SYSTEMATIC REVIEW

Outcomes of Patients with Bennett Fracture Treated with Three Different Surgical Techniques: A Systematic Review

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Abstract

Objectives: Bennett's fracture, the most common intra-articular fracture occurring at the base of the thumb, accounts for less than 1% of all hand fractures. It typically results from specific traumatic mechanisms, deforming forces, and ligamentous injuries. To compare the functional outcomes and sequelae in patients with Bennett's fracture treated surgically using: Open reduction and internal screw fixation, closed reduction and percutaneous fixation, arthroscopy-assisted reduction and screw fixation.

Methods: A systematic literature review was conducted to identify studies on Bennett's fracture dislocations in patients over 18 years of age without additional injuries. Searches were performed in PubMed, Scopus, Cochrane Central, Web of Science, Scielo, Lilacs, Oneme, and Epistemonikos databases, with language restrictions in English, French, Spanish, Portuguese, Italian, and German, and no date restrictions. Primary outcome variables included measures of functionality and secondary outcomes such as pain, stiffness, and osteoarthritis.

Results: A total of 18 studies met the selection criteria, with most being retrospective (94.45%). Pain measures were reported in 77.78% of the studies, predominantly using the VAS (min=0 and max=2). All techniques seemed to achieve similar functional outcomes. The main difference was the pain registered at follow-up, mainly by patients treated with open reduction. Osteoarthritis appeared as a common consequence of these fractures, regardless of the treatment type -excluding arthroscopy-assisted reduction as there was not enough data.

Conclusion: The three techniques had similar functional outcomes. Closed reduction and percutaneous fixation appear to result in less pain; however, both closed reduction with percutaneous fixation and open reduction with internal screw fixation have similar rates of osteoarthritis at follow-up. Unfortunately, there is insufficient data to evaluate arthroscopy-assisted reduction with screw fixation, suggesting the need for rigorous follow-up in patients undergoing this surgical intervention.

Level of evidence: III

Keywords: Bennett's fracture, First metacarpal, Functionality, Hand, Pain, Surgery

Introduction

Hand fractures are common,[1] comprising 15 to 20% of occupational accidents.[2] The kinematics of the trauma typically involve forced adduction mechanisms and axial trauma to the thumb.[3] Considering the biomechanics of the hand, the thumb is involved in up to 40% of hand movements, with the trapeziometacarpal joint positioning the thumb for activities such as flexion, extension, opposition, and adduction necessary for fine pinching. When this joint is compromised by a fracture-dislocation, it results in sequelae that indirectly alter and reduce hand functionality, which are associated with stiffness, pain, and osteoarthritis.[4]

Bennett's fracture is the most common fracture occurring at the base of the thumb.[5] This trauma results in an intra-

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articular fracture at the base of the first metacarpal with trapeziometacarpal dislocation due to deforming forces from the adductor pollicis brevis and longus muscles, leading to joint destabilization and involvement of the dorsal radial carpometacarpal ligament.[6,7] This fracture commonly occurs in men aged 15 to 65. Causes may include striking an object with a clenched fist while the thumb is flexed, falling onto the radial side of the hand, and motor vehicle or cycling accidents. Symptoms and signs of a fracture include severe pain, deformity, swelling, numbness, paresthesia, and functional limitation.[5]

Regarding the surgical treatment of Bennett's fracture, several methods are available, including open or arthroscopy-assisted reduction with screw fixation, and closed reduction with percutaneous fixation using a Kirschner wire.[8] It has been reported that methods such as open reduction and internal fixation (ORIF) with screws provide better functional outcomes than percutaneous fixation with pins.[9] In surgical parameters for articular fractures, anatomical reduction is recommended to minimize post-traumatic arthritis, which also applies to Bennett's fracture.

Few studies compare the treatment of Bennett's fractures via ORIF versus closed reduction and internal fixation (CRIF).[6,10] One such study by Lutz *et al*.[11] treated 32 patients with Bennett's fracture using open reduction and internal fixation versus closed reduction and percutaneous Kirschner wire fixation. The authors found no significant difference in clinical outcomes or the prevalence of radiographic post-traumatic arthritis between the treatment types, although the percutaneous group had a significantly higher incidence of adduction deformity of the first metacarpal.[11]

The decision to treat these fractures with open reduction, arthroscopy-assisted reduction, or closed reduction remains a topic of debate. Additionally, no correlation has been found between the quality of articular reduction and radiographic and functional outcomes. In this context, the objective of this systematic review is to compare the functional outcomes and sequelae in patients with Bennett's fracture treated surgically with: 1) Open reduction and internal screw fixation, 2) Closed reduction and percutaneous fixation, or 3) Arthroscopy-assisted reduction and internal screw fixation.

Materials and Methods

Protocol and Registration

This systematic review followed the recommendations set forth in the Cochrane Handbook for Systematic Reviews of Interventions[12] and the PRISMA 2020 statement.[13] The protocol was registered in the Open Science Framework database (osf.io/g38ka).

