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Factors associated with revision surgery for olecranon bursitis after bursectomy

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Background: The primary aim of our study was to identify the factors associated with revision surgery after bursal excision in patients with olecranon bursitis. The secondary aims were to describe the revision rate after bursectomy and to assess which factors are associated with flap surgery after bursectomy and describe the most common complications after bursectomy of the olecranon bursa.
Methods: We included 191 adult patients with olecranon bursitis who underwent olecranon bursa excision between January 2002 and October 2018. Patients who were pregnant, patients with incomplete records of the primary surgical procedure, and patients who underwent bursectomy during elbow arthroplasty were excluded. After manual chart review, we found that 22 patients had undergone revision surgery. Bivariate analysis was performed to assess the association between revision surgery and patient characteristics, comorbidities, and clinical characteristics. Additionally, we collected data regarding postoperative complications and intraoperative variables such as the use of drains, vacuum assisted closure therapy, and flap surgery.
Results: The overall revision rate in our cohort was 11.5% (22 of 191 patients). Bivariate analysis showed that patients who underwent revision surgery were more frequently women ($P = .004$), more often had a history of ipsilateral ($P = .020$) or contralateral ($P = .012$) olecranon bursitis, and more often received a diagnosis of rheumatoid arthritis ($P = .001$) or diabetes mellitus ($P = .019$). The most common complications were delayed wound healing (n = 8, 4.2%) and osteomyelitis (n = 8, 4.2%). Flap surgery was performed in 5 patients (2.6%). Bivariate analysis showed that patients with rheumatoid arthritis underwent flap surgery more frequently ($P = .011$).
Conclusion: The revision rate after bursectomy for olecranon bursitis was 11.5% (22 of 191 patients). Patients with rheumatoid arthritis, diabetes mellitus, or a history of ipsilateral and contralateral olecranon bursitis and female patients underwent revision surgery after bursectomy for olecranon bursitis more frequently. In addition, patients with rheumatoid arthritis underwent flap surgery after bursectomy more frequently.
Level of evidence: Level III; Retrospective Case-Control Design; Prognosis Study

Keywords: Bursitis; olecranon; inflammation; bursectomy; revision surgery; reoperation; orthopedics

Olecranon bursitis is an inflammatory pathology that may develop in response to minor repetitive trauma, infection, or a systemic disorder such as rheumatoid arthritis or gout.[2,21] The incidence of olecranon bursitis is estimated to be approximately 0.01%-0.1% of hospital

The study protocol was approved by the hospital's independent review board (Partners Human Research Committee, 2017, no. DR 2017P000694).

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admissions, but these numbers probably underestimate the true incidence because most patients with olecranon bursitis are treated successfully in an outpatient setting with conservative management.[6]

Patients with systemic inflammatory disorders or immunosuppression are more at risk of initial conservative treatment failing and recurrent olecranon bursitis developing.[20,21] Bursectomy is a common treatment for persistent bursitis; however, prior studies have shown that surgical intervention does not consistently provide satisfactory outcomes or prevent recurrence.[5,20,21] Some patients may experience complications that may necessitate further operations such as repeated bursectomy or flap coverage.[5]

The purpose of this study was to describe the rate of revision surgery after olecranon bursectomy and identify which factors are associated with revision surgery. In addition, we aimed to assess which factors are associated with flap surgery after bursectomy and describe the most common complications after olecranon bursa excision.

Materials and methods

Patient selection

In this retrospective cohort study, we reviewed the medical records of all consecutive patients who underwent olecranon bursectomy at 1 of 5 affiliated hospitals from January 2002 through October 2018. We identified 228 patients in our institutional database using *International Classification of Diseases* code 726.33 (olecranon bursitis) and Current Procedural Terminology code 24105 (olecranon bursectomy). We included adult patients who were aged $\geq$ 18 years and underwent olecranon bursectomy at 1 of 5 affiliated hospitals after December 31, 2001. Bursitis was classified as ''septic bursitis'' if the clinical chart note stated that the bursitis was septic, confirmed by either positive microbiology report findings or the administration of long-term antibiotic treatment prior to bursectomy. Review of the medical records of these 228 patients showed that 26 were treated before 2002 or were not treated with a bursectomy but were identified because of miscoding. Thus, a total of 202 patients met our inclusion criteria. We excluded 8 patients with incomplete records of the primary surgical procedure and 3 patients who underwent bursectomy during elbow arthroplasty. We believed that patients who underwent bursectomy in the setting of elbow arthroplasty were sufficiently different from our cohort of interest and thus were excluded. The final study population included 191 patients who underwent olecranon bursectomy.

