

Monteggia-like lesions: preliminary reports and mid-term results of a single center

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Summary. *Background and aim of the work:* Monteggia-like lesions are complex and rare elbow injuries. A detailed classification and a proper surgical treatment can provide quite good functional and radiological outcomes. The aim of this retrospective study was to evaluate the mid-term results of Monteggia-like lesions surgical treatment. The other purpose was to investigate whether the complexity of ulna and radius fractures could be prognostic factors of insufficient functional results. *Methods:* Seven women and five men, with a mean age of 59,25 years who had sustained a Monteggia-like lesion were followed up clinically and radiologically after surgical treatment. The Mayo Elbow Performance Score (MEPS) and the Quick Disabilities of the Arm, Shoulder and Hand (QUICK-DASH) score were used for evaluation at a mean of 17,5 months postoperatively (12-26). The range of movement (ROM), patients' satisfaction and neurological symptoms were also investigated. Osteolysis, implant loosening and heterotopic ossification were graded. Pearson's test was used to correlate the different classification systems used (AO/OTA, Bado and Jupiter, PURCCS, Mason) with MEPS and QUICK-DASH score. *Results:* The mean MEPS was 84,92 (65 to 100). The mean QUICK-DASH score was 18,75 (0 to 34,1). The mean active pronation and supination was 72,5° and 59,17°, respectively. The mean active ROM of the elbow was 101,43°. Heterotopic ossifications were absent in six cases but were found in six. No statistically significant correlation was found between the analyzed variables. *Conclusions:* Quite good functional results can be obtained in Monteggia-like lesions if injury pattern is recognized and each component of the injury is addressed. Further studies are needed to determine any prognostic factors. (www.actabiomedica.it)

Keywords: Monteggia-like; complex elbow fractures; outcomes; surgical treatment

1. Introduction

Monteggia-like lesions, also known as Monteggia variant or Monteggia equivalent, are considered to be part of elbow complex instability patterns [1-3]. These are challenging and rare injuries, in fact they represent only the 1-2% of all traumatic elbow injuries and the 2-5% of all proximal forearm fractures [4, 5]. These lesions are composed by different elementary injuries

such as proximal ulnar fracture, radial fracture, ulno-humeral dislocation, radio-ulnar dislocation, proximal radio-ulnar dislocation, distal radio-ulnar dislocation and interosseous membrane (IOM) lesion [6]. The most frequent association is proximal ulnar fracture and radial head fracture-dislocation [3,6]. Similarly to Monteggia lesions, they occur after a high energy trauma such as a direct posterior or anterior blow to the elbow or a fall on an outstretched arm with the hand

hyperpronated [3]. Bado and Jupiter classified Monteggia lesions, nevertheless these classifications are not exhaustive in describing Monteggia-like lesions [7,8]. The most functional and complete available classification is the Proximal Ulnar and Radial fracture-dislocation Comprehensive Classification System (PURCCS) elaborated in 2011 by Giannicola et al. [9]. Monteggia-like lesions need a precise diagnostic study and meticulous pre-operative planning. The aim of the surgical treatment is to obtain a stable fixation so that an early rehabilitation program can be started; also, a stable joint with painless and functional range of motion (ROM) is an important goal [3].

Few studies regarding the treatment of these injuries and their functional outcomes are available and this is still a topic of debate [5, 10-11].

The aim of this retrospective study was to evaluate the mid-term results of the operative treatment of patients with Monteggia-like lesion and to investigate if there are any prognostic factors that may influence the functional and radiological outcomes at mid-term follow-up. We hypothesized that the available classification systems of these lesions could not be a useful prognostic tool.

2. Patients and Methods

2.1 Patients

This retrospective study without control group was approved by the Scientific and Ethics local review board (n° 33610 - 05/09/2018). This study has been performed according to the Declaration of Helsinki.

Between June 2015 and December 2018, twelve patients with Monteggia-like lesion were treated in the Department of Trauma and Orthopaedics at our institution. The inclusion criteria for this study were: adult patients, who underwent surgery for Monteggia-like lesions and a 12 months minimum follow-up. All the epidemiological data are exposed in Table 1. There were not any open fractures or neurological deficit at the admission time.

