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Treatment of olecranon bursitis: a systematic review

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Abstract
Introduction The optimal management of olecranon bursitis is ill-defined. The purposes of this review were to systematically evaluate clinical outcomes for aseptic versus septic bursitis, compare surgical versus nonsurgical management, and examine the roles of corticosteroid injection and aspiration in aseptic bursitis.
Materials and Methods The English-language literature was searched using PubMed, Cumulative Index to Nursing and Allied Health Literature, Physiotherapy Evidence Database, Allied and Complementary Medicine, and Cochrane Central Register of Controlled Trials. Analyses were performed for clinical resolution and complications after treatment of aseptic and/or septic olecranon bursitis.
Results Twenty-nine studies containing 1278 patients were included. Compared with septic bursitis, aseptic bursitis was associated with a significantly higher overall complication rate ($p = 0.0108$). Surgical management was less likely to clinically resolve septic or aseptic bursitis ($p = 0.0476$), and demonstrated higher rates of overall complications ($p = 0.0117$), persistent drainage ($p = 0.0194$), and bursal infection ($p = 0.0060$) than nonsurgical management. Corticosteroid injection for aseptic bursitis was associated with increased overall complications ($p = 0.0458$) and skin atrophy ($p = 0.0261$). Aspiration did not increase the risk of bursal infection for aseptic bursitis.
Conclusions Based primarily on level IV evidence, nonsurgical management of olecranon bursitis is significantly more effective and safer than surgical management. The clinical course of aseptic bursitis appears to be more complicated than that of septic bursitis. Corticosteroid injection is associated with significant risks without improving the outcome of aseptic bursitis.
Level of evidence Therapeutic IV.

Keywords Olecranon · Elbow · Septic bursitis · Aseptic bursitis · Treatment · Management

Introduction

The olecranon bursa is a synovium-lined sac that promotes gliding between the olecranon and overlying skin [4]. Due to its subcutaneous position, the olecranon bursa is susceptible to pressure, trauma, infection, and inflammatory conditions [4]. Olecranon bursitis is characterized by fluid in the bursa with or without inflammation. The fluid can be serous in routine aseptic olecranon bursitis, sanguinous following trauma, or purulent in the case of infection, gout, rheumatoid arthritis, or similar inflammatory conditions. Olecranon bursitis can be painful, particularly when due to gout or infection, or asymptomatic until local swelling is noticed, as in many cases of aseptic bursitis. Infection may be secondary to cuts or scratches of the skin at the elbow, although no cause or risk factor may be apparent [4]. In addition to trauma, intensive physical labor, medical illnesses such as rheumatoid arthritis and gout, and long-term hemodialysis predispose patients to bursitis [21]. Structural

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factors such as a prominent olecranon process or bone spur are also recognized in association with bursitis [21]. Olecranon bursitis may be septic or aseptic in nature, although the clinical features of these two entities may be hard to differentiate, as in the case of gout [24], requiring diagnostic culture and analysis of bursal fluid. Septic olecranon bursitis is most commonly caused by *Staphylococcus aureus* [5, 16], which can potentially progress to osteomyelitis of the ulna if left untreated [4].

As there is no standardized approach to the management of olecranon bursitis, practice patterns are largely rooted in anecdotal experience [27]. Aseptic olecranon bursitis may be managed nonsurgically with "benign neglect" and avoidance of pressure to the area, non-steroidal anti-inflammatory drugs (NSAIDs), needle aspiration, corticosteroid injection (CSI), compression dressings, and/or padded splinting [4, 12, 21, 31]. Acute aseptic olecranon bursitis tends to subside over time with nonsurgical management, although some cases become chronic [21]. The treatment of septic bursitis requires needle aspiration for diagnosis and potentially definitive treatment, appropriate oral or intravenous antibiotics directed towards the offending organism, and, when clinically indicated, surgical evacuation of the bursa [16]. Although needle aspiration of the bursa is commonly performed [27] for suspected septic bursitis, it is not known whether the benefits of aspiration outweigh the possible drawbacks in the setting of aseptic bursitis, including the introduction or local dissemination of bacteria and the formation of sinus tracts that can cause chronic symptoms [22, 29]. While cortisone is sometimes injected into the bursa in the treatment of aseptic olecranon bursitis, there are potential risks of infection and skin atrophy [31].

The role of surgical intervention for aseptic or septic olecranon bursitis is not well defined [4]. Incision and drainage of the infected olecranon bursa is commonly performed for septic bursitis that does not respond to needle aspiration and antibiotic treatment, while open or endoscopic surgery [18, 28] may be undertaken for persistent aseptic olecranon bursitis and/or bony spurs of the olecranon [21]. Aside from progressive bursal enlargement or persistence and lack of improvement with nonsurgical methods [21], the indications for surgery are unclear [27]. Surgical treatment of aseptic olecranon bursitis must take into account the potentially tenuous skin coverage, risk of recurrence or persistent drainage, and proximity of the ulnar nerve [21].

Given that no consensus exists as to the optimal management of olecranon bursitis, the objective of this systematic review was to assess clinical outcomes following treatment of aseptic and septic bursitis, with an emphasis on (1) nonsurgical versus surgical management and (2) the roles of corticosteroid injection and aspiration in aseptic bursitis.

Materials and methods

Eligibility criteria

The systematic review was performed according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. Studies were included if they reported clinical outcomes after the treatment of aseptic and/or septic olecranon bursitis. Studies were excluded if they had a solely descriptive design, did not describe the treatment protocol, or inadequately reported clinical outcomes. No restrictions were imposed upon the publication date, level of evidence, or follow-up interval. Case reports, cadaveric studies, animal studies, systematic reviews, narrative reviews, and comments were excluded.

Literature search

PubMed, the Cumulative Index to Nursing and Allied Health Literature (CINAHL), Allied and Complementary Medicine (AMED), the Physiotherapy Evidence Database (PEDro), and the Cochrane Central Register of Controlled Trials (CENTRAL) were queried to identify relevant English-language studies. The search term was as follows: bursitis AND (olecranon OR elbow). The search was performed in January 2014 and repeated in March 2014. The resulting study titles and abstracts were reviewed according to the eligibility criteria. Full manuscripts were procured and reviewed for eligible studies, and their citations were manually screened in an effort to identify additional studies that might have been missed. A PRISMA trial flow demonstrates the study selection algorithm (Fig. 1).

Data extraction

Data from eligible studies were extracted for study and patient characteristics, the treatment protocol, and clinical outcomes pertaining to clinical resolution and complications. Clinical resolution was defined as significant improvement or subsidence of the bursitis after the initial course of management. Patients who failed to respond to treatment and exhibited chronic or recurrent bursitis were considered clinical failures. Study characteristics included the study design, sample size, type of bursitis (septic vs. aseptic), location of bursitis (olecranon only vs. multiple locations), and follow-up interval. Patient characteristics included the age, gender distribution, symptom duration, cause of bursitis, and causative organism, when applicable.

