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Original Research

Readmission and Reoperation Following Carpometacarpal Arthroplasty

Kenny Ling, MD, [*] Richelle Fassler, BA, [†] Jane Burgan, BS, [†] David E. Komatsu, PhD, [*] Edward D. Wang, MD [†]

[*] *Department of Orthopaedics, Stony Brook University, Stony Brook, NY*
[†] *Renaissance School of Medicine at Stony Brook University, Stony Brook, NY*

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Purpose: Carpometacarpal (CMC) arthroplasty is an effective surgical treatment for osteoarthritis of the CMC joint. Risk factors for readmission and reoperation have been studied for other joint arthroplasty procedures but have not yet been studied for CMC arthroplasty. The purpose of this study was to identify patient demographics and comorbidities associated with 30-day readmission and 30-day reoperation after CMC arthroplasty.

Methods: The American College of Surgeons National Surgical Quality Improvement Program database was queried for all records of patients who underwent CMC arthroplasty between 2015 and 2020. Variables collected in this study included patient demographics, comorbidities, surgical characteristics, and 30-day postsurgical complication data. Multivariate logistic regression was used to identify independent associations between patient characteristics and readmission and reoperation after CMC arthroplasty.

Results: In total, 6,432 records were included in this study: 34 (0.5%) were readmitted within 30 days, and 27 (0.4%) underwent reoperation within 30 days. Compared with the non-readmission cohort, the readmission cohort was significantly associated with higher rates of age $\geq$ 75 years ($P = .003$), body mass index (BMI) $\geq$ 40 kg/m^2 ($P = .005$), American Society of Anesthesiologists classification (ASA) $\geq$ 3; $P < .001$), insulin-dependent diabetes ($P = .016$), and chronic obstructive pulmonary disease (COPD; $P = .009$). Compared with the non-reoperation cohort, the reoperation cohort was significantly associated with higher rates of age $\geq$ 75 years ($P = .003$), BMI $\geq$ 40 kg/m^2 ($P = .005$), ASA $\geq$ 3 ($P < .001$), insulin-dependent diabetes ($p = .016$), and COPD ($P = .009$).

Conclusion: The clinically significant predictors for 30-day readmission and 30-reoperation after CMC arthroplasty were age $\geq$ 75 years, BMI $\geq$ 40 kg/m^2, ASA $\geq$ 3, insulin-dependent diabetes, and COPD. Of these risk factors, age and BMI were identified as independent predictors for 30-day readmission. A better understanding of presurgical risk factors for postsurgical complications may help surgeons with risk stratification and optimization of outcomes.

Type of study/level of evidence: Prognostic III.

The carpometacarpal (CMC) joint is the most common site of symptomatic osteoarthritis in the hand.[1] CMC arthritis occurs more often in women, with its age-adjusted prevalence reported to be 15% in women compared with 7% in men.[2] It has also shown an increasing trend with age, reaching 85% of patients aged between 71 and 80 years.[3] Since the thumb is responsible for 50% of the hand's function, the pain and instability that CMC arthritis causes can severely hinder hand mobility.[4] Given our rapidly aging population and the deteriorating nature of CMC arthritis, it is important to understand which treatments are effective in restoring patients' hand function and associated adverse outcomes.

Declaration of interests: No benefits in any form have been received or will be received related directly to this article.

Corresponding author: Edward D. Wang, MD, Department of Orthopaedics, Stony Brook University Hospital, HSC T-18, Room 080, Stony Brook, NY 11794-8181.
E-mail address: Edward.Wang@stonybrookmedicine.edu (E.D. Wang).

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CMC arthritis is often treated nonsurgically with splinting and corticosteroid injections, but surgical intervention can be considered when these treatments fail or with worsening function or instability.[4,5] One of the oldest and most common procedures is a simple trapeziectomy, although adaptations on this include trapeziectomy with ligament reconstruction and tendon interposition and trapeziectomy with tightrope suspension.[2] Several studies have shown that a simple trapeziectomy results in significant and sustained improvement in patient hand function.[6] However, joint replacement may result in better function, with improved grip and pinch strength.[7–9] Additionally, CMC arthroplasty ideally maintains pain-free thumb motion and improves stability.[10]

Readmission after hand surgery is usually infrequent and most commonly occurs due to infections.[11] Previous studies have reported chronic steroid use, white race, older age, and renal failure to be significantly associated with readmission.[12,13] These factors are different from those associated with reoperation rates, which include younger age, surgeon inexperience, index procedure type, scaphometacarpal impingement, and mechanical pain.[14–16] Additionally, CMC arthroplasty has been reported to have higher rates of reoperation when compared with simple trapeziectomy.[17]

Overall, specific risk factors of readmission and reoperation after CMC arthroplasty remain understudied. Given the widespread prevalence of CMC arthritis and the increasing use of various surgical procedures, it is important to further investigate how patient comorbidities and demographics can predict adverse outcomes. The purpose of this study was to identify patient demographics and comorbidities associated with 30-day readmission and 30-day reoperation after CMC arthroplasty.