Selection Criteria

Included studies were randomized controlled trials or observational studies (prospective or retrospective) involving populations over 18 years old with intra-articular fractures at the base of the first metacarpal (Bennett's fracture) without additional injuries. These studies involved interventions through open reduction and screw fixation, closed reduction and percutaneous pin fixation (using Kirschner or Steinmann wires), or arthroscopy-assisted reduction and screw fixation. Only articles presenting functional outcomes and sequelae related to pain, stiffness, and osteoarthritis were included. Studies evaluating fracture-dislocations of other metacarpals or Rolando fractures (which have different trauma mechanisms and osteoligamentous involvement) were excluded. Studies including cases of Bennett's fracture along with other types of fractures were included only if the results for Bennett's fracture were presented separately.

Information Sources and Search

Search strategies were developed with the assistance of a medical librarian and included combinations of various terms and synonyms for Bennett's fractures and their surgical treatment. Searches were conducted in PubMed, Scopus, Cochrane Central, Web of Science, Scielo, Lilacs, Oneme, and Epistemonikos databases, with language restrictions in English, French, Spanish, Portuguese, Italian, and German, and no date restrictions. A combination of MeSH terms and uncontrolled vocabulary relevant to the review's objectives was used, detailed in Supplementary Material 1.

Study Selection

Eligibility was assessed independently and standardized by two reviewers in a non-blinded manner. After removing duplicates, the titles and abstracts of the remaining studies were reviewed for inclusion criteria. Full-text articles were then selected using the same criteria. Disagreements were resolved by consensus.

Data Extraction and Synthesis of Results

The following study characteristics were extracted from the selected articles: country, year, study design, number of participants, sex, age (years), affected hand (right/left), trauma mechanism, time to surgery from fracture (days), radiographic imaging, type of supplementary imaging, treatment (conservative/surgical), type of approach, type of implant, follow-up duration, pain measurement, functional outcome measurement, osteoarthritis measurement, return to previous work activities, readmission, and complications. Data were organized using an extraction table in Microsoft Excel.

Two authors independently extracted data from eligible studies. The primary outcomes sought for this review were sequelae found in patients with Bennett's fracture who received surgical treatment with open reduction and internal fixation versus closed reduction and percutaneous fixation: pain, osteoarthritis, and stiffness (pinch function). Disagreements were resolved by consensus between the two reviewers or through a third reviewer.

Risk of Bias and Methodological Quality Assessment

Two authors independently assessed the methodological quality and risk of bias of the included studies using the Newcastle-Ottawa Scale (NOS) for retrospective and prospective cohort or case-control studies. This scale includes nine items: the selection criteria (four items: 1) adequate case definition, 2) case representativeness, 3) control selection, 4) control definition), comparability criteria (case-control comparability by design or analysis), and exposure criteria (three aspects: 1) exposure

determination, 2) same method of determination for cases and controls, 3) non-response rate). Disagreements were resolved through discussion until consensus was reached. Studies were rated as having: a) Low risk of bias (good quality) 8-9 points, b) Moderate risk of bias (fair quality) 5-7 points, c) High risk of bias (poor quality) <5 points.

Additionally, the tool proposed by Murad et al.[14] was used to assess the quality of case series or case reports included in this systematic review. This tool includes five questions: 1) Does the patient represent the entire experience of the investigator/center, or is the selection method unclear to the point that other similar cases might not have been reported? 2) Was the diagnosis established? 3) Were other significant diagnoses accurately ruled out? 4) Were all critical data referenced in the report? 5) Was the outcome determined correctly? Each question received a score of 1 (indicating yes) or 0 (indicating no). Study quality was classified as high, moderate, or low based on total scores of 5, 4, or ≤ 3, respectively. Any discrepancies in the assessment of bias and methodological quality were resolved through discussion between the two reviewers or by a third evaluator.

Results

The systematic search yielded a total of 631 articles, of which 129 were removed due to duplication. After a full-text review, 18 articles met the selection criteria and were included in the analysis [Figure 1].

