], and the 2015 Iordens one [22] reporting, respectively, on 86 and 100 patients.

The time to return to work was 47 days. Literature data reported a return to work time from 8 days [22] to 3 weeks [20] after functional treatment. After orthopaedic treatment, it reported a return to work time from 3 weeks [22] up to 7 weeks [20]. However, the 2015 Iordens et al. study [22] reported no significant difference between both treatments about recovery when assessed 1 year after the initial dislocation.

Few studies have analysed the incidence of elbow instabilities as a consequence of dislocations. In the telephone survey, two patients reported potential clinical signs of posterolateral rotatory instability despite a favourable clinical course, and one of them was diagnosed with clinical signs of elbow instability. However, these results were not significant enough to search for instability predictive factors. In 2015, Hackl et al. [23] showed MRI posterolateral rotatory instability signs criteria: a 1.2-mm radio-humeral joint incongruence in the sagittal plane and a 0.7-mm ulnar-humeral incongruence in the axial plane (posterior subluxation). This result was interesting as it is complicated to diagnose such conditions. When associated with a clinical examination, a broader MRI analysis of our data could lead to the diagnosis of more complications, especially as some cases of elbow instabilities occurred in our study.

To conclude, the main strength of our study is to be found in its prospective aspect. Indeed, for the first time ever, elbow ligament injuries due to dislocations have been systematically listed via high-performance imaging. However, the MRI scans analysis of acute elbow ligament injuries occurring on the day of the dislocation can be difficult to perform. The accuracy of the diagnosis is variable as it depends on the osteoarticular radiologist's experience [24]. Moreover, the duration of the time period before checking up the ligament healing might have been too short. The features of the population of our study were satisfactory as the matter was about a rare pathology. However, the statistical power of our study could have been higher if we had a bigger number of patients.

Conclusion

This study is the only one to classify on a prospective and systematic way ligament injuries using medical imaging. Contrary to the literature data, we did not find any significant ligament injuries specific to the medial plane. For this reason, we have reassessed the lesional sequence which has been known so far to occur from the medial plane to the lateral plane. We reported a low ligament healing rate. The 2-month duration after dislocation in order to assess ligament healing via MRI seems too early. Performing an MRI check-up after a longer duration would enable to rule on a reasonable waiting period before resuming of physical activities.

Acknowledgements We thank Dr Antonin Lereuil for his help in the translation.

Compliance with ethical standards

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

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 Declaration of Helsinki and its later amendments or comparable ethical standards.

References

1. Josefsson PO, Nilsson BE (1986) Incidence of elbow dislocation. Acta Orthop Scand 57(6):537–538
2. Robinson PM, Griffiths E, Watts AC (2017) Simple elbow dislocation. Shoulder Elbow 9(3):195–204
3. Hildebrand KA, Patterson SD, King GJ (1999) Acute elbow dislocations: simple and complex. Orthop Clin North Am 30(1):63–79
4. O'Driscoll SW, Bell DF, Morrey BF (1991) Posterolateral rotatory instability of the elbow. J Bone Joint Surg Am 73(3):440–446
5. Rhyou IH, Kim YS (2012) New mechanism of the posterior elbow dislocation. Knee Surg Sports Traumatol Arthrosc 20(12):2535–2541

6. Schreiber JJ, Potter HG, Warren RF, Hotchkiss RN, Daluiski A (2014) Magnetic resonance imaging findings in acute elbow dislocation: insight into mechanism. J Hand Surg 39(2):199–205
7. Hudak PL, Amadio PC, Bombardier C (1996) Development of an upper extremity outcome measure: the DASH (disabilities of the arm, shoulder and hand). The Upper Extremity Collaborative Group (UECG). Am J Ind Med 29(6):602–608
8. Morrey BF, An KN, Chao EYS (1993) Functional evaluation of the elbow. In: Morrey BF (ed) The elbow and its disorders, 2nd edn. WB Saunders Co, Philadelphia, p 95
9. Guerre E, Laronde P, Cussonneau J, Fontaine C, Wavreille G (2016) Experimental determination of the elbow's center of rotation using the VICON™ optoelectronic motion capture system. Surg Radiol Anat 38(4):395–401
10. Schweitzer ME, Tran D, Deely DM, Hume EL (1995) Medial collateral ligament injuries: evaluation of multiple signs, prevalence and location of associated bone bruises, and assessment with MR imaging. Radiology 194(3):825–829
11. Hwang J-T, Shields MN, Berglund LJ, Hooke AW, Fitzsimmons JS, O'Driscoll SW (2018) The role of the posterior bundle of the medial collateral ligament in posteromedial rotatory instability of the elbow. Bone Joint J 100-B(8):1060–1065
12. Janßen R, Falkowski AL, Hirschmann A (2018) Assessment of ligament and tendon injuries of the elbow using magnetic resonance imaging. Radiologe 58(11):996–1003
13. Kaplan LJ, Potter HG (2006) MR imaging of ligament injuries to the elbow. Radiol Clin North Am 44(4):583–594, ix
14. Wapler C, Fontaine C, Mesnil P, Chantelot C (2016) Medial collateral ligament healing after posttraumatic radial head arthroplasty: a retrospective study of 33 cases with a mean follow-up of 73 months. Hand Surg Rehabilit 35(1):44–50
15. de Haan J, Schep NWL, Zengerink I, van Buijtenen J, Tuinebreijer WE, den Hartog D (2010) Dislocation of the elbow: a retrospective multicentre study of 86 patients. Open Orthop J 4:76–79
16. Josefsson PO, Johnell O, Gentz CF (1984) Long-term sequelae of simple dislocation of the elbow. J Bone Joint Surg Am 66(6):927–930
17. Conn J, Wade PA (1961) Injuries of the elbow: a ten year review. J Trauma Acute Care Surg 1(3):248–268
18. Royle SG (1991) Posterior dislocation of the elbow. Clin Orthop Relat Res 269:201–204
19. Josefsson PO, Gentz CF, Johnell O, Wendeberg B (1987) Surgical versus non-surgical treatment of ligamentous injuries following dislocation of the elbow joint. A prospective randomized study. J Bone Joint Surg Am 69(4):605–608
20. Rafai M, Largab A, Cohen D, Trafeh M (1999) Pure posterior luxation of the elbow in adults: immobilization or early mobilization. A randomized prospective study of 50 cases. Chir Main 18(4):272–278
21. Maripuri SN, Debnath UK, Rao P, Mohanty K (2007) Simple elbow dislocation among adults: a comparative study of two different methods of treatment. Injury 38(11):1254–1258
22. Iordens GIT, Van Lieshout EMM, Schep NWL, De Haan J, Tuinebreijer WE, Eygendaal D et al (2015) Early mobilisation versus plaster immobilisation of simple elbow dislocations: results of the FuncSiE multicentre randomised clinical trial. Br J Sports Med 51(6):531–538
23. Hackl M, Wegmann K, Ries C, Leschinger T, Burkhart KJ, Müller LP (2015) Reliability of magnetic resonance imaging signs of posterolateral rotatory instability of the elbow. J Hand Surg Am 40(7):1428–1433
24. Schnetzke M, Schüler S, Hoffend J, Simon R, Keil H, Porschke F et al (2017) Interobserver and intraobserver agreement of ligamentous injuries on conventional MRI after simple elbow dislocation. BMC Musculoskelet Disord 18(1):85