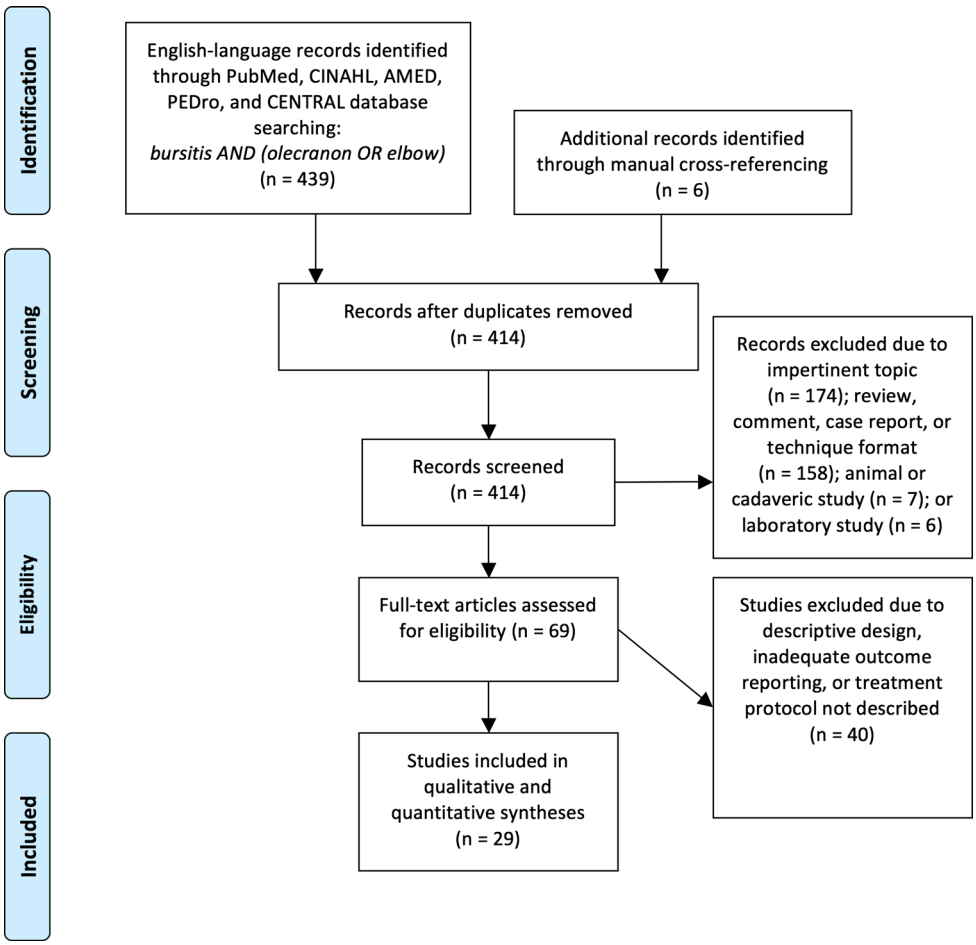

Fig. 1 Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram describing the inclusion process for the studies in the systematic review

Complications of interest included persistent tenderness, persistent drainage, bursal infection, and skin atrophy.

Data synthesis

Data were aggregated for outcome measures that were reported by at least two studies per group in the comparison. The overall results of different treatments were statistically compared as follows: septic versus aseptic bursitis, irrespective of the treatment employed; nonsurgical versus surgical management for septic and aseptic bursitis; CSI vs. no CSI for aseptic bursitis; and aspiration versus no aspiration for aseptic bursitis. Studies that only reported data for an aggregate of olecranon and other bursitides could not be included in any quantitative analyses. Likewise, studies that only reported data for an aggregate of treatment strategies could not be included in the analyses of specific treatment strategies. Lastly, studies that employed a single treatment but failed to differentiate outcomes for septic versus aseptic bursitis could not be used to separately compare treatments for septic and aseptic bursitis. Pearson's Chi square test was used to analyze categorical data, with statistical significance defined by $p < 0.05$. All other extracted data were descriptively reviewed.

Results

Literature search

The search of PubMed, CINAHL, PEDro, AMED, and CENTRAL identified 29 studies [1–5, 7–23, 25–31], containing 1278 total patients, for inclusion in the review. Seventeen studies [3, 4, 7–10, 12–15, 18, 21, 23, 25, 28, 30, 31] containing 354 patients were suitable for the statistical comparison of treatment strategies, as they clearly reported outcome data following a specific treatment for olecranon bursitis alone.

Study characteristics

There were twenty-five retrospective series [1–5, 7, 10–23, 26, 28–31], three prospective series [8, 9, 27], and one

Table 1 Overview of included studies

First author (year)	Study design	Cases (*n*)	Type	Location	Follow-up interval (months)
Perez [19]	RS	343	Septic	O (69.1 %) P (30.9 %)	23 (2.7–67)
Martinez-Taboada [17]	RS	82	Septic	O (26.8 %) P (73.2 %)	–
Degreef [4]	RS	34 3	Aseptic Septic	O	–
Cea-Pereiro [2]	RS	57	Septic	O (43.9 %) P (50.9 %) 1-MTP (3.5 %) EM (1.8 %)	–
Laupland [16]	RS	118	Septic	O	–
Ogilvie-Harris [18]	RS	50	Aseptic	O (62.0 %) P (38.0 %)	32.4[a] (13.2–66)
Garcia-Porrua [5]	RS	75	Septic	O (46.7 %) P (44.0 %) T (5.3 %) SA (2.7 %) I (1.3 %)	–
Stell [27]	PS	22 25	Septic Aseptic	O (68.2 %) P (31.8 %) O (72.0 %) P (28.0 %)	SB: 13.5 AB: 14.6
Stewart [28]	RS	21	Aseptic	O	62.4
Hassell [7]	RS	7	Septic	O	–
Kerr [13]	RS	10 1	Aseptic Septic	O (36.4 %) P (63.6 %)	5.1 (1–15)
Pien [20]	RS	47	Septic	O (72.3 %) P (27.7 %)	
Kerr [14]	RS	6	Aseptic	O (50.0 %) P (50.0 %)	6.3 (1.5–15)
Smith [25]	RCT	42	Aseptic	O	–
Raddatz [22]	RS	54	Septic	O (57.4 %) P (33.3 %) I (3.7 %) SD (1.9 %) T (1.9 %) 4,5-MCP (1.9 %)	–
Roschmann [23]	RS	30	Septic	O (66.7 %) I (30.0 %) S (3.3 %)	–
Soderquist [26]	RS	35	Septic	O (31.4 %) P (68.6 %)	(2–24)
Knight [15]	RS	12	Septic	O (83.3 %) P (16.7 %)	–
Jaffe [12]	RS	3 9	Septic Aseptic	O	22.4 (12–29)
Weinstein [31]	RS	47	Aseptic	O	31 (6–62)

Table 1 continued

First author (year)	Study design	Cases (*n*)	Type	Location	Follow-up interval (months)
Ho [8]	PS	25	Septic	O (84.0 %) P (12.0 %) I (4.0 %)	6.8 (1–13)
Hoffmeyer [11]	RS	17	Septic	O	–
Canoso [1]	RS	16	Septic	O (75.0 %) P (12.5 %) PT (12.5 %)	–
Ho [9]	PS	10	Septic	O (90.0 %) P (10.0 %)	(2–6)
		20	Aseptic	O (80.0 %) P (20.0 %)	
Vilbar [30]	RS	4	Aseptic	O	11.8 (10–14)
Ho [10]	RS	25	Septic	O (80.0 %) P (20.0 %)	–
Quayle [21]	RS	11	Aseptic	O	36 (6–72)
Thompson [29]	RS	12	Septic	O (75.0 %) P (16.7 %) SD (8.3 %)	–
Cruz [3]	RS	5	Aseptic	O	(41–70)