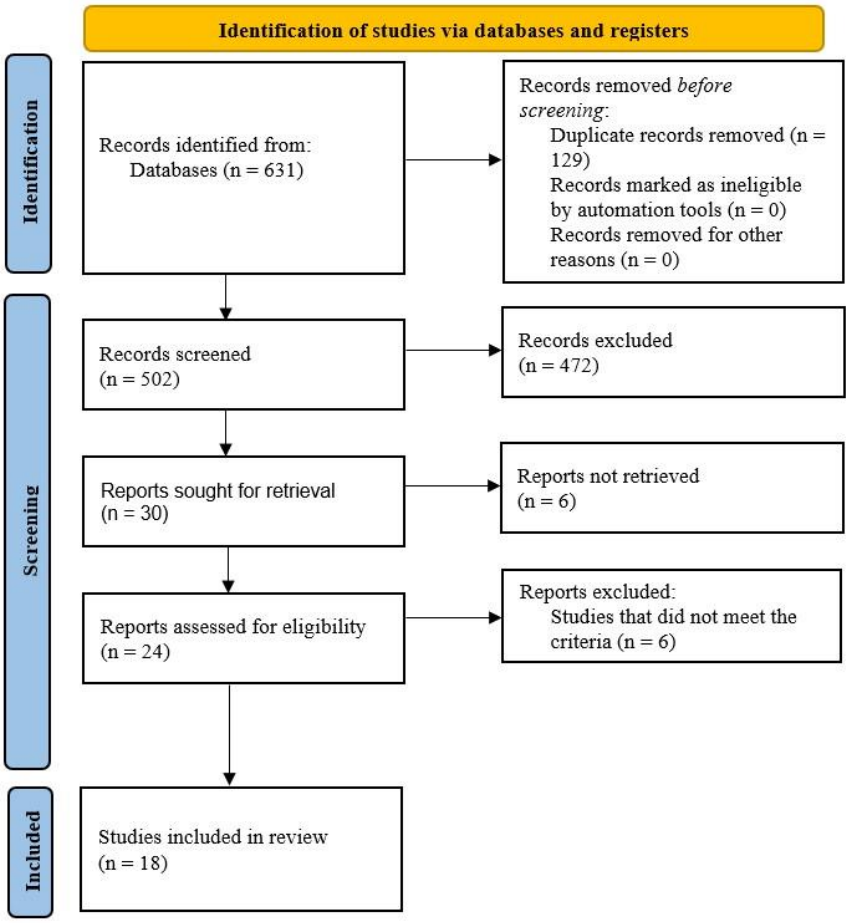

Figure 1. PRISMA 2020 Flow Diagram

Characteristics of the Studies and Sociodemographic Variables of the Population

The majority of studies were conducted in France (n=5), Germany (n=2), and the Netherlands (n=2), with a diverse range of other countries represented [Table 1]. Most studies were retrospective (n=17), and a predominance of male participants was observed (n=502, 82.6%). The average age was 33.57 years, and the right hand was the most commonly affected (n=175, 55.7%). It is important to note that not all studies reported the laterality of the affected hand, with some only indicating whether it was the dominant hand. Trauma mechanisms included occupational accidents, traffic accidents, sports injuries, falls, and fist injuries, with sports injuries being the most frequent cause. The average time from fracture to surgery was 5.83 days.

Table 1. Characteristics of Included Studies and Sociodemographic Data

Author/Year	Country	Study Design	Number of Participants	Male Participants	Affected Hand Side	Cause of Injury	Time to Surgery (Days)
Lutz et al.[14] 2002	Germany	Retrospective	24	20 (83.3%)	-	-	-
Adi et al.[15] 2014	France	Retrospective	7	7 (100%)	4 right (57.1%), 3 left (42.9%)	2 motorcycle falls, 2 playing volleyball, 1 bicycle fall, 1 unspecified fall, 1 fist injury	7
Bouaicha et al.[16] 2022	Tunisia	Prospective	40 24 long fragment group, 16 short fragment group	36 (90%) 21 long fragment group, 15 short fragment group	22 left (55%), 18 right (45%)	4 direct, 36 indirect (mostly domestic accidents, followed by traffic accidents)	-
Brazier et al.[8] 1996	France	Retrospective	35	33 (94.3%)	Not specified, dominant side in 26 cases (74.3%)	17 traffic accidents, 5 sports accidents, 6 work accidents, 7 home falls	-
Brüske et al.[23] 2001	Poland	Retrospective	21 19 Bennett, 2 Rolando, but not distinguished	-	18 right (85.7%), 3 left (14.3%)	9 hand falls, 5 street fights, 4 sports accidents, 3 direct hand injuries	0-15
Demir et al.[17] 2006	Germany	Retrospective	24	-	Not distinguished by fracture type	Not distinguished by fracture type	-
Greeven et al.[18] 2012	Netherlands	Retrospective	7	7 (100%)	2 right (28.6%), 5 left (71.4%)	Fall	-
Kamphuis et al.[5] 2019	Netherlands	Retrospective	50 35 open reduction, 15 closed reduction	42 (84%) 29 open reduction, 13 closed reduction	31 right (62.0%) 26 right for open reduction group, 5 for closed reduction group	Sports injuries, motorcycle and car accidents, fights, and falls with an extended hand	7
Kjær-Petersen et al.[24] 1990	Denmark	Retrospective	41 Closed reduction and cast 9, percutaneous pin fixation 6, open reduction and internal fixation 26	37 (90.2%)	Right (48%)	Fall on the hand or force applied to the finger	-
Levy et al.[26] 2018	Argentina	Retrospective	21	19 (90.5%)	14 right (66.7%), 7 left (33.3%)	13 work injuries, 3 sports injuries, 5 daily activities	6
Middleton et al.[19] 2015	UK	Retrospective	143	127 (88.9%)	-	48 sports injuries, 42 falls from standing height, 29 traffic accidents, 13 assaults, 12 unknown	-
Obert et al.[20] 1997	France	Retrospective (case series)	7	5 (71.4%)	6 dominant hand (85.7%)	1 work accident, 2 sports or leisure injuries, 4 public road accidents	0-8
Pomares et al.[29] 2016	France	Retrospective	21 10 open surgery, 11 percutaneous surgery	20 (95.2%) 10 open surgery group, 10 percutaneous surgery group	11 right (52.4%) 6 open surgery group, 5 percutaneous surgery group	-	-
Sälgeback et al.[25] 1971	Sweden	Retrospective	81 initially, but only follow-up data from 45 14 external fixation, 24 closed reduction, 5 open reduction, 2 no treatment	71 (87.6%)	48 right (59.3%), 33 left (68.8%)	18 falls, 4 fights, 7 sports injuries, 11 traffic accidents, 5 work accidents	-