2.2 Methods

All patients underwent routine pre-operative assessment, which included plain radiographs and CT scanning. All the ulnar fractures were classified according to AO/OTA [12], Bado and Jupiter classifications and PURCCS [6, 7, 13]. Radial head fractures were classified according to Mason classification modified by Broberg and Morrey (1986) as shown in Table 1 [14].

The same surgeon performed all the surgeries. The chosen surgical approach for each patient is reported in Table 2. A posterior pre-counteracted locked-angle 3.5 mm plate, hand-counteracted reconstruction plate or a straight plate (LC-DCP) was used to fix the ulna. Specific fixation techniques for coronoid fractures are radial head are reported in Table 2.

If collateral ligaments were torn then suture anchors were used to repair them. Annular ligament was also repaired with a direct suture in all cases of radial head internal fixation. Since at the end of the surgery all the elbows were stable, no external fixator was needed.

Postoperatively, the arm was immobilized in an above elbow cast for two weeks to facilitate wound healing then passive motion could start. Indomethacin was administered 25 mg three times a day for 3 weeks to prevent heterotopic ossification [15,16]. Radiographs were performed at one and three months post-operatively as routine controls. The last x-ray control was performed at minimum of twelve months post-operatively.

The same examiner performed a clinical evaluation for all the patients. The function of the elbow was assessed using the Mayo Elbow Performance Score (MEPS) and the Quick Disabilities of the Arm, Shoulder and Hand (QUICK-DASH) score. The range of movement of the operated elbow was measured using a goniometer. The patients were also questioned about satisfaction and neurological symptoms. Antero-posterior and lateral plain radiographs of the affected elbow were performed in all patients at follow-up. A bridging bone on antero-posterior and

Table 1. Demographics, classification of lesions and mechanism of injury

Pt	Sex	Age	Side	Dominant arm	Radial Head Fracture (Mason)	Ulna Fracture (AO/OTA)	Ulna Fracture (Bado & Jupiter)	Coronoid fracture (O'Driscoll/Regan-Morrey)	PURCCS
1	F	75	Left	No	1	2U1C3	2A	Basal 2	3BIIICIII
2	F	68	Left	No	3	2U1B1	2B	Basal 1	4BIIICIII
3	F	74	Left	No	3	2U1A2	2B	Basal 2	3BIIICIII
4	M	58	Right	Yes	3	2U1A3	2B	/	3BIIICIII
5	M	36	Left	No	2	2U1A3	2B	Basal 2	3BIIICI
6	F	66	Left	No	3	2U1A3	2B	/	2BIIICI
7	M	58	Left	No	3	2U1C3	2A	Basal 2	6BICIII
8	M	56	Left	No	1	2U2B	2C	/	2BIIICIE
9	F	75	Left	No	2	2U1A3	2D	/	4BIIICI
10	F	53	Left	No	4	2U1A3	2C	/	3BIIICIII
11	F	58	Left	No	4	2U1C3	2A	Basal 2	4BIIICIE
12	M	34	Right	Yes	1	2U1C3	2D	Basal 2	4BICI

lateral radiographs defined fracture healing. Osteolysis and implant loosening were evaluated using Morrey's criteria [17]. Heterotopic ossifications were graded according to Hastings and Graham' classification [16].

Statistical Analysis

Pearson's test was used to correlate the different classification systems used for ulnar fractures (AO/OTA, Bado and Jupiter, PURCCS) and radial fractures (Mason) with MEPS and QUICK-DASH score. The aim of the statistical analysis was to investigate if there were any relationships between the initial severity of the injury and the final outcomes. In particular we wanted to analyze if the presence and the severity of a specific fracture (radial head, coronoid, proximal ulna) could be a prognostic index therefore if any available classification system could be a prognostic tool.

It was considered significant for $P < 0,05$; the SPSS 25.0 software (IBM, Amork, NY) was used for statistical analysis.