When applicable, the range is given in parentheses

RS retrospective series, *PS* prospective series, *RCT* randomized-controlled trial, *SB* septic bursitis, *AB* aseptic bursitis, *O* olecranon, *P* prepatellar, *1-MTP* first metatarsophalangeal, *EM* external malleolar, *T* trochanteric, *SA* subacromial, *I* infrapatellar, *SD* subdeltoid, *4,5-MCP* fourth and fifth metacarpophalangeal, *PT* pretendinous

[a] Indicates that data were reported for the entire study, but not specifically for the olecranon bursitis subgroup

randomized-controlled trial (RCT) [25], published between 1977 and 2010 (Table 1). Ten studies [3, 4, 7, 11, 12, 16, 21, 25, 28, 30, 31] only evaluated olecranon bursitis, while 19 studies [1, 2, 5, 8–10, 13–15, 17–20, 22, 23, 26, 27, 29] also included bursitides of other locations, although not all of these studies separately reported outcomes according to the location of bursitis. Septic bursitis, aseptic bursitis, or a mixture of these were included in 16 [1, 2, 5, 7, 8, 10, 11, 15–17, 19, 20, 22, 23, 26, 29], eight [3, 14, 18, 21, 25, 28, 30, 31], and five studies [4, 9, 12, 13, 27], respectively. The mean follow-up interval ranged from 5.1 to 62.4 months [8, 12–14, 18, 19, 21, 27, 28, 30, 31].

Patient characteristics

The mean age ranged from 31 to 66 years; the proportion of male patients was between 25 and 100 %; and the symptom duration ranged from 2.6 days to 49.5 months (Table 3 in Appendix). Trauma, pressure on the bursa, and/or occupational risk factors were implicated as the chief cause of bursitis in 21 of 26 studies. *Staphylococcus aureus* was the most common causative organism identified in bursal fluid analysis of septic bursitis in all studies.

Treatment protocol

Patients with olecranon bursitis exclusively received nonsurgical management in 10 of 29 studies ($n = 206$) [3, 7–10, 12, 23, 25, 30, 31], which included antibiotic therapy, aspiration, CSI, and/or NSAIDs alone (Table 4 in Appendix). Of these studies that employed nonsurgical management, five treated septic olecranon bursitis, four treated aseptic olecranon bursitis, and one treated a combination of both. Patients exclusively received surgical management in seven studies ($n = 148$) [4, 13–15, 18, 21, 28], which included open or arthroscopic bursectomy, osseous resection, and/or percutaneous suction-drainage. Of these studies that employed surgical management, one treated septic olecranon bursitis, four treated aseptic olecranon bursitis, and two treated a combination of both. Twelve studies [1, 2, 5, 11, 16, 17, 19, 20, 22, 26, 27, 29] employed a combination of nonsurgical and surgical treatments in some or all patients, precluding specific analysis of any single treatment. CSI was administered to 92 patients with aseptic olecranon bursitis in six studies [3, 12, 18, 25, 27, 31]. Aspiration was performed initially for some or all patients with aseptic olecranon bursitis in all but one study [28] that employed surgery alone and

Table 2 Aggregated outcome statistics for included studies

	No. of studies	No. of cases	Aggregated rate (%)	Significance
Clinical resolution				
Septic vs. aseptic bursitis	22	685	89.6 vs. 92.6	NS
Nonsurgical vs. surgical management	19	339	93.2 vs. 86.7	SS
Septic bursitis	10	113	93.8 vs. 100	NS
Aseptic bursitis	10	273	89.6 vs. 89.6	NS
CSI vs. no CSI	10	177	93.3 vs. 88.5	NS
Overall complications				
Septic vs. aseptic bursitis	20	486	11.3 vs. 6.1	SS
Nonsurgical vs. surgical management	13	249	12.7 vs. 25.2	SS
Septic bursitis	5	50	3.0 vs. 11.8	NS
Aseptic bursitis	8	162	16.1 vs. 10.1	NS
CSI vs. no CSI	7	159	19.5 vs. 8.5	SS
Persistent tenderness				
Septic vs. aseptic bursitis	7	169	14.3 vs. 12.8	NS
Nonsurgical vs. surgical management	6	184	11.9 vs. 13.5	NS
CSI vs. no CSI	4	88	9.6 vs. 13.9	NS
Persistent drainage				
Septic vs. aseptic bursitis	8	129	8.5 vs. 0	NS
Nonsurgical vs. surgical management	6	107	0 vs. 14.9	SS
Bursal infection				
Nonsurgical vs. surgical management	6	151	15.4 vs. 2.7	SS
CSI vs. no CSI	5	147	6.5 vs. 5.9	NS
Aspiration vs. no aspiration	6	150	5.3 vs. 9.1	NS
Skin atrophy				
CSI vs. no CSI	2	89	10.9 vs. 0	SS

CSI corticosteroid injection, *SS* statistically significant, *NS* not significant

another study [4] that reserved aspiration for recurrences following surgical bursectomy.

The treatments employed for septic bursitis included antibiotics (100 %), aspiration (82.0 %), surgery (47.1 %), and/or NSAIDs (0.06 %). The route of antibiotic administration was either unspecified (57.3 %), intravenous only (37.9 %), both intravenous and oral (3.6 %), intrabursal (1.1 %), or oral only (0.03 %). The treatments employed for aseptic bursitis included aspiration (70.9 %), surgery (47.0 %), CSI (39.3 %), NSAIDs (10.3 %), antibiotics (1.9 %), anesthetic injection (1.3 %), and/or observation (0.4 %). In 14 of 21 studies on septic bursitis and 8 of 11 studies on aseptic bursitis, multimodal treatment was undertaken.

Clinical resolution

Septic and aseptic bursitis were equally likely to resolve after the treatment course ($p = 0.2236$) (Table 5 Appendix). When septic and aseptic bursitis were analyzed together, clinical resolution was significantly more common after nonsurgical management (93.2 %) than surgical management (86.7 %) ($p = 0.0476$). Patients who received CSI were not more likely to recover from aseptic bursitis at follow-up ($p = 0.0724$).

Overall complications

Complications were significantly more common in patients treated for aseptic bursitis (11.3 %) versus septic bursitis (6.1 %) ($p = 0.0108$). When septic and aseptic bursitis were analyzed together, there were significantly more overall complications in surgically (25.2 %) versus nonsurgically managed patients (12.7 %) ($p = 0.0117$). Complications were significantly more common in patients who received CSI (19.5 %) for aseptic bursitis than those who did not (8.5 %) ($p = 0.0458$).

Persistent tenderness

Persistent tenderness was equally likely after treatment of septic and aseptic bursitis ($p = 0.8536$), after surgical versus nonsurgical management ($p = 0.6554$) of either aseptic or septic bursitis, and in patients who received CSI for aseptic bursitis versus those who did not ($p = 0.5346$) (Table 6 in Appendix).

Persistent drainage

Persistent drainage was significantly more common after surgical management (14.9 %) than nonsurgical management (0 %) ($p = 0.0194$). Persistent drainage was not significantly more common after treatment of septic versus aseptic bursitis ($p = 0.0747$).

Bursal infection

In patients with aseptic bursitis, bursal infection was significantly more likely after surgical (16.1 %) versus nonsurgical treatment (3.4 %) of aseptic bursitis ($p = 0.0060$). Neither CSI administration ($p = 0.8916$) nor aspiration ($p = 0.3651$) for aseptic bursitis altered the incidence of infection relative to other patients.

