Treatment Outcomes of Simple Elbow Dislocations

A Systematic Review of 1,081 Cases

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Abstract

Background: The treatment of simple elbow dislocations (SEDs) has become more functional last decade with a tendency to shorter immobilization of the elbow, whereas simultaneously, surgical stabilization has been promoted by some authors. The primary aim of this study was to systematically review the literature and analyze the outcomes and complications of different treatment options for acute and persistent SEDs, including operative and nonoperative treatments with varying immobilization periods.

Methods: A literature search was performed based on the online medical databases MEDLINE, Embase, and the Cochrane databases. Articles presenting patients with a SED were eligible for inclusion. When an SED persists for >3 weeks, it is categorized as persistent. Various outcome measures were assessed, including the range of motion (ROM), patient-reported outcome measures, and complication rates. To get insight into the severity of complications, all complications were categorized as minor or major. The Methodological Index for Nonrandomized Studies was used to assess the methodological quality of nonrandomized studies. The risk of bias in the randomized studies was assessed with the Cochrane risk-of-bias tool.

Results: A total of 37 articles were included with 1,081 dislocated elbows (1,078 patients). A fair quality of evidence was seen for the nonrandomized studies and a low risk of bias for the randomized study. Nonoperative treatment was administered to 710 elbows, with 244 elbows treated with early mobilization, 239 with 1- to 3-week immobilization, and 163 with ≥3-week immobilization. These groups showed a ROM flexion-extension arc (ROM F/E) of 137, 129, and 131°, respectively. Surgical treatment as open reduction and ligament repair or reconstruction was performed in 228 elbows and showed a ROM F/E of 128°. All persistent SEDs were treated surgically and showed a ROM F/E of 90°.

Conclusion: The early mobilization treatment showed the most consistent satisfactory outcomes in the literature compared with the other treatment options. Nevertheless, there remains ambiguity regarding which patients would benefit more from surgery than nonoperative treatment.

Level of Evidence: Level IV. See Instructions for Authors for a complete description of levels of evidence.

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The elbow is the second most common dislocated joint after the shoulder joint[1]. An elbow dislocation can be classified as simple or complex. A simple elbow dislocation (SED) is a dislocation without associated fractures[2]. In many SEDs, small avulsions of the medial and/or collateral lateral ligaments or the capsule are seen; these avulsions are not classified as fractures[1]. The elbow dislocation has an incidence of 5 to 6 per 100,000 per year, of which 74% are SEDs[3,4].

The trends concerning the therapy of a SED have changed over time. Previously, nonoperative therapy consisted mainly of immobilization and casting the elbow, with relatively good long-term outcomes[5]. Approximately 8% of patients with SEDs may experience persistent instability after nonoperative treatment or stiffness. The latter led to a focus on short-term immobilization (<7 days) or no immobilization at all, with active movement initiated immediately after closed reduction[6,7]. In addition to nonoperative therapy, there is a trend toward surgical intervention for elbows with gross instability after SED[8]. Optimizing the treatment strategy is important as suboptimal treatment may result in pain, persistent or recurrent instability, stiffness, posttraumatic arthritis, and the need for additional surgical intervention[9].

The primary aim of this study was to systematically review the literature and analyze the outcomes and complications of different treatment options for acute and persistent elbow dislocations (PEDs), including operative and nonoperative treatments with varying immobilization periods. In addition, the secondary aims were to assess the outcomes of PED and SEDs in pediatric patients. By providing a comprehensive overview of the available evidence, this systematic review offers a new perspective on treating SEDs and can assist in shared decision-making regarding treatment options.

Methods

A systematic literature review was conducted according to the Preferred Reporting Items for Systematic Meta-Analyses guidelines[10]. The review was registered in an international prospective register of systematic reviews (PROSPERO). The protocol is registered under the following number CRD42021287756 and can be accessed electronically at http://www.crd.york.ac.uk/prospero.

Literature Search and Study Selection

A literature search was performed with the help of a clinical librarian (S.P.-V.) based on the online medical databases MEDLINE, Embase, and the Cochrane Central Register of Controlled Trials. The search strategy is presented in Appendix 1. Title, abstract, and full-text screening were performed by 2 independent reviewers (C.M.J.M.P. and H.H.d.K.) to identify potentially relevant articles. The authors independently selected articles. Studies were not blinded for author, affiliation, or source. Any disagreements were resolved by a third author (M.P.J.v.d.B.).

Inclusion and Exclusion Criteria

Articles presenting patients with a SED were eligible for inclusion. Patients with an acute or persistent total SED, without associated injuries, preexisting elbow pathology, or previous surgery in the ipsilateral elbow were included. Patients with an isolated radius dislocation were excluded. Studies were included if they were written in English, German, or Dutch; had at least 12 months of follow-up; and reported on a minimum of 5 patients. Studies had to contain at least one of the outcome parameters (patient-reported outcome measures [PROMs], range of motion [ROM], or complications) to be included. Reviews, biomechanical and cadaveric studies, expert opinions, and surgical technique articles were excluded.