Results

The mean follow-up was 17,5 months (12 to 26). All the fractures healed. At final follow-up, the mean MEPS was 84,92 (65 to 100), the mean QUICK-DASH score was 18,75 (0 to 34,1). The mean active pronation and supination of the forearm was 72,5° and 59,17° respectively. The mean active flexion of the elbow was from 124,58° flexion (100° to 140°) to -17,41° extension (0° to -45°). The mean active arc of movement of the elbow was 101,43°; the mean passive ROM was 106,14°.

All the elbows were stable and patients reported none or mild pain at rest or during daily activities. Only two patients complained tingle or numbness of the ulnar nerve. Osteolysis and heterotopic ossification are reported in Table 3 (Fig. 1).

We did not find any statistically significant correlation between the variables that we analyzed. In particular we could not recognize any relationship between the initial severity of the injury and the functional outcomes. We could not detect the presence/

Table 2. Surgery details and functional outcome measures

Pt	Access	Radial head Surgery	Ulna Surgery	Coronoid Surgery	Follow-up (months)	Active Arc of motion ° (flexion-extension)	Passive Arc of motion ° (flexion-extension)	Active Pronation °	Active Supination °	MEPS	QUICK-DASH
1	Posterior access + Taylor sham	Asportation of small fragments	Olecranon plate + lag screw	Small T plate + 2,4 mm screws	19	110 - 20	110 - 20	90	80	90	29.5
2	Posterior + kocher interval	Prosthesis	Olecranon plate + 2 lag screws	/	26	135 - 5	140 - 0	90	90	85	9.1
3	Posterior + kocher interval	Prosthesis	Olecranon plate + lag screw	/	18	130 - 12	130 - 15	60	85	85	2.3
4	Posterior + kocher interval	Prosthesis	Olecranon plate + lag screws + k wire	/	18	140 - 45	140 - 45	10	5	95	27.3
5	Boyd	2 screws	Olecranon plate + lag screw	Lag screws + K wire	15	100 - 35	105 - 30	40	10	65	16
6	Posterior + kocher interval	Resection	Recon plate + lag screw	Lag screw through plate	12	140 0	140 - 0	90	90	100	0
7	Posterior + kocher interval	Prosthesis	Olecranon plate + lag screws	Headless screw 18 mm + plate	21	105 - 30	110 - 25	90	5	70	34.1

Pt	Access	Radial head Surgery	Ulna Surgery	Coronoid Surgery	Follow-up (months)	Active Arc of motion ° (flexion-extension)	Passive Arc of motion ° (flexion-extension)	Active Pronation °	Active Supination °	MEPS	QUICK-DASH
1	Posterior access + Taylor sham	Asportation of small fragments	Olecranon plate + lag screw	Small T plate + 2,4 mm screws	19	110 - 20	110 - 20	90	80	90	29.5
2	Posterior + kocher interval	Prosthesis	Olecranon plate + 2 lag screws	/	26	135 - 5	140 - 0	90	90	85	9.1
8	Posterior + kocher interval	Asportation of small fragments	Plate	/	24	125 - 25	125 - 25	40	70	85	11.4
9	Posterior + kocher interval	1 screw	Olecranon plate + 2 lag screws	/	12	140 - 0	140 - 0	90	90	100	0
10	Posterior + kocher interval	Prosthesis	Olecranon plate + 2 lag screws	/	18	125 0	125 - 0	90	5	70	31.8
11	Posterior	/	Olecranon plate + T plate for sublime tubercle	Lag screws	15	110 - 15	110 - 15	90	90	74	59
12	Posterior access + taylor sham	/	Olecranon plate + T plate for antero-medial facet	Lag screws	12	135 - 22	135 - 22	90	90	100	4.5

Table 3. Osteolysis and heterotopic ossification

Pt	Osteolysis	Heterotopic ossification
1	1	2A
2	3	0
3	0	1
4	0	2C
5	2	2C
6	0	0
7	2	0
8	0	2C
9	0	0
10	2	3B
11	0	2A
12	0	2A

absence of a specific fracture pattern as a prognostic index. Finally, we could not identify a prognostic tool in any of the available classification systems.