Surgical procedure

All bursectomies consisted of open resection of the olecranon bursa under regional or general anesthesia. Revision surgery was defined as a second surgical procedure for bursitis in the same elbow. Intraoperative drains were placed at the surgeon's discretion.

Data collection

Medical records were reviewed to obtain data on explanatory variables, such as patient demographic characteristics, occupation, excessive alcohol use as indicated by the provider in the medical record, comorbidities at the time of the index procedure, hand dominance, type of bursitis (septic or inflammatory), history of ipsilateral or contralateral bursitis, history of elbow trauma, history of elbow surgery, preoperative aspiration, and preoperative incision and drainage. Additionally, we collected intraoperative variables such as the use of closed suction drains, negative-pressure wound vacuum assisted closure (VAC) therapy, and flap surgery. Revision surgery was defined as a re-excision of the olecranon bursa and/or irrigation and débridement owing to recurrence of the bursitis after excision of the bursa.

Statistical analysis

Parametric continuous data were reported as mean with standard deviation and analyzed using the Student t test. Nonparametric continuous data were reported as median with interquartile range (IQR) and analyzed with the Mann-Whitney *U* test. Categorical variables were analyzed using the Fisher exact test and reported as frequencies and percentages. $P < .05$ was considered statistically significant.

Results

Demographic characteristics

In our cohort of 191 patients, the mean age at the time of surgery was 57 years (standard deviation, 14 years) and most patients were men (n = 139, 73%) and white patients (n = 162, 91%). All patient, condition, and treatment characteristics are described in Table I.

There were 27 patients (14%) with a history of ipsilateral olecranon bursitis and 5 patients (3%) with a history of contralateral olecranon bursitis. Septic bursitis occurred in 60 patients (31%) in our cohort. Four patients underwent bursectomy bilaterally at different times. Of these 4 patients, 3 underwent revision surgery after initial bursectomy. The median time between index bursectomy and revision surgery was 1.3 years (IQR, 0.4-16.7 months). The last date of follow-up was determined based on the date of the last clinical visit to one of our centers, with a median of 8.7 years (IQR, 4.0-14.9 years).

Revisions

The revision rate after bursectomy was 11.5% (22 of 191 olecranon bursectomies). Of the 22 patients who underwent revision surgery, 12 required 1 surgical procedure whereas 10 required $\geq$2 surgical procedures.

Bivariate analysis showed that patients who underwent revision surgery were more frequently women ($P = .004$) and more often had a diagnosis of diabetes mellitus ($P = .019$) or