Table 1. Continued

Sawaizumi et al.[21] 2005	Japan	Retrospective	12	11 (91.7%)	4 right (33.3%), 8 left (66.7%)	8 motorcycle or bicycle falls, 2 work falls, 2 sports accidents	11
Zemirline et al.[28] 2014	France	Retrospective	7	6 (85.7%)	5 dominant hand (71.4%)	-	-
Huang et al.[22] 2023	Taiwan	Retrospective (case series)	13	10 (76.9%)	5 right (38.5%), 8 left (61.5%)	10 traffic accidents, 2 falls, 1 sports injury	7
Zhang et al.[27] 2012	China	Retrospective	56	51 (91.1%)	37 dominant hand (66.1%), 19 non-dominant hand (33.9%)	30 work injuries, 18 sports injuries, 8 daily activities	

Outcome Variables

Among the included studies, nine exclusively evaluated closed reduction and percutaneous fixation.[15–23] Four studies compared closed reduction and percutaneous fixation with open reduction and internal fixation with screws,[6,24–26] while three exclusively examined the latter technique [Table 2].[9,27,28] Only one study assessed arthroscopically assisted reduction and screw fixation,[29] and another study compared open reduction versus arthroscopic reduction [Table 2].[30] Follow-up periods ranged from 8 months to 13 years.

Pain assessment following intervention was reported in 77.78% of the studies (14 studies) [Table 2]. The tools used to measure pain included author-created pain intensity classifications, the Brazier scale, and the Visual Analog Scale (VAS), with the latter being the most commonly used [Table 2].[16,19,23,27–30]

Table 2. Characteristics of Interventions and Pain Measurement

Author/Year	Intervention	Follow-up Duration	Pain Measurement Scale	Pain Measurement Outcome
Adi *et al.*[15] 2014	A	16 months (range 9-24)	VAS (0 to 10)	0.4 (0, 2)*
Greeven et al.[18] 2012	A	24 months	VAS (0 to 10)	2 (0, 4)*
Kamphuis et al.[5] 2019	A vs. B	10 years	VAS (0 to 10)	0 (0-0) **. Four participants in the open reduction group reported pain levels of 3 or higher.
Levy et al.[26] 2018	B	8 months	VAS (0 to 10)	0 (0-1.5)**
Zemirline et al.[28] 2014	C	4.5 months	VAS (0 to 10)	1 (0, 4)*
Huang et al.[22] 2023	A	17.9 months (12-34)	VAS (0 to 10)	0.7 (0, 2)*
Zhang et al.[27] 2012	B	39 months (36-42)	VAS (0 to 10)	0 (0, 2)*
Bouaicha et al.[16] 2022	A	12.5 months (range 8-18)	Brazier scale	Level 0: 24 patients (60.0%). Level I: 12 patients (30.0%). Level II: 3 patients (7.5%). Level III: 1 patient (2.5%).
Brazier et al.[8] 1996	B	3 years	Brazier scale	Level 0: 19 patients (54.3%). Level I: 10 patients (28.6%). Level II: 5 patients (14.3%). Level III: 1 patient (2.8%).
Brüske et al.[23] 2001	A vs. B	1.5 years	Pain intensity	No pain: 14 patients (66.7%). Mild pain: 2 patients (9.5%). Weather-related pain: 5 patients (23.8%).
Lutz et al.[14] 2002	A	6.4 years	Pain intensity	No pain: 18 patients (75.0%). Pain with little effort: 2 patients (8.3%). Pain with intense effort: 4 patients (16.7%).
Kjær-Petersen et al.24 1990	A vs. B	7.3 years	Pain intensity	No pain: 31 patients (75.6%). Mild weather-related pain or intense hand use pain: 10 patients (24.4%).
Obert et al.[20] 1997	A	8 years (range 2-13)	Pain intensity	No pain: 5 patients (71.4%). Moderate weather-related pain: 2 patients (28.6%).
Sawaizumi et al.[21] 2005	A	51 months	Pain intensity	No pain: 9 patients (75.0%) Mild pain: 2 patients (16.7%). Moderate pain: 1 patient (8.3%).

Table 2. Continued

Demir et al.[17] 2006	A	39 months	-	-
Middleton et al.[19] 2015	A	11.5 years	-	-
Pomares et al.[29] 2016	B vs. C	Open reduction: 33 months. Percutaneous fixation: 27 months.	-	-
Sälgeback et al.[25] 1971	A vs. B	6 years	-	-

*Average (minimum, maximum). **Median (P25-P75). A: Closed reduction and Kirschner wire fixation. B: Open reduction and screw fixation. C: Arthroscopic reduction and screw fixation.