Skin atrophy

Skin atrophy was seen in patients treated with CSI (10.9 %) but not those who did not receive CSI (0 %) ($p = 0.0261$).

Discussion

Several disparate management approaches are employed for olecranon bursitis, with personal preference generally guiding practice patterns due to the lack of evidence-based guidelines. There is no consensus as to the effectiveness and safety of nonsurgical versus surgical management, and the roles of corticosteroid injection and aspiration in the management of aseptic bursitis are unclear. The findings of this systematic review (Table 2) suggest that nonsurgical management leads to better clinical resolution of olecranon bursitis than surgical management. Furthermore, surgical management leads to more overall complications, persistent drainage, and bursal infections than nonsurgical management. Interestingly, the treatment of aseptic bursitis was associated with a significantly higher overall complication rate than septic bursitis. Septic bursitis seems to resolve more readily than aseptic bursitis after treatment despite fairly similar rates of initial surgical intervention (47.1 vs. 47.0 %), although aspiration was more commonly performed for septic bursitis (82.0 vs. 70.9 %). CSI did not improve the rate of clinical resolution, but was associated with increased overall complications and skin atrophy. Skin atrophy is a recognized morbidity associated with subcutaneous injection of corticosteroid [6].

The nearly universal performance of bursal fluid aspiration in the treatment of aseptic olecranon bursitis precluded outcome comparison with a non-aspirated group in which the natural history of the condition might be seen. As only one patient with aseptic olecranon bursitis in this review was treated with observation alone [12], the merits of "benign neglect" as a management strategy are unclear, but should be explored in future studies. The only other study that came close to using a natural history-based approach was that of Weinstein et al. [31], who managed 22 patients with initial aspiration and subsequent observation compared with 25 patients managed with intrabursal injection of triamcinolone. Compared with the CSI group, the "control" patients demonstrated dramatically fewer complications and steady, albeit slower, clinical resolution in all but one patient.

An innate limitation of this systematic review is the quality of evidence upon which it is based. Twenty-five of 29 studies had a retrospective, non-randomized, and uncontrolled design, and thus were prone to selection, performance, and detection biases. Heterogeneity was present in the demographic and therapeutic characteristics of the analyzed patients. Most studies were observational series, which may overestimate the magnitude of the treatment effect, rather than high-level comparative evidence such as well-designed controlled trials or cohort studies. Type II error was possible for certain quantitative analyses in this review due to insufficient statistical power. Inadequate outcome reporting precluded quantitative comparison of subjective outcomes such as pain, satisfaction, and return to work, as well as objective measures of elbow pain and function. Twelve of the selected studies could not be included in the analyses of treatment strategies because they only reported outcomes for an aggregated population with multiple locations of bursitis and/or treatment algorithms. Similarly, some studies could not be included in the treatment comparisons that were stratified according to septic versus aseptic bursitis, because they did not separately report outcomes for each type of bursitis.

Going forward, RCTs with a sufficiently large sample size are required to corroborate the statistically significant differences identified across treatment paradigms in this systematic review. While nonsurgical management should be favored as the first-line strategy for most patients with olecranon bursitis due to its superior effectiveness and safety, future research should elucidate the specific clinical indications for surgical intervention. Additionally, data concerning the long-term natural history of untreated aseptic olecranon bursitis are unavailable and should be part of any future clinical trials for this condition.

Conclusion

In summary, the findings of this systematic review suggest that nonsurgical management is the optimal treatment

paradigm for olecranon bursitis, due to a significantly higher rate of clinical resolution and lower rates of overall complications, persistent drainage, and bursal infection than surgical management. The use of CSI should be reconsidered due to its lack of clear clinical benefit and significant association with increased overall complications and skin atrophy. For unclear reasons, aseptic bursitis is associated with a more complicated clinical course.

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

Appendix

See Appendix Tables 3, 4, 5, 6.

Table 3 Patient characteristics of included studies

First author (year)	Cases (*n*)	Type	Location	Age (years)	Male (%)	Symptom duration	Cause (s)	Causative organism (s)
Perez [19]	343	Septic	O (69.1 %) P (30.9 %)	51[a]	82.9[a]	–	Trauma (48.4 %), unknown (37.9 %), furunculosis (5.2 %), pressure (3.8 %), scratching (2.3 %), other (2.3 %); predisposing medical condition in 26.2 %	Culture (+) in 74.6 %; *S. aureus* (84.8 %), *S. pyogenes* (6.3 %), other *Streptococcus* (5.9 %), *E. faecalis* (1.6 %), mixed (1.6 %), other *Staphylococcus* (0.8 %)
Martinez-Taboada [17]	82	Septic	O (26.8 %) P (73.2 %)	47.2 (16.3)	79.3	6.1 (6.9) days	Trauma (39.0 %); predisposing medical condition in 32.9 %	Culture (+) in 66.7 %; *S. aureus* (94.4 %)
Degreef [4]	34 3	Aseptic Septic	O	52 (21–78)	97.2	–	Trauma (32.4 %), bone spur (8.1 %); predisposing medical condition in 10.8 %	–
Cea-Pereiro [2]	57	Septic	O (43.9 %) P (50.9 %) 1-MTP (3.5 %) EM (1.8 %)	49.4[a] (20–85)	87.5	–	Occupational (51.1 %) trauma (24.4 %); prior bursal disease (8.9 %); predisposing medical condition in 13.3 %	*S. aureus* (82.5 %), other *Staphylococcus* (7.0 %), mixed (7.0 %), other (3.5 %)
Laupland [16]	118	Septic	O	44 (13)	88	4 (1–26) days	Trauma (53.4 %); predisposing medical condition in 33.1 %	*S. aureus* (87.1 %3), group G *Streptococcus* (9.7 %), group A *Streptococcus* (6.5 %)
Ogilvie-Harris [18]	50	Aseptic	O (62.0 %) P (38.0 %)	31[a] (19–57)	54.0[a]	13.2[a] (3–48) months	Possibly sports-related (22.0 %)	–
Garcia-Porrua [5]	75	Septic	O (46.7 %) P (44.0 %) T (5.3 %) SA (2.7 %) I (1.3 %)	50.7[a] (16–89)	82.7	9.3[a] (0.5–92) days	Trauma (50.7 %), CSI (2.7 %), IV drug use (2.7 %); predisposing medical condition in 33.3 %	*S. aureus* (82.6 %), *Streptococcus* (8.7 %), *B. abortus* (4.3 %), other (5.8 %)
Stell [27]	22	Septic	O (68.2 %) P (31.8 %)	SB: 34.6 (24–55)	SB: 100	SB: 2.6 (1–8) days	–	–
	25	Aseptic	O (72.0 %) P (28.0 %)	AB: 45.9 (28–88)	AB: 76.5	AB: 5.5 (0–29) days		
Stewart [28]	21	Aseptic	O	50 (17–76)	85.0	49.5 (2.5–240) mos	Bone spur (52.4 %), trauma (38.1 %), occupational (28.6 %), arthritis (19.0 %), ossified body (4.8 %), soft-tissue mass (4.8 %); predisposing medical condition in 33.3 %	*S. aureus* (85.7 %), other (14.3 %)
Hassell [7]	7	Septic	O	66 (58-70)	71.4	–	Prior CSI (42.9 %); RA in 100 %	–
Kerr [13]	10 1	Aseptic Septic	O (36.4 %) P (63.6 %)	–	–	–	Trauma (50.0 %), infection (25.0 %); gout in 25.0 %	–