Discussion

There are several studies in literature which review classic Monteggia lesion. Over the past the results were unpredictable [4,18,19,20]. Boyd and Boals found out that best results were achieved with rigid internal fixation of the ulna and reduction of the radial head [19]. Since then, better outcomes have been obtained thanks to improved knowledge of the injury mechanism and the need to address associated lesions [8, 21-23].

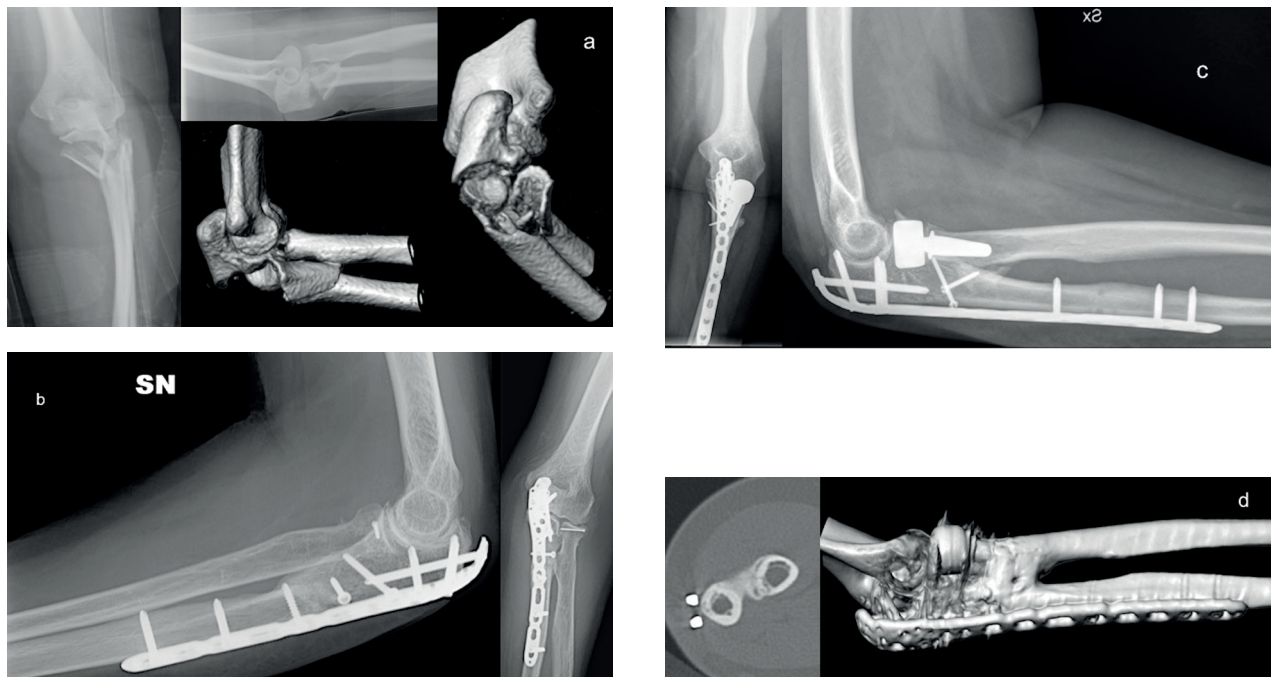


Figure 1. a) Pre-operative radiography and CT scan: complex fracture of the proximal ulna and comminuted radial neck fracture in a 53-year-old woman.

b) Post-operative radiography: global posterior approach and subcutaneous Kocher approach– Pre-contoured locking plate, lag screws and press-fit radial head prosthesis.

c) X-Rays at 4 months post-op.

d) Tc scan at 18 months post-op: proximal radio-ulnar synostosis grade IIIB.

However, other studies show that when this injury is associated with radial head and coronoid fracture the outcomes are poorer [8, 21,22,24, 25]. The unsatisfactory outcomes could be related to the unrecognized pattern of lesion: a multicentric study evaluating Monteggia lesions in adults reported fair results in 60% and complications in 43% of the patients [26]. In contrast, a study by Matar et al. who stressed the importance of a precise diagnose and preoperative planning reported excellent or good results in over 60% of the cases [3].