Table I Patient, condition, and treatment characteristics

Patient characteristic	All patients (N = 191)	No revision (n = 169)	Revision (n = 22)	*P* value
Age, mean (SD), yr	57 (14)	57 (14)	57 (14)	.901
Male sex	139 (73)	129 (76)	10 (45)	.004*
Race†				.318
White	162 (91)	143 (91)	19 (86)	
Black	2 (1)	2 (1)	0 (0)	
Asian	10 (6)	9 (6)	1 (5)	
Hispanic	5 (3)	3 (2)	2 (9)	
Dominant hand‡				.873
Right	144 (75)	127 (75)	17 (77)	
Left	16 (8)	15 (9)	1 (5)	
Ambidextrous	1 (1)	1 (1)	0 (0)	
Smoker	39 (21)	31 (19)	8 (36)	.091
Excessive alcohol use	23 (12)	21 (12)	2 (9)	>.999
Diabetes mellitus	38 (20)	29 (17)	9 (41)	.019*
Rheumatoid arthritis	45 (24)	33 (20)	12 (55)	.001*
Chronic kidney disease	8 (4)	6 (4)	2 (9)	.231
Gout	39 (20)	36 (21)	3 (14)	.576
Septic bursitis	60 (31)	49 (29)	11 (50)	.054
Crystals	13 (7)	12 (7)	1 (5)	>.999
Dominant hand affected	82 (51)	73 (51)	9 (50)	>.999
Ipsilateral history	27 (14)	20 (12)	7 (32)	.020*
Contralateral history	5 (3)	2 (1)	3 (14)	.012*
Prior elbow trauma				.872
No trauma	127 (67)	111 (66)	16 (73)	
Closed fracture	11 (6)	10 (6)	1 (5)	
Open fracture	22 (12)	19 (11)	3 (14)	
Minor elbow trauma or concussion	31 (16)	29 (17)	3 (9)	
Prior elbow surgery	19 (10)	17 (10)	2 (9)	>.999
Aspiration prior to bursectomy	75 (39)	64 (38)	11 (50)	.354
I&D prior to bursectomy	7 (4)	6 (4)	1 (5)	.582
Fistula before index surgery	5 (3)	4 (2)	1 (5)	.461
Triceps tendon avulsion before index surgery	13 (7)	11 (6.5)	2 (9)	.649
No. of aspirations prior to bursectomy				.422
0	116 (61)	105 (62)	11 (50)	
1	68 (35)	57 (34)	11 (50)	
2	6 (3)	6 (4)	0	
3	1 (1)	1 (1)	0	
Olecranon spur	13 (7)	10 (6)	3 (14)	.176

SD, standard deviation; *I&D*, incision and drainage.
Data are presented as number (percentage) unless otherwise indicated.
* Statistically significant ($P < .05$).
† n = 179.
‡ n = 161.

rheumatoid arthritis ($P = .001$). In addition, patients with either an ipsilateral ($P = .020$) or contralateral ($P = .012$) history of olecranon bursitis underwent revision surgery more frequently. Although not significant, there was a trend showing that patients with septic bursitis underwent revision surgery more frequently ($P = .054$). We did not find a correlation between needle aspiration prior to primary surgery and revision surgery ($P = .354$).

The most common complications were delayed wound healing (8 of 191 patients, 4%) and osteomyelitis (8 of 191 patients, 4%). Of the 131 patients with inflammatory bursitis, 16 (12%) had a postoperative infection. A fistula was present prior to the initial bursectomy in 5 patients (5 of 191 patients, 3%). None of these 5 patients had persistence of the fistula after their initial bursectomy. A fistula developed after the initial bursectomy in 2 patients (1%), and both underwent revision surgery (Table II). A total of 13 patients had a (partial) triceps tendon rupture or avulsion prior to bursectomy. Two other patients reported triceps tendon pathology after surgery. One of these patients had a high-grade partial tear of the triceps tendon at the olecranon attachment, whereas chronic postoperative triceps tendinopathy

Table II Complications after index surgery

Complication	All patients 191)	No revision after index surgery (n = 169)	Revision after index surgery (n = 22)
Hematoma	3 (2)	3 (2)	0 (0)
Non-healing wound	8 (4)	3 (2)	5 (23)
Fistula	2 (1)	0 (0)	2 (9)
Osteomyelitis	8 (4)	4 (2)	4 (18)
Triceps tendon problems	2 (13)	2 (15)	0 (0)

Data are presented as number (percentage).

Table III Perioperative wound management

Characteristic	At time of index surgery (N = 191)	At time of first revision surgery (n = 22)	At time of second revision surgery (n = 7)
Drain			
Yes	48 (25)	6 (27)	1 (14)
No	143 (75)	16 (73)	6 (86)
VAC therapy			
Yes	1 (1)	4 (18)	2 (29)
No	190 (99)	18 (82)	5 (71)
Flap			
Yes	0 (0)	5 (23)	0 (0)
No	191 (100)	16 (77)	7 (100)

Data are presented as number (percentage).
VAC, vacuum assisted closure.