Table 3 continued

First author (year)	Cases (*n*)	Type	Location	Age (years)	Male (%)	Symptom duration	Cause (s)	Causative organism (s)
Pien [20]	47	Septic	O (72.3 %) P (27.7 %)	51[a]	74	4.8 (0–30) days	Trauma (48.9 %), pressure (40.4 %); predisposing medical condition in 27.7 %; prior joint disease in 21.3 %	*S. aureus* (70.2 %), mixed (17.0 %), Gram-negative bacteria (6.4 %)
Kerr [14]	6	Aseptic	O (50.0 %) P (50.0 %)	–	–	–	Trauma (66.7 %)	–
Smith [25]	42	Aseptic	O	60.5 (27–92)	100	17.7 days	Idiopathic (59.5 %), trauma (38.1 %); gout in 2.4 %	–
Raddatz [22]	54	Septic	O (57.4 %) P (33.3 %) I (3.7 %) SD (1.9 %) T (1.9 %) 4,5-MCP (1.9 %)	48.5[a] (5–88)	86.7[a]	5.4 (1–30) days	Trauma, skin breakage, and/or occupational (74 %), prior CSI (1.9 %); predisposing medical condition in 57.4 %	Culture (+) in 98.0 %; *S. aureus* (77.6 %), mixed (12.2 %), other (10.2 %)
Roschmann [23]	30	Septic	O (66.7 %) I (30.0 %) S (3.3 %)	45.3[a] (17–85)	93.1[a]	2.6[a] days	Trauma (70.0 %)	*S. aureus* (76.9 %), *S. pyogenes* (15.4 %), *C. albicans* (7.7 %) [b]
Soderquist [26]	35	Septic	O (31.4 %) P (68.6 %)	47[a] (18–83)	91.4	–	Trauma (77.1 %), prior CSI (11.4 %); predisposing medical condition in 31.4 %	*S. aureus* (62.9 %), *S. pyogenes* (34.3 %), α-hemolytic *Streptococcus* (2.9 %)
Knight [15]	12	Septic	O (83.3 %) P (16.7 %)	–	–	–	Prior CSI (33.3 %), trauma (25.0 %), bone spur (16.7 %), prior aspiration (16.7 %)	*S. aureus* (75.0 %), *S. pyogenes* (16.7 %), *S. epidermidis* (8.3 %)
Jaffe [12]	3 9	Septic Aseptic	O	57 (35–68)	100	42 (7–364) days	Trauma (80.0 %); hemodialysis (20.0 %)	–
Weinstein [31]	47	Aseptic	O	57.4 (22–64)	–	12.4 (1–180) days	Trauma (100 %)	–
Ho [8]	25	Septic	O (84.0 %) P (12.0 %) I (4.0 %)	50[a] (17–87)	–	5.9 (1–30) days	Occupational (29.8 %)	*S. aureus* (85.7 %), *S. pyogenes* (9.5 %), *S. epidermidis* (4.8 %)
Hoffmeyer [11]	17	Septic	O	41 (22–59)	88.2	2 (1–3) days	Trauma (70.6 %); predisposing medical condition in 58.8 %	*S. aureus* (70.6 %), mixed (23.5 %), *S. hemolyticus* (5.9 %)
Canoso [1]	16	Septic	O (75.0 %) P (12.5 %) PT (12.5 %)	59.1 (48–81)	100	17 (2–90) days	Trauma (58.3 %), prior CSI (16.7 %); predisposing medical condition in 91.7 %	*S. aureus* (83.3 %), other (16.7 %)

Table 3 continued

First author (year)	Cases (*n*)	Type	Location	Age (years)	Male (%)	Symptom duration	Cause (s)	Causative organism (s)
Ho [9]	10	Septic	O (90.0 %) P (10.0 %)	SB: 56 (39–84)	100	–	Trauma (36.7 %); predisposing medical condition in 16.7 %	–
	20	Aseptic	O (80.0 %) P (20.0 %)	AB: 56 (30–72)				
Vilbar [30]	4	Aseptic	O	60.3 (47–72)	100	–	Hemodialysis (100 %)	—
Ho [10]	25	Septic	O (80.0 %) P (20.0 %)	47[a] (17–84)	100	5.5 (0–24) days	Trauma or pressure (68.0 %), gouty tophi (8.0 %), rheumatoid nodules (4.0 %)	*S. aureus* (88.0 %), other (12.0 %)
Quayle [21]	11	Aseptic	O	53.5 (40–72)	77.8	–	Trauma was "main initiating cause," bone spur (63.6 %), large or prominent olecranon (54.5 %)	–
Thompson [29]	12	Septic	O (75.0 %) P (16.7 %) SD (8.3 %)	48.7 (34–74)	100	–	–	*S. aureus* (90.0 %), *S. pyogenes* (10.0 %)
Cruz [3]	5	Aseptic	O	–	25.0	–	–	–

When applicable, the range or standard deviation is given in parentheses

SB septic bursitis, *AB* aseptic bursitis, *O* olecranon; *P* prepatellar, *1-MTP* first metatarsophalangeal, *EM* external malleolar, *T* trochanteric, *SA* subacromial, *I* infrapatellar, *SD* subdeltoid, *4,5-MCP* fourth and fifth metacarpophalangeal, *PT* pretendinous, *CSI* corticosteroid injection, *RA* rheumatoid arthritis

[a] Indicates that data were reported for the entire study, but not specifically for the olecranon bursitis subgroup

[b] In the study of Roschmann et al. the causative organism was only reported for the group of 13 immunocompromised patients

Table 4 Treatment algorithm in included studies

First author (year)	Cases (*n*)	Type	Location	Treatment (s)	Duration of antibiotic therapy
Perez [19]	343	Septic	O (69.1 %) P (30.9 %)	Antibiotics (100 %) Aspiration (100 %) Bursectomy (91.0 %) ± lavage and closure	13 days (total), 3 days (IV)
Martinez-Taboada [17]	82	Septic	O (26.8 %) P (73.2 %)	IV antibiotics (100 %) Aspiration (100 %) Surgical I&D (12.2 %)	–
Degreef [4]	34 3	Aseptic Septic	O	Open bursectomy (100 %) SB: + Antibiotics	–
Cea-Pereiro [2]	57	Septic	O (43.9 %) P (50.9 %) 1-MTP (3.5 %) EM (1.8 %)	Antibiotics (100 %) Aspiration (100 %) Surgical I&D (10 %)	Hospitalization for 10.5 days
Laupland [16]	118	Septic	O	IV antibiotics (100 %) Surgical I&D (43.2 %) Aspiration (27.1 %)	–
Ogilvie-Harris [18]	50	Aseptic	O (62.0 %) P (38.0 %)	Arthroscopic bursectomy (100 %) Aspiration (100 %) CSI (100 %)	–
Garcia-Porrua [5]	75	Septic	O (46.7 %) P (44.0 %) T (5.3 %) SA (2.7 %) I (1.3 %)	IV antibiotics (100 %) Aspiration (100 %) Bursectomy (4.0 %)	–
Stell [27]	22 25	Septic Aseptic	O (68.2 %) P (31.8 %) O (72.0 %) P (28.0 %)	SB: Antibiotics (100 %), aspiration (100 %), NSAIDs (28.6 %), surgical I&D (7.1 %) AB: Aspiration (100 %), CSI (43.8 %), antibiotics (25.0 %)	–
Stewart [28]	21	Aseptic	O	Bursectomy (59.1 %) Bursectomy with osseous resection (36.4 %) Osseous resection (4.5 %)	–
Hassell [7]	7	Septic	O	Intrabursal antibiotics (100 %) Aspiration (100 %)	–
Kerr [13]	10 1	Aseptic Septic	O (36.4 %) P (63.6 %)	Arthroscopic bursectomy (100 %) Aspiration (100 %)	–
Pien [20]	47	Septic	O (72.3 %) P (27.7 %)	Antibiotics (100 %) Aspiration (75 %) Surgical I&D (18 %)	–
Kerr [14]	6	Aseptic	O (50.0 %) P (50.0 %)	Arthroscopic bursectomy (100 %)	–
Smith [25]	42	Aseptic	O	Aspiration (100 %) (a) CSI + NSAID (26.2 %) (b) CSI + placebo (23.8 %) (c) NSAID (23.8 %) (d) Placebo (26.2 %)	–
Raddatz [22]	54	Septic	O (57.4 %) P (33.3 %) I (3.7 %) SD (1.9 %) T (1.9 %) 4,5-MCP (1.9 %)	IV antibiotics (75.5 %) PO antibiotics (24.5 %; followed by IV antibiotics in 75.0 %) Aspiration (85.7 %) Surgical I&D (10.2 %)	–