Nine studies reported on the return to work (266 patients in total).[9,16,19–23,27,30] Of these, only three studies indicated that one or more patients could not continue working due to the injury.[9,21,30] One study, which indicated that one patient could not return to work, evaluated the technique of open reduction and internal fixation with screws.[9] Another evaluated closed reduction and percutaneous fixation and also reported that one patient did not return to work.[21] The third study compared open reduction and internal fixation with screws versus arthroscopic reduction and screw fixation,[30] reporting that in the first group (open reduction), three participants could not return to work, while in the percutaneous surgery group only one could not return to work [Table 3].

Table 3. Measurement of functional results

Author	Intervention	Return to Previous Work	Q-DASH or DASH	Lateral Pinch Strength	Grip Strength	First Web Space Opening	Kapandji (Thumb Opposition)	Thumb Position	Palmar Abduction
Adi *et al.*[15] 2014	A	Yes	4.5*	75.6% of contralateral side	88.3% of contralateral side	79.1% of contralateral side	-	-	-
Greeven *et al.*[18] 2012	A	Yes	-	***Affected side:*** 8.3 kg* ***Unaffected side:*** 8.14 kg*	***Affected side:*** 56.4 kg* ***Unaffected side:*** 53.8 kg*	-	-	-	-
Kamphuis *et al.*[5] 2019	A vs. B	-	**Overall:** 5 (0-8)** ***Open reduction group:*** 0 (0-6)** ***Closed reduction group:*** 4 (0-12)**	***Overall affected side:*** 11 kg** ***Open reduction group:*** 11 kg** ***Closed reduction group:*** 10 kg** ***Unaffected side average:*** 10 kg (both techniques)	***Overall affected side:*** 47.9 kg* ***Open reduction group:*** 48.6 kg* ***Closed reduction group:*** 46.3 kg* ***Unaffected side:*** 47.7 kg* ***Open reduction group:*** 48.6 kg* ***Closed reduction group:*** 45.4 kg*	-	-	-	-
Levy *et al.*[26] 2018	B	Yes	15*	-	84.6% of opposite side	63° ± 6°*	-	-	63°*
Zemirline *et al.*[28] 2014	C	-	5 (min 0, max 61)*	73% (min 45%, max 89%)* of contralateral side	85% (min 40%, max 100%)*	86% (min 58%, max 100%)* of contralateral side	9 min 5, max 10*	-	
Huang *et al.*[22] 2023	A	Yes	4.7 (min 0, max 15.9)*	***Affected side:*** 5.4 kg* ***Unaffected side:*** 5.9 kg*	***Affected side:*** 34.7 kg* ***Unaffected side:*** 35.5 kg*	66.2°±3.6°*; 96.6% of affected side	-	-	

Table 3. Continued

Zhang *et al.*[27] 2012	B	-	-	***Affected side:*** 7.4 kg* ***Unaffected side:*** 7.5 kg*	***Affected side:*** 43 kg* ***Unaffected side:*** 45 kg*	-	-		
Bouaicha *et al.*[16] 2022	A	-	-	-	***Excellent:*** 23 patients (57.5%). ***Good:*** 12 patients (30.0%). ***Fair:*** 4 patients (10.0%). ***Poor:*** 1 patient (2.5%).	***Normal:*** 34 patients (85.0%). ***Reduced:*** 9 patients (22.5%). ***Highly reduced:*** 2 patients (5.0%).	***9-10:*** 29 patients (72.5%). ***7-8:*** 9 patients (22.5%). ***≤6:*** 2 patients (5.0%).	-	-
Brazier *et al.*[8] 1996	B	Yes	-	***Fractured side:*** 12.11 kgf (min 3, max 29 kgf)* ***compared to healthy side:*** 13.41 kgf (min 4, max 30 kgf)*	***Fractured side:*** 31.75 kgf (min 10, max 53 kgf)* ***compared to healthy side:*** 33.25 kgf (min 13, max 62 kgf)*	-	***Fractured side:*** 8.73*; ***Healthy side:*** 8.81*	-	-
Brüske *et al.*[23] 2001	A vs. B	-	-	-	80% min 72%, max 85%* of expected standard value	-	-	Full range of thumb opposition achieved by all participants	Min 30°, max 50° (5°-12° less than affected hand)
Lutz *et al.*[14] 2002	A	-	-	-	85.4 Kpa*	-	-	-	32.9°*
Kjær-Petersen *et al.*[24] 1990	A vs. B	-	-	-	-	-	-	***Excellent position:*** 18 patients	9% reduction in 8 patients range 5%-10%
Obert *et al.*[20] 1997	A	Yes	-	104% (min 91% - max 115%)* of uninjured side	103% (min 95% - max 115%)* of uninjured side	-	9.5*	-	-
Sawaizumi *et al.*[21] 2005	A	Yes	-	-	***Affected side:*** 40 kg* ***Unaffected side:*** 42.6 kg*	-	-	-	42° min 35°, max 52°*, 84% of uninjured hand
Demir *et al.*[17] 2006	A	-	Functioning/common ***symptoms:*** 5.6 ± 1.9* ***Free time***: 8.9 ± 3.2* ***Work:*** 6.6 ± 2.1*	-	-	-	-	-	-
Middleton *et al.*[19] 2015	A	Yes	3 (min 0, max 38)*	-	-	-	-	-	
Pomares *et al.*[29] 2016	B vs. C	Yes	***Open surgery:*** 4.3 ± 1.9* ***Percutaneous surgery:*** 3.1 ± 1.7*	***Open surgery:*** 10.7 ± 0.8 kg* ***Percutaneous surgery:*** 9.3 ± 1.0 kg*	***Open surgery:*** 52 ± 2.3 kg* ***Percutaneous surgery:*** 48.7 ± 3.5 kg*	-	***Open surgery:*** 9.5 ± 0.2* ***Percutaneous surgery:*** 9.9 ± 0.1*	-	
Sälgeback *et al.*[25] 1971	A vs. B	-	-	-	-	-	-	-	