Data Extraction

When available, the following baseline parameters were recorded: number of patients and elbows, sex, age, dominant side, and laterality of injury. Furthermore, the following intervention parameters were recorded: type of nonoperative treatment (the type of immobilization, duration of immobilization, and duration of early motion) or surgical treatment (medial collateral ligament repair and/or lateral collateral ligament repair). Relevant outcome parameters included the months of follow-up; pain score measured using the visual analog scale; continuous satisfaction rate; ROM of the elbow in flexion-extension and pronation-supination; Mayo Elbow Performance Score (MEPS); Quick Disabilities of the Arm, Shoulder, and Hand (qDASH) score; rate of return to sport; complications; and information about revision surgery or surgery after initial nonoperative treatment. The MEPS is an elbow outcome score used to test the limitations in the elbow during activities of daily living. A total score between 90 and 100 points can be considered excellent; between 75 and 89 points, good; between 60 and 74 points, fair; and <60 points, poor[11]. The Disabilities of the Arm, Shoulder, and Hand (DASH) score is a well-recognized instrument for measuring upper-limb function and symptoms. The qDASH score represents the disability/symptom score, which includes 11 items from the original DASH's 30 questions. This tool is performing well with strong evidence supporting reliability[12]. Each item of the qDASH has 5 response options (scored 1-5) used to create a summative score ranging from 0 (no disability or symptoms) to 100 (greater disability or symptoms).

Because there were many different options for the duration of immobilization and mobilization, we categorized them under treatment groups. Treatment groups consisted of early mobilization (<7 days), 1- to 3-week immobilization, ≥3-week immobilization, and surgery. The surgery group included 2 subheadings: patients who underwent surgery as their first choice of treatment or after failed nonoperative treatment and patients with PEDs. An

TABLE I Outcomes of Nonoperative Treatment in SED*

Study	Total					Adults				
	No. of Elbows	Mean Age (yr)	Mean Functional Outcome by Study†	Complications, n (%)	Mean Follow-up (mo)	No. of Elbows	Mean Age (yr)	Mean Functional Outcome by Study†	Complications, n (%)	Mean Follow-up (mo)
Early mobilization										
Hopf et al., 2015[19]	22	53.1	MEPS 94.1 qDASH 6.1 ROM F/E 146° ROM P/S 165°	0 (0) minor 3 (4) major	59.6	22	53.1	MEPS 94.1 qDASH 6.1 ROM F/E 146° ROM P/S 165°	0 (0) minor 3 (4) major	59.6
Krticka et al., 2018[20]	28	48	MEPS 97 OES 46.2 qDASH 2.5 ROM F/E 132°	14 (50) minor 0 (0) major	32	28	48	MEPS 97 OES 46.2 qDASH 2.5 ROM F/E 132°	14 (50) minor 0 (0) major	32
Van Lieshout, 2020[18]	48	43	EQ-5D 0.88 OES 93 qDASH 4 SF-36 PCS 53	25 (52) minor 3 (6) major	12	48	43	EQ-5D 0.88 OES 93 qDASH 4 SF-36 PCS 53	25 (52) minor 3 (6) major	12
Schnetzke et al., 2017[8]	68	37.2	MEPS 94.2 ROM F/E 135° Flexion 138° Extension 3° VAS 0.8	0 (0) minor 4 (6) major	40.8	68	37.2	MEPS 94.2 ROM F/E 135° Flexion 138° Extension 3° VAS 0.8	0 (0) minor 4 (6) major	40.8
Beirer et al., 2018[21]	10	44	ESAS 91.8 ROM F/E 140° ROM P/S 176	0 (0) minor 1 (10) major	44	10	44	ESAS 91.8 ROM F/E 140° ROM P/S 176	0 (0) minor 1 (10) major	44
Maripuri et al., 2007[38]	22	41	DASH 2.7 MEPS 96.5	0 (0) minor 0 (0) major						
1-3 wk immobilization										
Ataoglu et al., 2017[22]	14		OES 91 qDASH 5 ROM F/E 118 Flexion 132° Extension 14°	2 (14) minor 0 (0) major	12	14		OES 91 qDASH 5 ROM F/E 118 Flexion 132° Extension 14°	2 (14) minor 0 (0) major	12
Calderazzi et al., 2020[5]	26	43	DASH 12.8 MEPS 93.8	6 (23) minor 0 (0) major	40	26	43	DASH 12.8 MEPS 93.8	6 (23) minor 0 (0) major	40
Maripuri et al., 2007[38]	20	44.4	DASH 7.5 MEPS 90.5	0 (0) minor 1 (2) major						
Cho et al., 2018[23]	3	61.7	MEPS 81.7 qDASH 22 ROM F/E 130° Flexion 133° Extension 3° ROM P/S 146° Pronation 73° Supination 73°	1 (33) minor 0 (0) major	48	3	61.7	MEPS 81.7 qDASH 22 ROM F/E 130 Flexion 133° Extension 3° ROM P/S 146 Pronation 73° Supination 73°	1 (33) minor 0 (0) major	48
Kerschbaum et al., 2017[24]	10	38	DASH 2 MEPS 90 OES 45 ROM F/E 145° Flexion 145° Extension 0°	0 (0) minor 7 (70) major	54					
Willin et al., 2020[39]	5	46.4	Bromberg-Morrey 94 MEPS 90 OES 55.8 qDASH 20.9 SEV 82	1 (20) minor 2 (40) major	27	5	46.4	Bromberg-Morrey 94 MEPS 90 OES 55.8 qDASH 20.9 SEV 82	1 (20) minor 2 (40) major	27

continued

TABLE I (*continued*)