Table IV Perioperative wound management at time of index surgery

Characteristic	All patients (N = 191)	No revision (n = 169)	Revision (n = 22)
Drain			
Yes	48 (25)	41 (24)	7 (32)
No	143 (75)	126 (76)	17 (68)
VAC therapy			
Yes	1 (1)	1 (1)	0 (0)
No	190 (99)	167 (99)	22 (100)
Flap			
Yes	0 (0)	0 (0)	0 (0)
No	191 (100)	169 (100)	22 (100)

Data are presented as number (percentage).
VAC, vacuum assisted closure.

developed in the other patient. However, it is unclear whether these conditions were directly related to the bursectomy.

Perioperative wound management was surgeon specific and dependent on the presence of infection or impaired wound healing. Of the 10 patients who required ≥2 revision procedures, 6 underwent revision with multiple irrigation and débridement procedures, of whom some underwent multiple VAC therapy applications, and delayed primary closure procedures. In one of these patients, there was impaired wound healing and a concern for osteomyelitis; bone biopsy specimens were obtained, and the wound was eventually closed with a transposition arm flap. Two other patients were treated with multiple débridements and wound VAC therapy applications and eventually underwent closure with a split-thickness skin graft and a reverse lateral arm flap. In the patient who received the reverse lateral arm flap, necrosis of the distal tip of the flap developed and an additional irrigation and débridement procedure, as well as VAC therapy, was performed. Perioperative wound management in bursectomy patients is described in Tables III and IV.

Five patients underwent flap surgery. These flap operations included 1 fasciocutaneous lateral arm flap, 2 anconeus rotational flaps, 1 staged transposition flap, and 1 subcutaneous tissue-advancement flap. The indications for flap closure were infection and impaired wound healing. Bivariate analysis showed that patients who had rheumatoid arthritis underwent flap surgery after bursectomy more frequently than patients without rheumatoid arthritis (P = .011). More details are provided in Table V. Of the 5 patients who underwent flap surgery, 4 (80%) received a previous diagnosis of rheumatoid arthritis.

Discussion

The purpose of this study was to determine the revision rate after bursectomy and identify factors associated with reoperation after bursectomy in patients with olecranon bursitis. The revision surgery rate was 11.5% (22 of 191 patients). Patients who underwent revision surgery were more frequently women, more often had a history of either ipsilateral or contralateral olecranon bursitis, and more often received a diagnosis of rheumatoid arthritis or diabetes.

Prior studies have focused on factors associated with recurrence and complications after bursectomy.[5,20] However, not every recurrence after bursectomy is treated with revision surgery, and most patients with bursitis are successfully treated conservatively in an outpatient setting.[3,6] Our study showed a revision rate of 11.5%, which is comparable to the surgical revision rate of 8.1% reported in another study.[5] However, the recurrence rate of bursitis after bursectomy reported in prior studies was up to 2 times higher, ranging between 14.6% and 21.6%.[5,20] This finding suggests that not all patients with a recurrence after bursectomy undergo a revision operation. However, these prior studies only focused on patients with septic bursitis or patients without rheumatoid arthritis. Our study demonstrates that patients who underwent revision surgery and flap surgery after bursectomy had rheumatoid arthritis more frequently, which may explain the higher revision rate in our study

compared with studies that did not include patients with rheumatoid arthritis.[5] On the basis of these findings, conservative treatment may be preferred in patients with rheumatoid arthritis who have olecranon bursitis. A prior systematic review also concluded that nonsurgical management of olecranon bursitis is more effective than surgical treatment because surgical treatment was less likely to clinically resolve the bursitis and showed higher rates of complications such as persistent drainage and infection.[22] In patients with septic bursitis and rheumatoid arthritis, nonoperative management is reasonable as long as antibiotic treatment is demonstrating clinical benefit. However, operative intervention should still be considered in patients who have systemic illness or show no clinical response to antibiotics.