Table 4 continued

First author (year)	Cases (*n*)	Type	Location	Treatment (s)	Duration of antibiotic therapy
Roschmann [23]	30	Septic	O (66.7 %) I (30.0 %) S (3.3 %)	IV antibiotics (100 %) Aspiration (100 %)	–
Soderquist [26]	35	Septic	O (31.4 %) P (68.6 %)	IV antibiotics (100 %; preceded by PO antibiotics in 25.7 %) Aspiration (100 %) Surgical I&D (22.9 %)	–
Knight [15]	12	Septic	O (83.3 %) P (16.7 %)	IV antibiotics (100 %) Aspiration (100 %) Percutaneous suction-drainage and antibiotic irrigation (100 %)	19 days (IV)
Jaffe [12]	3 9	Septic Aseptic	O	Antibiotics (25.0 %) (a) Aspiration (33.3 %) + CSI + anesthetic injection (b) Aspiration + NSAID (33.3 %) (c) Observation (8.3 %)	–
Weinstein [31]	47	Aseptic	O	(a) Aspiration + CSI (53.2 %) (b) Aspiration (46.8 %)	–
Ho [8]	25	Septic	O (84.0 %) P (12.0 %) I (4.0 %)	Antibiotics (100 %) Aspiration (100 %)	9.7 (6–21) days
Hoffmeyer [11]	17	Septic	O	Antibiotics (100 %) Aspiration (100 %) Surgical I&D (35.3 %) or bursectomy and debridement (5.9 %)	–
Canoso [1]	16	Septic	O (75.0 %) P (12.5 %) PT (12.5 %)	IV antibiotics (100 %; followed by PO antibiotics in 93.8 %) (a) Aspiration (41.7 %) (b) Aspiration + I&D (41.7 %) (c) I&D (8.3 %) (d) Observation (8.3 %)	15–21 days (PO)
Ho [9]	10 20	Septic Aseptic	O (90.0 %) P (10.0 %) O (80.0 %) P (20.0 %)	SB: Antibiotics (100 %), aspiration (100 %) AB: —	12.3 days
Vilbar [30]	4	Aseptic	O	Aspiration (100 %)	–
Ho [10]	25	Septic	O (80.0 %) P (20.0 %)	IV antibiotics (100 %; preceded by PO antibiotics in 20.0 %) Aspiration (100 %)	24 days
Quayle [21]	11	Aseptic	O	Osseous resection (100 %) Aspiration (36.4 %)	–
Thompson [29]	12	Septic	O (75.0 %) P (16.7 %) SD (8.3 %)	Antibiotics (100 %) (a) Aspiration (58.3 %) (b) Surgical I&D (41.7 %)	–
Cruz [3]	5	Aseptic	O	Aspiration (100 %) CSI (100 %)	–

SB aseptic bursitis, *AB* aseptic bursitis, *O* olecranon; *P* prepatellar, 1-MTP first metatarsophalangeal, *EM* external malleolar, *T* trochanteric, *SA* subacromial, *I* infrapatellar, *SD* subdeltoid, *4,5-MCP* fourth and fifth metacarpophalangeal, *PT* pretendinous, *I&D* incision and drainage, *CSI* corticosteroid injection, *NSAID* non-steroidal anti-inflammatory drug, *IV* intravenous, *PO* oral

Table 5 Outcomes in included studies

First author (year)	Cases (*n*)	Type	Location	Treatment(s)	Clinical resolution	Subjective outcomes	Requirement for surgery or reoperation after initial treatment	Overall complications
Perez [19]	343	Septic	O (69.1 %) P (30.9 %)	Antibiotics (100 %) Aspiration (100 %) Bursectomy (91.0 %) ± lavage and closure	200/237	–	–	–
Martinez-Taboada [17]	82	Septic	O (26.8 %) P (73.2 %)	IV antibiotics (100 %) Aspiration (100 %) Surgical I&D (12.2 %)	81/82	–	10/82[a]	5/82[a]
Degreef [4]	34 3	Aseptic Septic	O	Open bursectomy (100 %) SB: + Antibiotics	29/37	–	3/34 (lateral arm flap surgery in 2/3; I&D in 1/3) 0/3	20/37
Cea-Pereiro [2]	57	Septic	O (43.9 %) P (50.9 %) 1-MTP (3.5 %) EM (1.8 %)	Antibiotics (100 %) Aspiration (100 %) Surgical I&D (10 %)	–	–	6/58[a] (I&D)	–
Laupland [16]	118	Septic	O	IV antibiotics (100 %) Surgical I&D (43.2 %) Aspiration (27.1 %)	113/118	–	1/118 (bursectomy)	3/118
Ogilvie-Harris [18]	50	Aseptic	O (62.0 %) P (38.0 %)	Arthroscopic bursectomy (100 %) Aspiration (100 %) CSI (100 %)	28/29	–	–	1/31
Garcia-Porrua [5]	75	Septic	O (46.7 %) P (44.0 %) T (5.3 %) SA (2.7 %) I (1.3 %)	IV antibiotics (100 %) Aspiration (100 %) Bursectomy (4.0 %)	72/75[a]	–	–	2/35
Stell [27]	22	Septic	O (68.2 %) P (31.8 %)	SB: Antibiotics (100 %), aspiration (100 %), NSAIDs (28.6 %), surgical I&D (7.1 %)	12/13	VAS: Δ −3.1	1/47[a]	5/13
	25	Aseptic	O (72.0 %) P (28.0 %)	AB: Aspiration (100 %), CSI (43.8 %), antibiotics (25.0 %)	7/14 (7/7 after subsequent CSI)	VAS: Δ −0.3		1/14
Stewart [28]	21	Aseptic	O	Bursectomy (59.1 %) Bursectomy with osseous resection (36.4 %) Osseous resection (4.5 %)	17/21	–	3/21 (bursectomy)	2/21
Hassell [7]	7	Septic	O	Intrabursal antibiotics (100 %) Aspiration (100 %)	6/7	–	1/7	1/7