Study	Total					Adults				
	No. of Elbows	Mean Age (yr)	Mean Functional Outcome by Study†	Complications, n (%)	Mean Follow-up (mo)	No. of Elbows	Mean Age (yr)	Mean Functional Outcome by Study†	Complications, n (%)	Mean Follow-up (mo)
Panteli et al., 2015[43]	27	41.4		1 (4) minor 0 (0) major	12					
Borris et al., 1987[44]	63	22.2		52 (83) minor 17 (27) major	84					
Josefsson et al., 1987[45]	34	39		3 (9) minor 5 (15) major	84					
Bettuzzi et al., 2023[47]	5	11		2 (40) minor 2 (40) major	67.2					
Bua et al., 2022[41]	10	11	Kim 87.5	0 (0) minor 1 (10) major						
>3 wk immobilization										
Sofu et al., 2016[25]	12	8	MEPS 91.6 ROM: F/E 120° ROM P/S 146° Pronation 67° Supination 79°	0 (0) minor 4 (33) major	46					
Adaş et al., 2014[26]	11	9.8	MEPS 96.8 ROM F/E 129° Flexion 137° Extension 8° ROM P/S 150° Pronation 73° Supination 77°	0 (0) minor 0 (0) major	24.3					
Van Lieshout, 2020[18]	52	47	EQ-5D 0.89 OES 95 qDASH 4 SF36-PCS 53	29 (56) 2 (4) major	12	52	47	EQ-5D 0.89 OES 95 qDASH 4 SF36-PCS 53	29 (56) 2 (4) major	12
Panteli et al., 2015[43]	14	35.4		0 (0) minor 0 (0) major	12					
Eygendaal et al., 2000[46]	31	33		25 (80) minor 45 (145) major	108	31	33		25 (80) minor 45 (145) major	108
Geyer et al., 2022[37]	21	37.4	ESAS 99.4 MEPS 97.3 qDASH 7.8 ROM F/E 139 ROM P/S 180	2 (10) minor 5 (24) major	72.8	21	37.4	ESAS 99.4 MEPS 97.3 qDASH 7.8 ROM F/E 139 ROM P/S 180	2 (10) minor 5 (24) major	72.8
Pincin et al., 2022[42]	18		MEPS 100 OES 47.8 qDASH 0.25							

*DASH = Disabilities of the Arm, Shoulder, and Hand, EQ-5D = EuroQol-5 Dimensions, ESAS = Elbow Self-assessment Score, Kim = Kim's elbow performance score, MEPS = Mayo Elbow Performance Score, OES = Oxford Elbow Score, qDASH = Quick Disabilities of the Arm, Shoulder, and Hand, ROM F/E = range of motion flexion-extension arc, ROM P/S = range of motion pronation-supination arc, SEV = subjective elbow value, SF-36 PCS = Short Form 36 physical component summary, and VAS = Visual Analog Scale.
†Posttherapy values are presented.

elbow dislocation is defined as persistent when it persists for >3 weeks[13]. Some studies compared different groups; therefore, the different groups were collected separately when possible. The ROM flexion-extension arc was determined by subtracting ROM extension values from the ROM flexion values. Pediatric patients were also presented in Tables I and II, but Table III presents a subgroup analysis. Pediatric patients are defined as patients younger than 18 years.

The definitions of complications and reoperations were the same as those formulated and used by the authors of the included studies. To get insight into the severity of complications, all complications were categorized as minor or major. Categorization was made with the help of orthopaedic elbow specialists (M.P.J.v.d.B. and D.E.). Minor complications were those who did not seriously affect daily functioning in a patient's daily life, were treatable in a timely manner, and where the patient did not have any after effects.

TABLE II Outcomes of Surgical Treatment in SED*

Study	Total					Adults				
	No. of Elbows	Mean Age (yr)	Mean Functional Outcome by Study†	Complications, n (%)	Mean Follow-up (mo)	No. of Elbows	Mean Age (yr)	Mean Functional Outcome by Study†	Complications, n (%)	Mean Follow-up (mo)
Surgery										
Krticka et al., 2018[20]	26	50	MEPS 87.7 OES 42.5 qDASH 8.3 ROM F/E 117°	29 (112) minor 0 (0) major	26	26	50	MEPS 87.7 OES 42.5 qDASH 8.3 ROM F/E 117°	29 (112) minor 0 (0) major	26
Micic et al., 2009[27]	14	34.1	MEPS 95.4 ROM F/E 116 Flexion 130° Extension 14°	8 (57) minor 4 (29) major	32.6	14	34.1	MEPS 95.4 ROM F/E 116 Flexion 130° Extension 14°	8 (57) minor 4 (29) major	32.6
Adolfsson et al., 2017[28]	8	54	ROM F/E 130° Flexion 136° Extension 6°	4 (50) minor 0 (0) major		8	54	ROM F/E 130° Flexion 136° Extension 6°	4 (50) minor 0 (0) major	
Lee et al., 2019[29]	21	45.1	qDASH 4.3 ROM F/E 134 Flexion 138° Extension 4° ROM P/S 163 Pronation 73° Supination 90°	1 (5) minor 16 (76) major	43.3	21	45.1	qDASH 4.3 ROM F/E 134° Flexion 138° Extension 4° ROM P/S 163° Pronation 73° Supination 90°	1 (5) minor 16 (76) major	43.3
Cho et al., 2018[23]	17	49.5	MEPS 86.5 qDASH 8.4 ROM F/E 121 Flexion 130° Extension 9° ROM P/S 153° Pronation 71° Supination 82°	5 (29) minor 0 (0) major	57.5	17	49.5	MEPS 86.5 qDASH 8.4 ROM F/E 121° Flexion 130° Extension 9° ROM P/S 153° Pronation 71° Supination 82°	5 (29) minor 0 (0) major	57.5
Schnetzke et al., 2017[8]	50	44.4	MEPS 93.4 ROM F/E 134° Flexion 139° Extension 5° VAS 1	1 (2) minor 5 (10) major	40.8	50	44.4	MEPS 93.4 ROM F/E 134° Flexion 139° Extension 5° VAS 1	1 (2) minor 5 (10) major	40.8
Jung et al., 2019[30]	10	30.5	MEPS 85 NRS 2 qDASH 11.4 ROM F/E 130° ROM P/S 161°		29	10	30.5	MEPS 85 NRS 2 qDASH 11.4 ROM F/E 130° ROM P/S 161°		29
Beirer et al., 2018[21]	10	43	ESAS 91.6 ROM F/E 131° ROM P/S 173°	0 (0) minor 3 (30) major	44	10	43	ESAS 91.6 ROM F/E 131° ROM P/S 173°	0 (0) minor 3 (30) major	44
Jeon et al., 2008[40]	12	36.2	MEPS 94.2		27.8	12	36.2	MEPS 94.2		27.8
Willin et al., 2020[39]	9	57.3	Bromberg-Morrey 94 MEPS 91 OES 54.7 qDASH 9.8 SEV 85	0 (0) minor 1 (11) major	36	9	57.3	Bromberg-Morrey 94 MEPS 91 OES 54.7 qDASH 9.8 SEV 85	0 (0) minor 1 (11) major	36
Josefsson et al., 1987[45]	28	36		4 (14) minor 2 (7) major	36					
Geyer et al., 2022[37]	23	21	ESAS 99.8 MEPS 98.7 qDASH 6.3	4 (17) minor 6 (26) major	58.7	23	21	ESAS 99.8 MEPS 98.7 qDASH 6.3	4 (17) minor 6 (26) major	58.7