Bivariate analyses showed that patients who underwent revision bursectomy were more likely to be women or to have rheumatoid arthritis. Previous studies showed that olecranon bursitis is associated with immunosuppression and systemic diseases that require immunosuppressive treatment, such as rheumatoid arthritis and human immunodeficiency virus.[2,6,11,21] The incidence of rheumatoid arthritis is higher in women than in men (3:1), and expression of this disease is more severe in female patients.[8,13,14] In our study, we found a positive correlation between female sex and rheumatoid arthritis, which suggests that these 2 factors are covariant factors. Female patients had a diagnosis of rheumatoid arthritis (26 of 45, 57.8%) more often than male patients (19 of 45, 42.2%; $P = .001$). Prior studies showed that both the immunomodulatory effects of rheumatoid arthritis and the agents with immunosuppressive effects used in its treatment, such as corticosteroids, anti–tumor necrosis factor α, cyclooxygenase 2 inhibitors, and disease-modifying antirheumatic drugs, are associated with postoperative complications such as delayed wound healing, wound dehiscence, infection, and impaired collagen synthesis.[3,7,17,23] The effect of immunomodulators on wound healing may help explain our finding that patients with rheumatoid arthritis underwent flap closure after bursectomy more frequently than patients without rheumatoid arthritis; however, further study is needed.[5,29] Flap closure may therefore be considered at an earlier stage to prevent multiple débridements and reoperations in patients with rheumatoid arthritis.

In our study, bivariate analysis showed that patients with a diagnosis of diabetes mellitus underwent revision surgery more frequently than patients without diabetes. To our knowledge, there are no studies describing the association between diabetes mellitus and revision surgery in patients who underwent bursectomy for olecranon bursitis. However, similarly to immunomodulator administration, diabetes mellitus is associated with an increased risk of postoperative complications such as infection and impaired wound healing.[3,9,10,12,16,19,23,25,27,30]

Our results show that patients with a history of ipsilateral or contralateral olecranon bursitis underwent revision surgery more frequently than patients without a history of bursitis. A history of bursitis or the occurrence of bilateral bursitis may indicate that these patients have an inherent predisposition for the development of bursitis. Our data are consistent with the findings of prior studies that suggest that bilateral disease may represent more severe disease and the existence of genetic or systemic factors that contribute to the development of several upper-extremity diseases.[2,15,18,21,24,28] In our study, a history of ipsilateral ($P = .003$) or contralateral ($P = .011$) olecranon bursitis also correlated with the presence of rheumatoid arthritis. Prior studies showed that (chronic) bursitis is frequently secondary to systemic diseases such as rheumatoid arthritis.[1,2,21]

Bivariate analysis did not show that patients who received needle aspiration prior to the index bursectomy underwent revision surgery more frequently ($P = .354$). However, because of the small sample size, we are not able to study the independent association of our explanatory variables using a multivariate analysis and our study is underpowered to conclude that there is no association between needle aspiration and revision surgery. A recent study evaluating treatment with and without needle aspiration in patients with a diagnosis of uncomplicated septic olecranon bursitis demonstrated that patients in the bursal aspiration group were more likely to undergo bursectomy.[4] However, a systematic review did not show a higher rate of septic bursitis after needle aspiration.[22] Patients in our study who received 1 or more needle aspirations had septic bursitis more frequently (42 of 75 [56%] vs. 33 of 75 [44%], $P < .001$). One confounder, however, is that some of these patients received a needle aspiration for symptom relief and were not suspected of having septic bursitis. If we exclude those patients who had positive culture findings at the time of their first aspiration, septic bursitis developed after a negative culture finding of the first aspiration prior to initial bursectomy in only 1 patient (1 of 37, 3%).

Regarding septic bursitis, we found a trend toward a higher revision rate in this group of patients, but this did not reach significance ($P < .05$). In our study, when comparing inflammatory and septic bursitis with 80% power, we could detect a 3- to 4-fold increase in the revision rate. Regarding needle aspiration, we could detect a 3- to 5-fold increase in revision rate. These are large effect sizes. Future studies should assess the independent association of our explanatory variables with bursectomy as the outcome.