Few studies regarding specifically Monteggia variant injury have been reported; there is confusion in literature when Monteggia-like term is used [11,27].

In our study we analyzed only Monteggia-like lesions.

The key of a successful treatment is restoring ulnar length, an accurate fixation of coronoid fracture but also addressing the radial head fracture [1, 3, 28].

As some authors suggest, we confirm that it is better to treat ulnar fracture first and then to synthesize or substitute radial head [27, 28]. We do not totally agree with other studies that advice to start by treating radial head and to approach ulna first only in case of severe comminution of radial head, indeed that would give the right size for prosthesis replacement [3, 29, 30].

Coronoid process should be reduced and fixed after ulnar length has been restored [30]. At last, ligaments should be repaired [29,30].

The morphology of ulna fracture influences the choice of treatment: a simple oblique fracture pattern can be treated by a normal tension banding [1, 10], however in case of complex proximal ulna fracture and comminution, it is insufficient [31, 32]. A biomechanical study has recently shown that locked-angle plate construct achieves the highest stability [33]. The dorsal plate acts primarily as a tension band, but also as a buttress function preventing flexion of the fracture site in the presence of a deficient anterior cortex [1, 24].

Many other authors suggest that a posterior pre-contoured or countered plate is the best treatment choice for ulnar proximal fracture [1,5,21,24,29]. In accordance to these authors we treated all but one ulnar fractures with a dorsal pre-contoured plate.

The coronoid process is one the main stabilizers of the elbow and it is necessary to restore ulnohumeral joint and to fixe coronoid fragments to minimize the risk of instability and ulnohumeral arthritis [5, 10, 22,34].

Since a coronoid base fracture involve the sublime tubercle and/or the anteromedial facet, osteosynthesis is also essential to re-establish the biomechanical function of medial collateral ligament [1] (Fig.2).

In our series we approached each coronoid fracture according to the different classification, to provide the most suitable treatment.

We used lag screws inserted through the dorsal plate or independent lag screw as suggested by Laun [5, 27]. In case of big fragments, the osteosynthesis

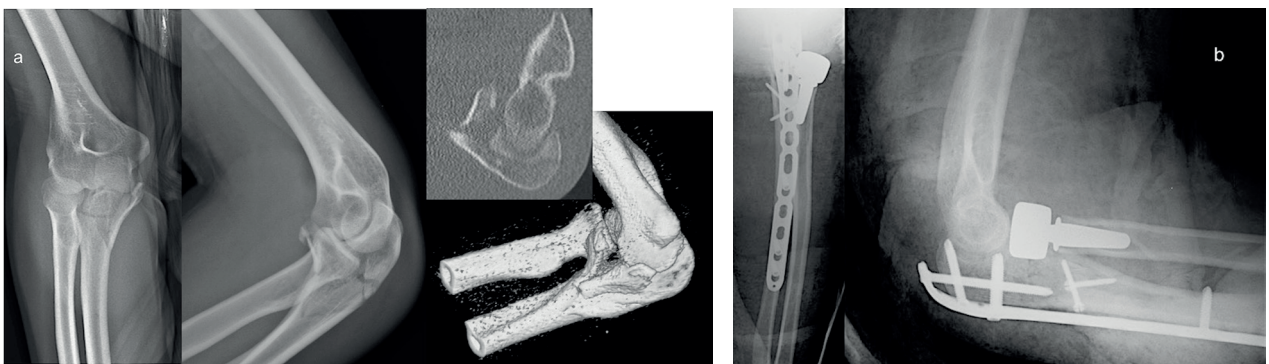


Figure 2. a) Pre-operative radiography and CT scan: complex fracture of the proximal ulna and comminuted coronoid fracture involving the anteromedial facet; small fracture and slight dislocation of radial head in a 34-year old man. b) Surgical field of Taylor-Sham approach and post-operative radiograph: cancellous gap was filled with an autograft cored from olecranon process. Pre-contoured locking compression plate for proximal ulnar fracture, free screws for coronoid process and 2.4 buttress plate for anteromedial facet fracture. Removal of a small fragment and no fixation of the radial head. c) Radiographs at 12 months after surgery: healed fracture; presence of heterotopic ossification grade 2A.

was performed with a second antero-medial plate, whereas if there were too small pieces they were secured with a pull-out technique [3, 27] (Fig. 2). Iliac crest bone graft is recommended for comminuted fractures [22], though we did not need to use it in this case series. Nevertheless, among the selected patients, one had a considerable cancellous bone gap resulting after reconstruction of a complex proximal ulnar fracture: we filled it with autologous bone taken from the removed radial head.