continued

TABLE II (*continued*)

Study	Total					Adults				
	No. of Elbows	Mean Age (yr)	Mean Functional Outcome by Study†	Complications, n (%)	Mean Follow-up (mo)	No. of Elbows	Mean Age (yr)	Mean Functional Outcome by Study†	Complications, n (%)	Mean Follow-up (mo)
			ROM F/E 135 ROM P/S 177					ROM F/E 135 ROM P/S 177		
Persistent										
Devnani, 2004[31]	7	30.1	ROM F/E 83° Flexion 110° Extension 27°	7 (100) minor 2 (29) major	51.4	6	39.1	ROM F/E 100° Flexion 120° Extension 20°		43
Mahaisavariya et al., 2005[32]	21	25.9	ROM F/E 84°	1 (5) minor 0 (0) major	50.3	16	31.1	ROM F/E 87°		
Salihu et al., 2021[33]	49	31.9	MEPS 92.6 PSFS 9.1 ROM F/E 87°	1 (2) minor 43 (89) major	12	49	31.9	MEPS 92.6 PSFS 9.1 ROM F/E 87°		12
Kapukaya et al., 2013[13]	20	20	MEPS 79.3 ROM F/E 85°	0 (0) minor 10 (50) major	39.1	4	51.8	ROM F/E 51°		46.3
Anderson et al., 2018[34]	32	25	MEPS 93 ROM F/E 101° Flexion 132° Extension 31° ROM P/S 121° Pronation 71° Supination 150° SOD 9	1 (3) minor 0 (0) major	22	24	30.6	MEPS 91.9 ROM F/E 83° ROM P/S 120° SOD 9 (8.6)		20.9
Mehta et al., 2007[35]	6	25.2	MEPS 81.7 ROM F/E 92° ROM P/S 150°		18	4	30.5	ROM F/E 83° ROM P/S 150°		21
Krishnamoorthy et al., 1976[36]	8	27.5	ROM F/E 93° Flexion 124° Extension 31°		31.5	7	36.7	ROM F/E 103° Flexion 135° Extension 32°		40.3

*ESAS = Elbow Self-assessment Score, MEPS = Mayo Elbow Performance Score, NRS = numeric rating scale, OES = Oxford Elbow Score, PSFS = Patient-Specific Functional Scale, qDASH = Quick Disabilities of the Arm, Shoulder, and Hand, ROM F/E = range of motion flexion-extension arc, ROM P/S = range of motion pronation-supination arc, SEV = subjective elbow value, SOD = Summary Outcomes Determination score, and VAS = Visual Analog Scale.
†Posttherapy values are presented.

Methodological Quality

To assess the risk of bias, the Methodological Index for Nonrandomized Studies (MINORS) was used for nonrandomized studies, and the Cochrane risk-of-bias tool was used for randomized studies[14]. The MINORS is a validated and established index for evaluating the methodological quality of nonrandomized studies[15]. A MINORS score between 0 and 6 indicated very low quality of evidence, a score between 6 and 10 indicated low quality of evidence, a score between 10 and 15 to indicated fair quality of evidence, and a score ≥16 indicated a relatively good quality of evidence for nonrandomized studies[16]. Two reviewers (C.M.J.M.P. and H.H.d.K.) independently evaluated each study according to the MINORS index, and scoring differences were discussed until a consensus was reached. Randomized controlled trials (RCTs) were evaluated using the Cochrane tool[14]. The Cochrane tool is a comprehensive approach to assessing the risk of the potential for bias in RCTs.