Table 5 continued

First author (year)	Cases (*n*)	Type	Location	Treatment(s)	Clinical resolution	Subjective outcomes	Requirement for surgery or reoperation after initial treatment	Overall complications
Kerr [13]	10	Aseptic	O (36.4 %)	Arthroscopic bursectomy (100 %)	2/3	–	–	1/3
	1	Septic	P (63.6 %)	Aspiration (100 %)	1/1			0/1
				SB: + IV antibiotics				
Pien [20]	47	Septic	O (72.3 %)	Antibiotics (100 %)	34/34	–	–	0/34
			P (27.7 %)	Aspiration (75 %)				
				Surgical I&D (18 %)				
Kerr [14]	6	Aseptic	O (50.0 %)	Arthroscopic bursectomy (100 %)	2/3	–	1/3 (I&D)	1/3
			P (50.0 %)	Aspiration (NR)				
Smith [25]	42	Aseptic	O	Aspiration (100 %)	11/11	–	–	0/11
				(a) CSI + NSAID (26.2 %)	9/10			0/10
				(b) CSI + placebo (23.8 %)	9/10			0/10
				(c) NSAID (23.8 %)	10/11			0/11
				(d) Placebo (26.2 %)				
Raddatz [22]	54	Septic	O (57.4 %)	IV antibiotics (75.5 %)	20/20	–	–	3/31
			P (33.3 %)	PO antibiotics (24.5 %; followed by IV antibiotics in 75.0 %)				
			I (3.7 %)					
			SD (1.9 %)	Aspiration (85.7 %)				
			T (1.9 %)	Surgical I&D (10.2 %)				
			4,5-MCP (1.9 %)					
Roschmann [23]	30	Septic	O (66.7 %)	IV antibiotics (100 %)	19/20	–	–	–
			I (30.0 %)	Aspiration (100 %)				
			S (3.3 %)					
Soderquist [26]	35	Septic	O (31.4 %)	IV antibiotics (100 %; preceded by PO antibiotics in 25.7 %)	10/11	–	–	0/11
			P (68.6 %)	Aspiration (100 %)				
				Surgical I&D (22.9 %)				
Knight [15]	12	Septic	O (83.3 %)	IV antibiotics (100 %)	10/10	–	2/10 (bone spur excision)	0/10
			P (16.7 %)	Aspiration (100 %)				
				Percutaneous suction-drainage and antibiotic irrigation (100 %)				
Jaffe [12]	3	Septic	O	SB: Antibiotics (100 %)	2/3	–	–	–
	9	Aseptic		AB:	2/4			
				(a) Aspiration + CSI + anesthetic injection (44.4 %)	5/5			
				(b) Aspiration + NSAID (44.4 %)	0/1			
				(c) Observation (11.1 %)				

Table 5 continued

First author (year)	Cases (*n*)	Type	Location	Treatment(s)	Clinical resolution	Subjective outcomes	Requirement for surgery or reoperation after initial treatment	Overall complications
Weinstein [31]	47	Aseptic	O	(a) Aspiration + CSI (53.2 %)	25/25	–	–	15/25
				(b) Aspiration (46.8 %)	21/22			0/22
Ho [8]	25	Septic	O (84.0 %) P (12.0 %) I (4.0 %)	Antibiotics (100 %) Aspiration (100 %)	20/21	–	–	0/21
Hoffmeyer [11]	17	Septic	O	Antibiotics (100 %) Aspiration (100 %) Surgical I&D (35.3 %) or bursectomy and debridement (5.9 %)	–	–	–	3/17
Canoso [1]	16	Septic	O (75.0 %) P (12.5 %) PT (12.5 %)	IV antibiotics (100 %; followed by PO antibiotics in 93.8 %) (a) Aspiration (41.7 %) (b) Aspiration + I&D (41.7 %) (c) I&D (8.3 %) (d) Observation (8.3 %)	10/12	–	1/12 (bursectomy)	3/12
Ho [9]	10	Septic	O (90.0 %) P (10.0 %)	SB: Antibiotics (100 %), aspiration (100 %)	9/9	–	–	–
	20	Aseptic	O (80.0 %) P (20.0 %)	AB: —	16/16			
Vilbar [30]	4	Aseptic	O	Aspiration (100 %)	4/4	–	–	0/4
Ho [10]	25	Septic	O (80.0 %) P (20.0 %)	IV antibiotics (100 %; preceded by PO antibiotics in 20.0 %) Aspiration (100 %)	19/20	–	1/20	–
Quayle [21]	11	Aseptic	O	Osseous resection (100 %) Aspiration (36.4 %)	11/11	RTW: 9/9	–	4/11
Thompson [29]	12	Septic	O (75.0 %) P (16.7 %) SD (8.3 %)	Antibiotics (100 %) (a) Aspiration (58.3 %) (b) Surgical I&D (41.7 %)	12/12[a]	–	–	–
Cruz [3]	4	Aseptic	O	Aspiration (100 %) CSI (100 %)	2/4	–	2/4	–

SB septic bursitis, *AB* aseptic bursitis, *O* olecranon, P prepatellar, 1-MTP first metatarsophalangeal, *EM* external malleolar, *T* trochanteric, *SA* subacromial, *I* infrapatellar, *SD* subdeltoid, *4,5-MCP* fourth and fifth metacarpophalangeal, *PT* pretendinous, *I&D* incision and drainage, *CSI* corticosteroid injection, *NSAID* non-steroidal anti-inflammatory drug, *IV* intravenous, *PO* oral, *VAS* visual analog scale, *RTW* return to work, *NR* percentage not reported

[a] Indicates that data were reported for the entire study, but not specifically for the olecranon bursitis subgroup