This is a retrospective study, which means there is a risk of selection bias and non-differential misclassification bias. Patients were identified using *International Classification of Diseases* and Current Procedural Terminology codes, and miscoding may lead to inaccuracy or missing cases. To minimize the effect of miscoding, we manually reviewed the medical chart of each patient to determine whether he or she underwent an excision or re-excision of the olecranon bursa for bursitis. To minimize the effect of missing data, we used pair-wise deletion in our analysis in case of missing data. Furthermore, our study included patients treated at 1 of 5 academic urban hospitals in the Northeastern United States,

Table V Factors associated with flap surgery

Patient characteristic	All patients (N = 191)	Postoperative flap (n = 5)	No postoperative flap (n = 186)	*P* value
Age, mean (SD), yr	57 (14)	57 (17)	57 (13)	.979
Male sex	139 (74)	2 (40)	137 (74)	.126
Race*				>.999
White	162 (91)	5 (100)	157 (90)	
Black	2 (1)	0 (0)	2 (1)	
Asian	10 (6)	0 (0)	10 (6)	
Hispanic	5 (3)	0 (0)	5 (3)	
Dominant hand†				.145
Right	144 (75)	2 (40)	142 (76)	
Left	16 (8)	1 (20)	15 (8)	
Ambidextrous	1 (1)	0 (0)	1 (1)	
Smoker	39 (21)	2 (40)	37 (20)	.284
Excessive alcohol use	23 (12)	0 (0)	23 (12)	>.999
Diabetes mellitus	38 (20)	1 (20)	37 (20)	>.999
Rheumatoid arthritis	45 (24)	4 (80)	41 (22)	.011‡
Chronic kidney disease	8 (4)	0 (0)	8 (4)	>.999
Gout	39 (20)	0 (0)	39 (21)	.585
Septic bursitis	60 (31)	3 (60)	57 (31)	.180
Crystals	13 (7)	0 (0)	5 (100)	>.999
Dominant hand affected	82 (51)	3 (60)	79 (42)	.246
Ipsilateral history	27 (14)	2 (40)	25 (93)	.147
Contralateral history	5 (3)	0 (0)	5 (100)	>.999
Prior elbow trauma				.714
No trauma	127 (67)	4 (80)	123 (66)	
Closed fracture	11 (6)	0 (0)	11 (6)	
Open fracture	21 (11)	1 (20)	20 (11)	
Minor elbow trauma or concussion	31 (17)	0 (0)	31 (17)	
Prior elbow surgery	19 (10)	0 (0)	19 (10)	>.999
Aspiration prior to bursectomy	75 (39)	3 (60)	72 (39)	.383
I&D prior to bursectomy	7 (4)	1 (20)	6 (3)	.172
Fistula prior to bursectomy	5 (3)	0 (0)	5 (100)	>.999
Triceps tendon avulsion before index surgery	13 (7)	0 (0)	5 (100)	>.999
No. of aspirations prior to bursectomy				.470
0	116 (61)	2 (40)	114 (61)	
1	68 (36)	3 (60)	65 (35)	
2	6 (3)	0 (0)	6 (3)	
3	1 (1)	0 (0)	1 (1)	
Olecranon spur	13 (7)	1 (20)	4 (80)	.300

SD, standard deviation; *I&D*, incision and drainage.
Data are presented as number (percentage) unless otherwise indicated.
* n = 179.
† n = 161.
‡ Statistically significant ($P < .05$).

which means that our findings may not be generalizable to other settings. Moreover, patients could have undergone revision surgery outside the study time frame or at another hospital. Finally, even though our study is among the larger cohorts described in the literature, the number of patients who underwent revision surgery was still relatively small, at 22 patients. Logistic and Cox models should be used with approximately 10 events per explanatory variable, which limits the possibility to use a multivariate analysis without overfitting.[26] Therefore, this study was not amenable to identify what factors are independently associated with revision surgery.

Conclusion

The overall rate of revision surgery in our study was 11.5%. Female patients and patients with rheumatoid

arthritis, diabetes mellitus, and a history of ipsilateral or contralateral bursitis underwent revision surgery more frequently. In addition, we found that rheumatoid arthritis was associated with flap surgery after bursectomy for olecranon bursitis. The results of this study may assist surgeons in counseling patients about the potential need for revision surgery and flap surgery after bursectomy, particularly those at high risk of poor wound healing.

Disclaimer

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