Data and Statistical Analysis

In this systematic review, studies were pooled per treatment group, and a comparison between the groups was not conducted due to their high heterogeneity. A mean and standard deviation were provided for each treatment group. A weighted mean was calculated to account for the varying sizes of the study populations. In this calculation, larger study populations were given more weight than smaller study populations, and each patient contributed equally to the final mean. The introduction of grades of recommendation, as divided by Wright, enabled the assessment of the strength and homogeneity of evidence within each treatment group[17]. This analytical approach allowed for critically evaluating the available literature without directly comparing the groups. Grade A indicates good evidence (Level I studies with consistent findings) for or against recommending intervention; grade B indicates fair evidence (Level II or III studies with consistent

TABLE III Outcomes of Children with SED*

Study	No. of Elbows	Mean Age (yr)	Mean Functional Outcome by Study†	Complications, n (%)	Mean Follow-up (mo)
1-3 wk immobilization					
Borris et al., 1987[44]	43	10		16 (37) minor 11 (26) major	84
Subasi et al., 2015[48]	22	11.6		0 (0) minor 0 (0) major	
Bettuzzi et al., 2023[47]	5	11	MEPS 88.3	2 (40) minor 2 (40) major	67.2
Bua et al., 2022[41]	10	11	Kim 87.5	0 (0) minor 1 (10) major	
3 wk immobilization					
Sofu et al., 2016[25]	12	8	MEPS 91.6 ROM F/E 120	0 (0) minor 4 (33) major	46
Adaş et al., 2014[26]	11	9.8	MEPS 96.8 ROM F/E 129 Flexion 137° Extension 8° ROM P/S 150° Pronation 73° Supination 77°	0 (0) minor 0 (0) major	24.3
Neglected					
Devnani, 2004[31]	3	11.7	ROM F/E 28° (62-33°)		58
Mahaisavariya et al., 2005[32]	6	10.8	ROM F/E 72°		59.5
Kapukaya et al., 2013[13]	16	12.1	MEPS 81.3 ROM F/E 92° Flexion 119° Extension 27°		37.3
Anderson et al., 2018[34]	8	13.3	MEPS 93 ROM F/E 100° ROM P/S 106° SOD 9		24.9
Mehta et al., 2007[35]	2	14.5	MEPS 90 ROM F/E 110° Flexion 125° Extension 15° ROM P/S 145° Pronation 85° Supination 60°		12
Krishnamoorthy et al., 1976[36]	3	12	ROM F/E 85° Flexion 107° Extension 22°		20

*MEPS = Mayo Elbow Performance Score, ROM F/E = range of motion flexion-extension arc, ROM P/S = range of motion pronation-supination arc, and SOD = Summary Outcomes Determination score.
†Posttherapy values are presented.

findings) for or against recommending intervention; grade C indicates poor-quality evidence (Level IV or V studies with consistent findings) for or against recommending intervention; and grade I indicates insufficient or conflicting evidence not allowing a recommendation for or against intervention.

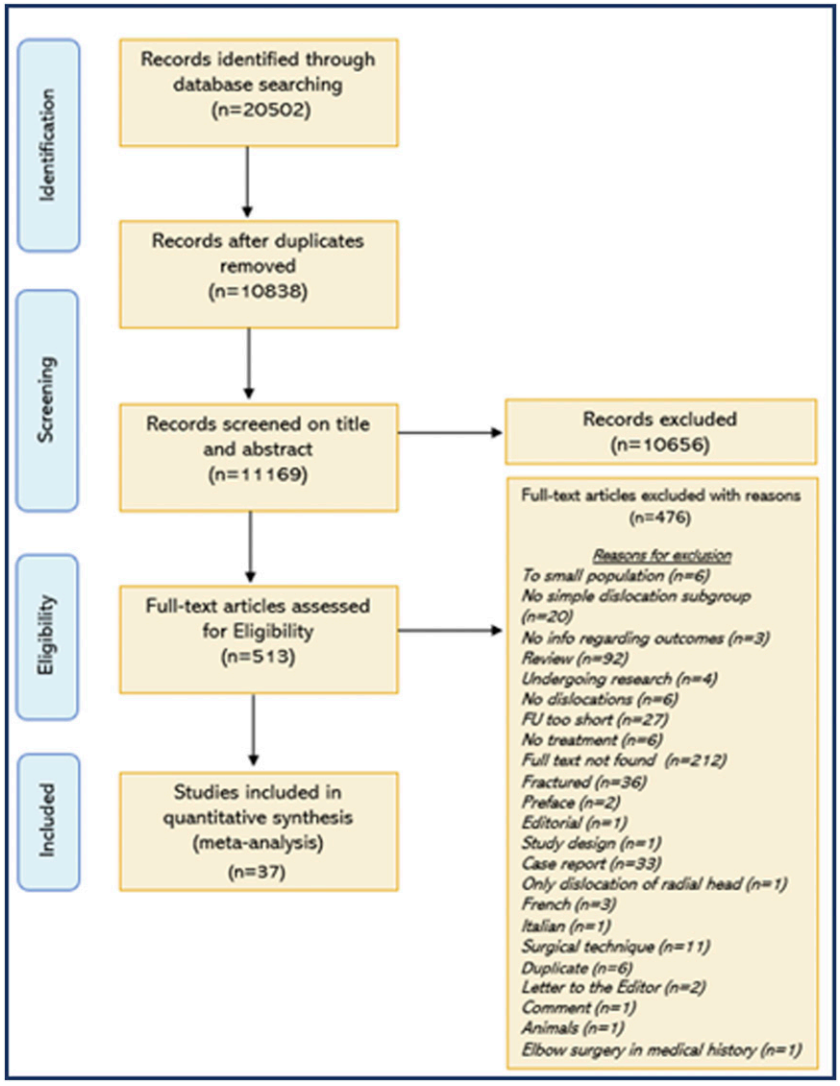

Fig. 1

Flowchart demonstrating Preferred Reporting Items for Systematic Meta-Analyses study selection.