Table 6 Complications in included studies

First author (year)	Cases (*n*)	Type	Location	Treatment(s)	Persistent tenderness	Persistent drainage	Bursal infection	Skin atrophy	Osteomyelitis	Delayed wound healing	Neurovascular compromise	Hematoma formation	Hypoesthesia	Scar-related complications
Perez [19]	343	Septic	O (69.1 %)	Antibiotics (100 %)	–	–	–	–	–	–	–	–	–	–
			P (30.9 %)	Aspiration (100 %)										
				Bursectomy (91.0 %) ± lavage and closure										
Martinez-Taboada [17]	82	Septic	O (26.8 %)	IV antibiotics (100 %)	–	–	–	–	–	–	–	–	–	–
			P (73.2 %)	Aspiration (100 %)										
				Surgical I&D (12.2 %)										
Degreef [4]	34	Aseptic	O	Open bursectomy (100 %)	–	10/37	5/34	–	–	–	–	5/37	–	–
	3	Septic		SB: + Antibiotics			–							
Cea-Pereiro [2]	57	Septic	O (43.9 %)	Antibiotics (100 %)	–	–	–	–	–	–	–	–	–	–
			P (50.9 %)	Aspiration (100 %)										
			1-MTP (3.5 %)	Surgical I&D (10 %)										
			EM (1.8 %)											
Laupland [16]	118	Septic	O	IV antibiotics (100 %)	–	–	–	–	0/118	–	–	–	–	–
				Surgical I&D (43.2 %)										
				Aspiration (27.1 %)										
Ogilvie-Harris [18]	50	Aseptic	O (62.0 %)	Arthroscopic bursectomy (100 %)	4/31	–	–	–	–	1/31	0/31	–	–	–
			P (38.0 %)	Aspiration (100 %)										
				CSI (100 %)										
Garcia-Porrua [5]	75	Septic	O (46.7 %)	IV antibiotics (100 %)	–	–	–	–	2/35	–	–	–	–	–
			P (44.0 %)	Aspiration (100 %)										
			T (5.3 %)	Bursectomy (4.0 %)										
			SA (2.7 %)											
			I (1.3 %)											
Stell [27]	22	Septic	O (68.2 %)	SB: Antibiotics (100 %), aspiration (100 %), NSAIDs (28.6 %), surgical I&D (7.1 %)	2/13	3/13	–	–	–	—	–	–	–	–
			P (31.8 %)											
	25	Aseptic	O (72.0 %)	AB: Aspiration (100 %), CSI (43.8 %), antibiotics (25.0 %)	1/14	0/14								
			P (28.0 %)											
Stewart [28]	21	Aseptic	O	Bursectomy (59.1 %)	–	0/21	0/21	–	–	–	–	1/21	–	–
				Bursectomy with osseous resection (36.4 %)										
				Osseous resection (4.5 %)										
Hassell [7]	7	Septic	O	Intrabursal antibiotics (100 %)	1/7	0/7	–	0/7	–	–	–	–	–	–
				Aspiration (100 %)										
Kerr [13]	10	Aseptic	O (36.4 %)	Arthroscopic bursectomy (100 %)	0/3	–	1/3	–	–	0/3	–	–	0/3	–
	1	Septic	P (63.6 %)	Aspiration (100 %)	0/1		0/1			0/1			0/1	

Table 6 continued

First author (year)	Cases (*n*)	Type	Location	Treatment(s)	Persistent tenderness	Persistent drainage	Bursal infection	Skin atrophy	Osteomyelitis	Delayed wound healing	Neurovascular compromise	Hematoma formation	Hypoesthesia	Scar-related complications
Pien [20]	47	Septic	O (72.3 %) P (27.7 %)	Antibiotics (100 %) Aspiration (75 %) Surgical I&D (18 %)	–	–	–	–	–	–	–	–	–	–
Kerr [14]	6	Aseptic	O (50.0 %) P (50.0 %)	Arthroscopic bursectomy (100 %)	–	–	1/3	–	–	–	–	–	0/3	–
Smith [25]	42	Aseptic	O	Aspiration (100 %) (a) CSI + NSAID (26.2 %) (b) CSI + placebo (23.8 %) (c) NSAID (23.8 %) (d) Placebo (26.2 %)	0/11 1/10 2/10 1/11	–	0/11 0/10 0/10 0/11	0/11 0/10 0/10 0/11	–	–	–	–	–	–
Raddatz [22]	54	Septic	O (57.4 %) P (33.3 %) I (3.7 %) SD (1.9 %) T (1.9 %) 4,5-MCP (1.9 %)	IV antibiotics (75.5 %) PO antibiotics (24.5 %; followed by IV antibiotics in 75.0 %) Aspiration (85.7 %) Surgical I&D (10.2 %)	–	3/31	–	–	–	–	–	–	–	–
Roschmann [23]	30	Septic	O (66.7 %) I (30.0 %) S (3.3 %)	IV antibiotics (100 %) Aspiration (100 %)	–	–	–	–	–	–	–	–	–	–
Soderquist [26]	35	Septic	O (31.4 %) P (68.6 %)	IV antibiotics (100 %; preceded by PO antibiotics in 25.7 %) Aspiration (100 %) Surgical I&D (22.9 %)	–	–	–	–	–	–	–	–	–	–
Knight [15]	12	Septic	O (83.3 %) P (16.7 %)	IV antibiotics (100 %) Aspiration (100 %) Percutaneous suction-drainage and antibiotic irrigation (100 %)	–	0/10	–	–	–	–	–	–	–	–
Jaffe [12]	3 9	Septic Aseptic	O	Antibiotics (25.0 %) (a) Aspiration (33.3 %) + CSI + anesthetic injection (b) Aspiration + NSAID (33.3 %) (c) Observation (8.3 %)	–	–	–	–	–	–	–	–	–	–
Weinstein [31]	47	Aseptic	O	(a) Aspiration + CSI (53.2 %) (b) Aspiration (46.8 %)	7/25 2/22	–	3/25 0/22	5/25 0/22	–	–	–	–	–	–
Ho [8]	25	Septic	O (84.0 %) P (12.0 %) I (4.0 %)	Antibiotics (100 %) Aspiration (100 %)	–	0/21	–	–	0/21	–	–	–	–	–

Table 6 continued

First author (year)	Cases (*n*)	Type	Location	Treatment(s)	Persistent tenderness	Persistent drainage	Bursal infection	Skin atrophy	Osteomyelitis	Delayed wound healing	Neurovascular compromise	Hematoma formation	Hypoesthesia	Scar-related complications
Hoffmeyer [11]	17	Septic	O	Antibiotics (100 %) Aspiration (100 %) Surgical I&D (35.3 %) or bursectomy and debridement (5.9 %)	–	–	–	–	–	–	–	–	–	–
Canoso [1]	16	Septic	O (75.0 %) P (12.5 %) PT (12.5 %)	IV antibiotics (100 %; followed by PO antibiotics in 93.8 %) (a) Aspiration (41.7 %) (b) Aspiration + I&D (41.7 %) (c) I&D (8.3 %) (d) Observation (8.3 %)	–	2/12	–	–	1/12	–	–	–	–	–
Ho [9]	10	Septic	O (90.0 %) P (10.0 %)	SB: Antibiotics (100 %), aspiration (100 %)	–	–	–	–	0/25	–	–	–	–	–
	20	Aseptic	O (80.0 %) P (20.0 %)	AB: —										
Vilbar [30]	4	Aseptic	O	Aspiration (100 %)	–	–	–	–	–	–	–	–	–	–
Ho (1978) [10]	25	Septic	O (80.0 %) P (20.0 %)	IV antibiotics (100 %; preceded by PO antibiotics in 20.0 %) Aspiration (100 %)	–	–	–	–	–	–	–	–	–	–
Quayle [21]	11	Aseptic	O	Osseous resection (100 %) Aspiration (36.4 %)	2/11	–	–	–	–	–	–	–	2/11	3/11 (tethering), 2/11 (tenderness)
Thompson [29]	12	Septic	O (75.0 %) P (16.7 %) SD (8.3 %)	Antibiotics (100 %) (a) Aspiration (58.3 %) (b) Surgical I&D (41.7 %)	–	2/12[a] (after I&D)	–	–	–	–	–	–	–	–
Cruz (1977) [3]	5	Aseptic	O	Aspiration (100 %) CSI (100 %)	–	–	–	–	–	–	–	–	–	–

SB septic bursitis, *AB* aseptic bursitis, *O* olecranon, *P* prepatellar, *1-MTP* first metatarsophalangeal, *EM* external malleolar, *T* trochanteric, *SA* subacromial, *I* infrapatellar, *SD* subdeltoid, *4,5-MCP* fourth and fifth metacarpophalangeal, *PT* pretendinous, *I&D* incision and drainage, *CSI* corticosteroid injection, *NSAID* non-steroidal anti-inflammatory drug, *IV* intravenous, *PO* oral

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