There are controversial opinions regarding radial head treatment. Indeed, Egol found that reconstruction and resection have similar outcomes, Ring had better results with resection rather than reconstruction, whereas Reynders recommended against early resection [21,25,26]. According to Giannicola et al.,

radial head resection is not advisable since it may worsen instability of the forearm. As the tear of the interosseous membrane is frequently associated with this lesion, radial head resection may cause a proximal migration of the radius [1]. Many Authors suggest excision of small fragments in Mason I, open reduction and fixation with mini screws in case of Mason II, prosthesis substitution in case of Mason III/IV radial head fracture [3, 5, 10, 27]. Our radial head treatments are in accordance to these Authors (Fig. 3).

The results of previous studies show that the treatment of fracture-dislocations of the proximal ulna and radius remain a controversial issue. Some studies report worse functional outcomes in Monteggia lesion associated with radial head fracture [13,21,25,35].

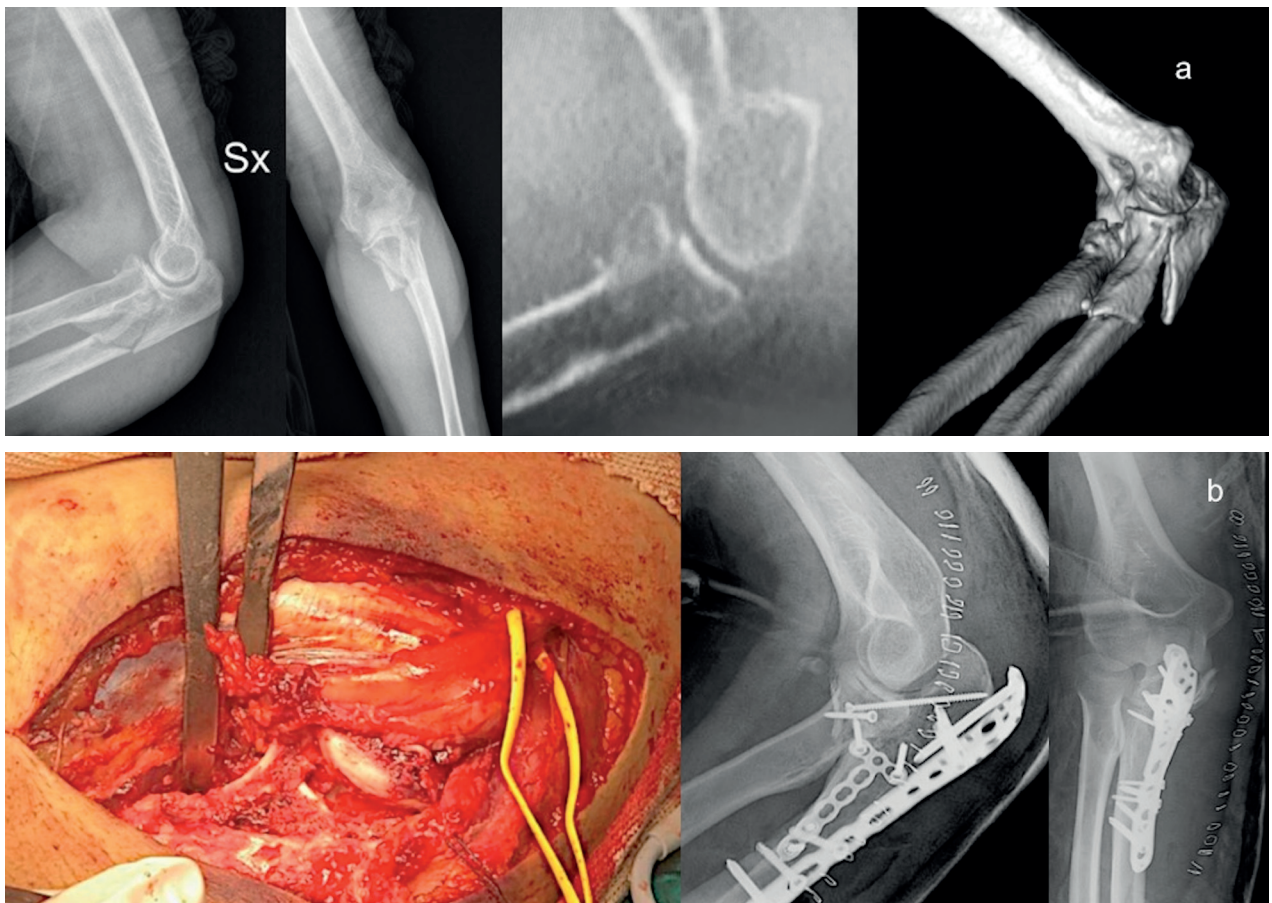


Figure 3. a) Pre-operative radiography and CT scan: complex fracture of the proximal ulna and a Mason type 2 radial head fracture in a 75-year old woman.
b) Radiographs at 12 months after surgery: global posterior approach and subcutaneous Kocher approach – Pre-contoured locking compression plate, free screws and radial head fixation with a 2.0 mm screw.

Nevertheless, these Authors did not analyze them as separate entities.

There are very few studies that analyze Monteggia-like lesion separately [5,9,11]. Laun reports mean MEPS 89.2 mean DASH 20.1 mean pronation 85°, mean supination 75°, mean flexion 9° fixed flexion to 131° [5].

Giannicola et al. used a classification system and algorithm for treatment and found mean DASH 14.9, mean MEPS 91.2. They had 72% excellent results, 20% good which means that their classification system leads to very good outcomes [9]. Also, Jungbluth et al. found good results though only mid-term results were evaluated. They used CT scan to identify radial head or coronoid fracture [11].

We also used CT scan before surgery to identify each component of the lesions and then we surgically approached them, thus obtaining good results: all elbows were stable and had a functional range of motion in most cases, no patient complained about pain at rest, nor during activities.