Results

The Search of the Literature

A flow diagram of study inclusion is presented in Figure 1. A clinical librarian (S.P.V.) performed a search of the literature databases PubMed, Embase/OVID, CENTRAL, Web of Science/Clarivate Analytics, and SPORTDiscus/EBSCO for studies on February 8, 2023. The search comprised keywords for elbow or ulnohumeral and dislocation. The search strategies have been informally peer-reviewed by a second clinical librarian. Duplicate articles were excluded by the information specialist (S.P.V.) using EndNote X8 (Analytics Clarivate, 2018). The search contained a total of 20,502 articles. The duplicates were removed (n = 10,838), and 11,169 articles were screened by title and abstract. A total of 513 studies were screened on the full text. This concluded in a total of 37 for data extraction.

Methodological Quality Evaluation

An overview of the methodological quality evaluations is presented in Appendix 1. The Cochrane risk-of-bias tool was used for the RCT by van Lieshout et al.[18], showing a low risk of bias. The mean MINORS scores for the 20 noncomparative and 16 comparative studies were 10.5 ± 0.9 (range 8.5-11.5) and 15.0 ± 2.2 (range 12-18.5), respectively, indicating fair quality of evidence for the nonrandomized studies[16].

Patients

Overall, 1,078 patients were included, with a total of 1,081 dislocated elbows. The dominant extremity's involvement rate ranged from 24% to 91%. The percentage of men in the studies ranged from 13% to 95%. The mean patient age ranged from 8 to 53 years (overall range, 5-91 years), and the mean follow-up ranged from 12 to 69 months (overall range, 12-228 months). Twenty-nine articles (79% of the patients) described

TABLE IV Classification Complications

Minor Complications	Occurrence (%)	Major Complications	Occurrence (%)
Contracture, stiffness	9	Degenerative changes	22
Heterotopic ossification	33	Chronic pain	6
Transient nerve injury	5	Instability	17
Calcifications	7	Permanent nerve injury	0
Superficial wound infections	0	Muscle rupture	0
		Deep wound infection	0

patients who presented at the hospital with an unreduced SED. Fourteen articles (46% of the patients) diagnosed SED through radiographs of the elbow before reduction. Four articles (17% of the patients) did not describe if the elbows were reduced before the first presentation at the hospital and how the diagnosis was made.

Outcome Measures

An overview of the outcomes is presented in Table I for nonoperative treatment and for surgical treatment in Table II. The ROM was reported in 21 studies[8,13,19-37]. PROMs were reported in 24 studies[5,8,13,18-27,29,30,33-35,37-42]. The postintervention MEPS was the only PROM reported in all groups. Complication rates were reported in 28 studies[5,8,13,18-29,31-34,37-39,41,43-47]. The complications are categorized as minor and major in Table IV.

Nonoperative Treatment

An overview of the outcome measures in patients with nonoperative treatment is presented in Table I. Twenty-five articles[2,5,7,8,18-26,37-39,41-49] (710 elbows) reported patients who received nonoperative treatment in addition to the closed reduction. Reported treatments after reduction were early mobilization (<7 days) and immobilization. The immobilization period differed between 1 to 3 weeks and ≥3 weeks. There was no PED treated with a nonoperative treatment. Seven articles[8,18,24,37-39,45] reported 15 patients (5%) with late operative interventions for complications such as redislocation and nerve complaints after nonoperative treatment.

Early Mobilization (Mobilization <7 days). Eight studies[7,8,18-21,38,43] (244 elbows) investigated the outcomes of early mobilization. Seven studies were retrospective, and 1 study was prospective[7]. The weighted mean MEPS, ROM, and complication rates are presented in Table V. The study by Panteli et al.[43] investigated a group with a mean immobilization of 6 days, ranging from 3 to 11 days. Within this group, 21 of 26 patients achieved a ROM of >100°. The study by Ross et al.[7] (20 elbows) used a "7-day mobilization protocol," and all patients attained full or near full (within 5°) ROM.

Immobilization.

1- to 3-week immobilization. Twelve studies[5,22-24,38,39,41,43-45,47,48] (239 elbows) used an immobilization period of 1 to 3 weeks. All the studies in this treatment group were conducted retrospectively. The weighted mean MEPS, ROM, and complication rates are presented in Table V. A study by Subasi et al.[48] showed in 15 patients no limitation of elbow ROM, in 4 < 10° of loss of movement, in 1 a 10 to 30° loss of movement, and in 2 a >30° loss of movement was seen.

≥3-week immobilization Eight studies[2,18,25,26,37,42,43,46] (163 elbows) investigated an immobilization period of 3 weeks or more. Six were retrospective studies, 1 prospective study[42], and 1 multicenter RCT[18]. The weighted mean MEPS, ROM, and complication rates are presented in Table V.

Other. The studies below are not included in Tables I and II because they cannot be assigned to our specified groups or the outcomes of different treatment options were not reported separately. In the study by Schippinger et al.[49], 47 elbows were treated nonoperatively. The patients were divided into 3 groups of immobilization: Group I as <2 weeks, Group II as 2 to 3 weeks, and Group III as >3 weeks. The results were given for the total group, not specified for the subgroups, and therefore not included in Table I. Twenty-five patients (56%) achieved an excellent result (Morrey score 95-100 points), 15 patients (33%) obtained a good result (Morrey score 80-95), and 5 patients (11%) experienced a fair result (Morrey score 50-80). In the study by Kesmezacar and Sarikaya[2], 21 patients were treated nonoperatively. Among them, 17 patients were immobilized for 3 weeks, while 4 were subjected to early mobilization. The results were given for the total group and not specified for the subgroups. The mean MEPS was 97, and the mean Bromberg-Morrey Functional Rating Index score was 98. The scores of both systems were excellent in 20 patients (95%) and moderate in 1 patient (5%).