*Average ± Standard deviation. **Median (percentile 25-percentile 75). A: Closed reduction and Kirschner wire fixation. B: Open reduction and screw fixation. C: Arthroscopic reduction and screw fixation

Complications were reported for all types of surgery [Table 4]. Most common complication in the closed reduction and percutaneous fixation groups was pin site infections in 2 studies (25%),[20,25] Both studies that used arthroscopic reduction and screw fixation reported as complication minimal secondary displacement.[29,30]

Functional outcomes and osteoarthritis measurements from the included studies are presented in [Table 3]. One

of the included studies used a classification system created by the authors to report functional outcomes. The study by Sälgeback *et al.*[26] (81 patients in total, 45 patients in follow-up) used a three-group classification: Group I: no complaints, Group II: normal work capacity, slight discomfort, Group III: reduced work capacity, moderate pain. The authors reported 41 participants in Group I, 3 in Group II, and 1 in Group III. The Disabilities of the Arm, Shoulder, and Hand (DASH) or Quick-DASH (Q-DASH) score was used in 8 of the included studies,[6,16,18,20,23,27,29,30] with an overall average of 5.39. Pinch strength was evaluated in 9 articles,[6,9,16,19,21,23,28–30] while grip strength was assessed by 14 studies.[6,9,27–30,15–17,19,21–24] However, not all reported results in the same unit of measurement; some reported the percentage of strength compared to the unaffected hand, while others reported strength in kilograms (kg) or kilopascals (kPa) [Table 3]. Overall, for pinch strength, the affected hand resisted an average load of 9.28 kg, while the unaffected hand resisted an average load of 9.15 kg. For grip strength, the affected hand resisted an average load of 46.21 kg, while the unaffected hand resisted an average load of 45.15 kg. The Kapandji score was evaluated by five studies,[9,17,21,29,30] with an average score of 9.37 for the affected hand.

Eight studies reported osteoarthritis outcomes,[6,15,18,19,21,23,25,26] encompassing a total of 247 patients. Of these, 68.42% (169 patients) reported some degree of osteoarthritis postoperatively, most of them using the Eaton-Little scale,[6,15,18,19,21] while the remaining three described observations through radiographs.[23,25,26] No study evaluating the open reduction and internal screw fixation technique reported osteoarthritis outcomes. Finally, three studies that compared the two techniques (172 patients in total) reported a total of 126 patients with osteoarthritis,[6,25,26] although only one study presented results for each group [Table 4].[6]

Table 4. Measurement of osteoarthritis and complications

Author	Intervention	Eaton - Litter	Radiography	Complications
Adi *et al.*[15] / 2014	A	-	-	Malunion
Greeven *et al.*[18] /2012	A	Grade I: 6 (85.7%) Grade II: 1 (14.3%)	-	None
Kamphuis *et al.*[5]/ 2019	A vs. B	Grade I: 24 (48.0%) Grade II: 18 (36.0%) Grade III: 6 (12.0%) Grade IV: 2 (4.0%) ***Open reduction:*** Grade I: 19 (54.3%) Grade II: 11 (31.4%) Grade III: 5 (14.3%) ***Closed reduction:*** Grade I: 5 (33.3%) Grade II: 7 (46.7%) Grade III: 1 (6.7%) Grade IV: 2 (13.3%)	-	Tingling and numbness (11 treated with open surgery and 2 with closed surgery)
Levy et al.[26] /2018	B	-	-	None
Zemirline et al.[28] / 2014	C	-	-	Minimal secondary displacement with submillimeter step, and secondary displacement with a step of 1 or 2 mm.
Huang *et al.*[22]/ 2023	A	-	No signs of osteoarthritic changes in the thumb CMC joint at final follow-up in any patient. None.	None
Zhang et al.[27]/ 2012	B	-	-	-
Bouaicha et al.[16] / 2022	A	-	-	-
Brazier et al.[8]/ 1996	B	-	-	Skin and radial irritations. Superficial sepsis and dismantling of synthesis adopted by arthrodesis
Brüske *et al.*[23] / 2001	A vs. B	-	-	-
Lutz et al.[14] / 2002	A	Grade I: 5 (20.8%) Grade II: 12 (50.0%) Grade III: 6 (25.0%) Grade IV: 1 (4.2%)	-	-