Nevertheless, our results are on average good, not excellent, especially in terms of residual stiffness and loss of movement, both in flexion-extension and prone-supination.

Above all, the excellent, good and fair results that we obtained do not directly correlate with the severity of the initial trauma.

Therefore, these injuries are associated with unpredictable outcomes, possibly owing to the lack of widely accepted guidelines for classification and treatment.

Indeed, the statistical analysis confirms our hypothesis that nowadays no classification system has a prognostic value. It also confirms the hypothesis that there is no particular fracture pattern that may affect the final clinical outcome.

The main limit of this study is certainly the low number of cases. This is probably due to the rarity of this lesion. It is also a retrospective study, with a short follow up and the included cases are not fully homogeneous. Probably because of these reasons we could not find any statistically correlation between classification systems and functional results. Nevertheless, further studies will be necessary to better understand this issue.

Conclusions

It is mandatory to recognize the injury pattern of a Monteggia-like lesion and address all components of the injury in order to achieve joint stability, early mobilization and good functional results. Further studies with larger patients' population and longer follow up periods are needed to evaluate the long-term effectiveness of these treatment concepts and to find prognostic factors.

Funding Source

This study did not receive any financial support.

Author Contribution: Filippo Calderazzi: Study design, editing the manuscript. Margherita Menozzi: Writing the manuscript, statistics. Alessandro Nosenzo: Data collection, article selection. Cristina Galavotti: Data collection, article selection. Sofia Solinas: Data collection, statistics. Enrico Vaienti: Supervision. Francesco Ceccarelli: Supervision. All authors contributed to and approved the final version of manuscript

Conflicts of Interest: Each author declares that he or she has no commercial associations (e.g. consultancies, stock ownership, equity interest, patent/licensing arrangement etc.) that might pose a conflict of interest in connection with the submitted article

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Received: 19 May 2020

Accepted: 01 June 2020

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