Surgical Treatment

An overview of the outcome measures of patients with surgical treatment is presented in Table II. Nineteen studies[8,13,20,21,23,27-37,39,40,45] (380 elbows) reported patients who had operative treatment. Surgical treatment was performed after closed or open reduction; 146 elbows (38%) had an open reduction. A total of 236 elbows (66%) had ligament reconstruction or repair. A K-wire was used for fixation in 55 elbows (14%), a tendon graft in 10 elbows (3%), internal ligament bracing in 2 elbows (1%), and in some cases, a

TABLE V Overview Weighted Mean MEPS and ROM*†

Group	MEPS	ROM F/E (°)	ROM P/S (°)	Compl Minor (%)	Compl Major (%)
Early mobilization					
Total	95.1 ± 1.5 (94.1-97) (n = 140)	137 ± 6.1 (132-146) (n = 128)	173 ± 7.9 (165-176) (n = 32)	20 ± 26.3 (0-52) (n = 198)	5 ± 3.9 (0-10) (n = 198)
Adults	94.9 ± 1.6 (94.1-97) (n = 118)	137 ± 5.1 (132-146) (n = 128)	168 ± 5.5 (165-176) (n = 32)	22 ± 27.9 (0-52) (n = 178)	5 ± 3.6 (0-10) (n = 178)
Pediatric	—	—	—	—	—
1-3-wk immobilization					
Total	90.0 ± 5.6 (81.7-95.8) (n = 64)	129 ± 13.5 (118-145) (n = 27)	147 (n = 3)	21 ± 24.8 (0-52) (n = 217)	19 ± 23.2 (0-70) (n = 217)
Adults	92.2 ± 6.2 (81.7-93.8) (n = 34)	120 ± 8.5 (118-130) (n = 17)	147 (n = 3)	20.7 ± 7.9 (14-33) (n = 48)	40 ± 20 (0-40) (n = 48)
Pediatric	88 (n = 5)	—	—	23 ± 22.3 (0-40) (n = 80)	1 ± 17.6 (0-40) (n = 80)
≥3-wk immobilization					
Total	96.9 ± 3.5 (91.6-100) (n = 62)	131 ± 9.6 (120-139) (n = 44)	163 ± 18.6 (146-180) (n = 44)	40 ± 34.9 (0-80) (n = 141)	40 ± 55.9 (0-145) (n = 141)
Adults	97.3 (n = 21)	139 (n = 12)	180 (n = 21)	54 ± 35.6 (10-80) (n = 106)	50 ± 76.3 (4-145) (n = 106)
Pediatric	94 ± 3.7 (91.6-96.8) (n = 23)	124 ± 6.7 (120-129) (n = 23)	150 (n = 11)	0 (n = 23)	1 ± 23.6 (0-4) (n = 23)
Surgery					
Total	92.1 ± 4.8 (85-98.7) (n = 160)	128 ± 7.4 (116-135) (n = 179)	167 ± 10.0 (153-177) (n = 91)	27 ± 35.7 (0-112) (n = 206)	18 ± 23.3 (0-76) (n = 206)
Adults	92.1 ± 4.8 (85-98.7) (n = 160)	128 ± 7.5 (116-135) (n = 179)	166 ± 9.6 (153-177) (n = 91)	33 ± 37.4 (0-112) (n = 178)	28 ± 24.3 (0-76) (n = 178)
Pediatric	—	—	—	—	—
Neglected					
Total	89.6 ± 7.1 (81.7-93) (n = 115)	90 ± 6.5 (83-101) (n = 143)	126 ± 20.5 (85-150) (n = 87)	8 ± 43.6 (0-100) (n = 129)	43 ± 37.5 (0-89) (n = 129)
Adults	92.4 ± 0.5 (91.9-92.6) (n = 73)	90 ± 17.7 (51-104) (n = 110)	124 ± 21.4 (120-150) (n = 77)	—	—
Pediatric	86 ± 6.1 (81.3-93) (n = 26)	86 ± 29.0 (28-110) (n = 38)	114 ± 27.4 (106-145) (n = 10)	—	—

*MEPS = Mayo Elbow Performance Score, ROM F/E = range of motion flexion-extension arc, and ROM P/S = range of motion pronation-supination arc.
†Weighted mean ± SD (range).

transfixing pin (exact number unknown). Seven elbows were treated with a hinged external fixator (2%), and additional neurolysis of the ulnar nerve was performed in 11 patients (3%).

Surgery. Twelve articles[8,20,21,23,27-30,37,39,40,45] reported on 228 elbows that underwent surgery in a timely manner. Of these, 225 patients reported in the same 12 articles[8,20,21,23,27-30,37,39,40,45] underwent closed reduction before surgery, while 3 elbows underwent open reduction[23]. The indication for surgical treatment was subluxation in 7 articles[20,23,27,29,30,37,40], noncongruent elbow joint in 6 articles[8,20,23,27,37,40], redislocation in 5 articles[8,23,28,29,37], failed closed reduction in 1 article[23], high functional demands in 1 article[37], surgical indication depending on surgeon in 1 article[45], and unclear indication in 1 article[21]. All studies were retrospective. The weighted mean MEPS, ROM, and complication rates are presented in Table V.

Surgery on PEDs. Seven articles[13,31-36] (143 elbows) reported patients with PED. Elbow dislocation is defined as persistent when it persists for >3 weeks[13]. All studies were retrospective. The weighted mean MEPS, ROM, and complication rates are presented in Table V.