Table 4. Continued

Kjær-Petersen *et al.*[24]/ 1990	A vs. B	-	Mild arthritic changes: 2 people. Arthritic changes: 8 people (with persistent irregularity of the articular surface, only 1 with advanced arthritis). Arthritis: 3 people whose fractures healed in excellent position and 7 with residual displacement.	Superficial wound infection. Kirschner wire migration and secondary displacement (only in the open reduction group).
Obert *et al.*[20]/ 1997	A	.	-	Algodystrophies (stepped trauma of the upper limb).
Sawaizumi *et al.*[21]/ 2005	A	-	-	Hyperesthesia in the area of the superficial branch of the radial nerve (disappeared after surgery). Discharge from wire insertion sites (decreased after oral antibiotics).
Demir *et al.*[17] /2006	A	Grade 0: 8 (42.1%) Grade I: 6 (31.6%) Grade II: 2 (10.5%) Grade III: 2 (10.5%) Grade IV: 1 (5.3%)	-	-
Middleton *et al.*[19]/ 2015	A	-	-	Infection
Pomares *et al.*[29]/ 2016	B vs. C	-	-	Persistent pain at the base of the first metacarpal and defective consolidation, loss of grip strength on the dominant side, paresthesia of the dorsal thumb. Inadequate reduction of the articular surface and postoperative articular remodeling. Migration of fixation material into the joint (open surgery group). Complex regional pain syndrome type I (percutaneous surgery group).
Sälgeback *et al.*[25] /1971	A vs. B	-	Osteoarthritis in the first carpometacarpal joint in 69% of cases and 63% of those treated with percutaneous pins, compared to 15% and 12% respectively, at the time of injury.	-

A: Closed reduction and Kirschner wire fixation. B: Open reduction and screw fixation. C: Arthroscopic reduction and screw fixation

Comparison of Surgical Techniques

In general, studies that evaluated only the open reduction and internal screw fixation technique reported pain in almost 50% of the patients evaluated, good functional outcomes, and adequate return to work, although some patients did not return to their previous occupations, and few complications (irritation and infection) were noted. However, no study reported data on osteoarthritis, making it impossible to assess this aspect with this technique. In comparison to studies that evaluated closed reduction and percutaneous fixation, which reported a lower proportion of patients with pain at follow-up and good return-to-work rates but lower pinch strength, almost 60% of patients with some degree of osteoarthritis, and more complications (malunion, infections, pain syndrome).

Of the four studies comparing the two previous techniques, three reported on the pain variable.[6,24,25] According to these studies, no differences were found in grip and pinch strength between the two groups. Osteoarthritis was reported in 73.2% of patients, with one study reporting more cases in the open reduction and internal fixation group, as well as more complications in this group.[6]

The arthroscopic reduction and screw fixation technique was the least evaluated among the included studies, with only two studies reporting results for this technique.[29,30] No data on osteoarthritis or difficulties returning to work were reported with this technique, making it impossible to evaluate these aspects in this review. However, secondary displacement cases were recorded.[29] Additionally, the study comparing open reduction and internal fixation with screws versus arthroscopic reduction and screw fixation reported higher DASH scores in the former group, as well as more complications.[30]

Risk of Bias Assessment

The methodological quality and risk of bias of the included studies using the Newcastle-Ottawa scale are presented in [Table 5]. Most of the studies were considered to have a low risk of bias. The quality assessment of retrospective case series was determined using the tool suggested by Murad et al.[14]. It was found that all the studies included in this

evaluation were of moderate quality, as they all received a global rating of 4 points [Table 6].

The heterogeneity in study designs, variability in outcome measures, insufficient long-term data, small sample sizes, diverse surgical techniques, and inconsistent reporting of complications all contribute to the decision not to perform a meta-analysis. These factors collectively prevent the generation of reliable, pooled estimates, which are essential for a robust meta-analysis. Therefore, this systematic review focuses on a qualitative synthesis of the available evidence to provide insights into the functional outcomes and complications associated with different surgical techniques for Bennett's fracture.

Table 5. Risk of bias assessment of retrospective and prospective cohort or case-control articles according to the New Castle Ottawa scale

Author	Year	Selection	Comparability	Result	Total	Quality
Greeven *et al.*[18]	2012	4	1	3	8	Low risk
Kamphuis et al.[5]	2019	4	1	3	8	Low risk
Levy et al.[26]	2018	4	1	3	8	Low risk
Zhang et al.[27]	2012	3	1	3	7	Moderate risk
Bouaicha et al.[16]	2022	4	1	3	8	Low risk
Brazier et al.[8]	1996	4	1	3	8	Low risk
Brüske et al.[23]	2001	4	1	3	8	Low risk
Lutz et al.[14]	2002	4	1	3	8	Low risk
Kjær-Petersen et al.[24]	1990	4	1	3	8	Low risk
Sawaizumi et al.[21]	2005	4	1	3	8	Low risk
Demir et al.[17]	2006	4	1	3	8	Low risk
Middleton et al.[19]	2015	4	1	3	8	Low risk
Pomares et al.[29]	2016	4	1	3	8	Low risk
Sälgeback et al.[25]	1971	4	1	3	8	Low risk

Low risk of bias (good quality) 8-9 points. Moderate risk of bias (fair quality) 5-7 points. High risk of bias (poor quality) <5 points

Table 6. Quality Assessment of Case Series and Case Reports Using the Tool Suggested by Murad et al.[14]

Author	Year	1	2	3	4	5	Total	Quality
Adi et al.[15]	2014	0	1	1	1	1	4	Moderate risk
Zemirline et al.[28]	2014	0	1	1	1	1	4	Moderate risk
Huang et al.[22]	2023	0	1	1	1	1	4	Moderate risk
Obert et al.[20]	1997	0	1	1	1	1	4	Moderate risk

Discussion

Most studies included in this systematic review were case series.[31] The majority of patients evaluated were male, which aligns with various studies attributing this to biological, behavioral, and occupational factors that make men more prone to such injuries, particularly in the age group where most fractures occur.[32,33] The dominant hand, usually the right in approximately 90% of the global population,[34] was most frequently affected, likely due to its higher usage and exposure to impacts and stress. Sports injuries were the most common cause, followed by falls and traffic accidents, consistent with other studies on fracture causes.[35,36] A systematic review by Goru et al.[37] also found that traffic accidents, sports injuries, falls, and physical assaults were the common causes of Bennett's fracture. The consensus from the articles included in this review indicates that all three surgical techniques—open reduction with internal fixation, closed reduction with percutaneous fixation, and arthroscopic reduction with screw fixation—generally yield good functional outcomes.

DASH and Q-DASH scores reported in the studies show minimal disability, with scores generally below 15, indicating good functional recovery. Current clinical evidence suggests that these two scales are appropriate for evaluating functional outcomes in hand fractures like Bennett's fracture[38] as they are comprehensive and user-friendly, allowing for consistent and comparable assessments of disability and symptom severity across different studies. Goru et al.[37] and Daher et al.[39] similarly reported high return-to-work rates and good functional outcomes using both scales. Kamphuis et al.[6] and Tsang et al.[40] have utilized DASH and Q-DASH scales to evaluate outcomes of Bennett's

fracture treatment and have shown their effectiveness in capturing the impact of different surgical techniques, including closed reduction and percutaneous fixation and open reduction and internal fixation. Despite the reliability of both scales, not all the studies included in this review used them consistently.

Pain outcomes vary, with open reduction and internal fixation showing a higher incidence of long-term pain compared to closed reduction and percutaneous fixation. In general, studies evaluating different surgical techniques for this type of fracture report a low percentage of patients with long-term pain.[6,28,30] A recent systematic review by Daher et al.[39] found that pain was mainly observed in patients treated with open reduction, though no significant differences were reported. This review's findings align with those in the literature. Comparing the three surgical techniques, closed reduction and percutaneous fixation appear to have fewer pain-associated issues.

The data on osteoarthritis outcomes are insufficient to compare the three surgical techniques evaluated. Nearly 70% of patients across all studies exhibited some symptoms of osteoarthritis during the follow-up period; however, the follow-up periods in the included studies may have been insufficient to fully identify osteoarthritis, a complication that often manifests in the long term.[41] Complication rates and osteoarthritis incidences align with those reported in previous systematic reviews and meta-analyses, underscoring the need for standardized follow-up protocols and evaluation methods across future studies to enhance data comparability and patient outcomes.

Grip and pinch strength data show similar results across all techniques. The average Kapandji score for the affected hand was 9.37 out of 10, indicating satisfactory outcomes across all techniques. Similar results were found in the review by Goru et al.[37] The return-to-work rates are high across all techniques, with most patients resuming their previous occupations within a few weeks post-surgery, especially those treated with open reduction and internal screw fixation. Goru et al.[37] also reported a high rate of return to work within the first 6 weeks post-surgery. Similarly, Torres-Fuentes et al.[42] who evaluated 30 patients treated with arthroscopic reduction and screw fixation, reported that all patients returned to work.

Limitations

The limitations of this systematic review include those typically associated with retrospective studies, such as the lack of an appropriate experimental design with control groups, loss of patients during follow-up, lack of information in some areas, and the use of different scales and evaluation methods. Furthermore, some aspects related to arthroscopic reduction and screw fixation could not be evaluated due to a lack of studies assessing this surgical approach.

Conclusion

The results of this systematic review are consistent with those reported in other reviews and similar studies. In terms of functional outcomes, all techniques seem to yield similar results. However, patients treated with open reduction and internal screw fixation experienced pain after the surgery more frequently than those treated with closed reduction and percutaneous fixation. There is insufficient data to evaluate this aspect in arthroscopic reduction and screw fixation. The data reviewed indicates that osteoarthritis seems to be a common consequence of these fractures, regardless of the treatment type. However, like pain, we could not effectively evaluate this condition in patients treated with arthroscopic reduction and screw fixation. Given the limitations in study design and follow-up periods, it is crucial to standardize the use of reliable functional evaluation scales such as DASH and QuickDASH, and to conduct longer-term studies to accurately assess the incidence of osteoarthritis and other long-term complications.

Since the arthroscopic reduction and screw fixation technique is relatively newer, it is necessary to conduct rigorous follow-up with patients who undergo surgery with this approach to compare long-term functional outcomes effectively.

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