Adult Patients

A total of 30 articles[5,7,8,13,18-23,25-37,39-42,46-48], including 736 adults, described

TABLE VI Recommendations for Care

Treatment	Grade of Recommendation*
Nonoperative	
Early mobilization	B
1-3-wk immobilization	I
3-wk immobilzation	I
Operative treatment	I

*According to the study by Wright[17], grade A indicates good evidence (Level I studies with consistent findings) for or against recommending intervention; grade B indicates fair evidence (Level II or III studies with consistent findings) for or against recommending intervention; grade C indicates poor-quality evidence (Level IV or V studies with consistent findings) for or against recommending intervention; and grade I indicates insufficient or conflicting evidence not allowing a recommendation for or against intervention.

outcomes of treatment of an elbow dislocation in adults (Tables I and II). The percentage of male patients ranged from 13% to 92% in the studies. The mean patient age was 35 years (overall range, 18-91 years), and the mean follow-up was 37 months (overall range, 12-157 months). The weighted mean MEPS, ROM flection-extension arc, ROM pronation-supination arc, and complications are presented in Table V.

Pediatric Patients

A total of 12 articles[13,25,26,31,32,34-36,41,44,47,48], including 141 children, described outcomes of treatment of an elbow dislocation in children (Table III). The percentage of male patients ranged from 19% to 100% in the studies. The mean patient age was 11 years (overall range, 5-17 years), and the mean follow-up was 43 months (overall range, 12-192 months). The weighted mean MEPS, ROM flection-extension arc, ROM pronation-supination arc, and complications are presented in Table V.

Discussion

The primary aim of this study was to systematically review the literature regarding the outcomes and complications of the different treatment options for a SED. An overview of the weighted mean MEPS, ROM flexion-extension arc, ROM pronation-supination arc, and complications per treatment group is presented in Table V. The early mobilization and ≥3-week immobilization groups showed excellent outcomes, while the 1- to 3-week immobilization, surgery, and persistent groups reported good to excellent mean MEPS. The weighted mean flexion-extension arc and pronation-supination arc were sufficient for activities of daily life in all the groups (i.e., 110 and 127°), except for the PED group[50].

Grades of recommendation, as described by Wright[17], were used to assign grades of recommendation to each treatment option, as presented in Table VI. The consistency of findings is an important factor in determining the strength of a recommendation because it indicates that the results are reliable and can be generalized to different populations and settings. The highest recommendation of the treatment options was given to the early mobilization group, whereas the other treatment groups received a lower grade of recommendation based on inconsistency in the literature regarding the treatment outcomes. This high variability in outcomes highlights the need for further research to establish more definitive guidelines and reduce variability in outcomes.

To contextualize the findings of this review, comparing them with previous reviews on the same topic is essential. The review of Anakwe et al.[51] assessed the epidemiology and long-term clinical and patient-reported outcomes after simple dislocation of the elbow in adults. Patients received various treatments, such as early elbow motion with splinting, immobilization for 1 to 3 weeks, or immobilization for 4 to 6 weeks. Anakwe et al. reported the results of the total patient group, and not specific for each treatment group. After a mean follow-up period of 88 months, the mean OES was 90 points. In our study, we found the following OES scores: the early mobilization group reported a mean OES of 70 (SD ± 33.1), the 1- to 3-week immobilization group reported a mean OES of 64 (SD ± 24.1), and the ≥3-week immobilization group reported a mean OES of 71 (SD ± 33.4).

PEDs are uncommon in developed countries but are more common in countries with a less developed medical system[33]. The ROM flexion-extension arc and supination-pronation arc in PEDs after surgery in this study were 90° (SD ± 6.5, range 83-101°) and 126° (SD ± 20.5, range 85-150°), respectively. This stresses the importance of ruling out SED in all elbows suspected of dislocation (a patient with a posterior dislocation will typically present with the forearm shortened, the elbow flexed at 45°, and a prominent olecranon) with standard radiographs and in case of SED to perform an adequate reduction and treatment with adequate radiological follow-up to assess redislocation[52]. In this study, we assessed cases of SEDs, including cases with small avulsions of the medial and lateral collateral ligament complex, excluding elbow dislocations with associated fractures. Singh et al.[53] described different soft tissue injuries correlating with trauma mechanisms. They stated that stratification of the extent of the injury with examination under anesthesia, magnetic resonance imaging, or ultrasound might identify those patients in whom all the soft tissue stabilizers have been stripped from the humerus and may benefit from early surgical stabilization. In this study, we

did not subdivide different trauma mechanisms and soft tissue injuries.

Limitations

This study has some limitations. First, many different PROMs were used in the included articles, complicating the ability to compare the articles and conclude what treatment gives the best results. We advise future studies regarding the treatment of SEDs to take the MEPS, OES, or ROM as the main outcome measures, as these scores are the most common outcome measures in this study. Second, most studies have a grade IV level of evidence. More heterogeneity is often observed in retrospective studies compared with studies with a higher level of evidence, such as RCTs, due to inherent differences in their study design and methodology. Hence, it is not possible to make statistical comparisons of data from different studies. Finally, this review relied on the definitions of complications and reoperations as provided by the respective authors of the included studies. These articles may have used varying criteria for categorizing complications, potentially leading to differences in the number of identified complications and subsequent discussions on this matter.

Conclusion

Owing to the extensive range of results, an abundance of PROMs, and low evidence studies, it is not possible to strongly recommend one of the treatment options. However, the early mobilization treatment showed the most consistent findings compared with the other treatment options. Future retrospective case series should be avoided as they tend to introduce inconsistency in the existing literature. Subsequent research efforts should focus on prospective studies that incorporate well-defined admission criteria, particularly assessing the extent of instability resulting from soft tissue damage.

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Appendix

Supporting material provided by the authors is posted with the online version of this article as a data supplement at jbjs.org (http://links.lww.com/JBJSREV/B52). This content was not copyedited or verified by JBJS.

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