Methods

The American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) database was queried for all records of patients who underwent CMC arthroplasty between 2015 and 2020. The NSQIP database is fully deidentified, therefore rendering this study exempt from approval by our University's Institutional Review Board. Data in the NSQIP database are obtained from more than 600 hospitals in the United States and are collected by trained Surgical Clinical Reviewers.

Current Procedural Terminology code 25447 was used to identify records of CMC arthroplasty from 2015 to 2020. Records for patients younger than 18 years of age or cases performed in the trauma setting were automatically excluded from the database. Records were also excluded if any of the following variables had missing information: height/weight, American Society of Anesthesiologists (ASA) classification, and functional health status before surgery. Among the excluded records, two cases of readmission and one case of reoperation exist.

Variables collected in this study included patient demographics, comorbidities, surgical characteristics, and 30-day postsurgical complication data. Patient demographics included age, body mass index (BMI), sex, functional health status before surgery, ASA classification, current smoking status, and chronic steroid use. Presurgical comorbidities included insulin- and noninsulin-dependent diabetes mellitus, chronic obstructive pulmonary disease (COPD), congestive heart failure, hypertension requiring medication, disseminated cancer, open wound/wound infection, and bleeding disorder. Surgical characteristics included transfusion before surgery and surgical duration. Postsurgical complications that occurred within 30 days included readmission and reoperation.

The initial pool of records was divided into cohorts based on whether readmission occurred within 30 days after the procedure. Similarly, the initial pool of records was divided into cohorts based on whether reoperation occurred within 30 days after the procedure.

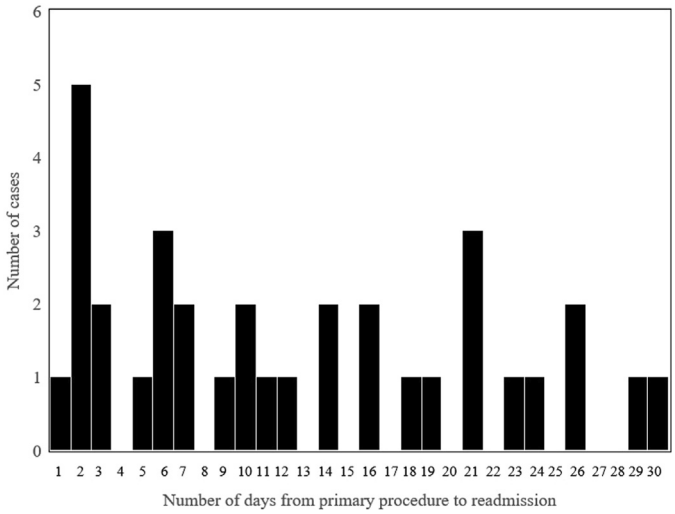

Figure 1. The number of readmissions based on number of days after primary procedure.

Patient demographics and comorbidities were compared between cohorts using bivariate logistic regression. Multivariate logistic regression, adjusted for all significantly associated patient demographics and comorbidities, was used to identify independent associations between patient characteristics and readmission and reoperation after CMC arthroplasty. Odds ratio (OR) were reported with 95% confidence interval (CI). The level of statistical significance was set at a P value of <.05.

Results

A total of 6,624 records of CMC arthroplasty were identified in NSQIP from 2015 to 2020. Records were excluded as follows: 63 for missing height/weight, 14 for missing ASA classification, and 116 for missing functional health status before surgery. Of the 6,432 records remaining after exclusion criteria, 34 (0.5%) had readmission within 30 days and 27 (0.4%) had reoperation within 30 days.

The overall rate of readmission within 30 days after CMC arthroplasty was 0.5%. The number of days from procedure to readmission is shown in Figure 1. Of the records with readmission, half were readmitted by day 10 after their procedure. The most frequent timing for readmission was 2 days after the procedure (n = 5).

Patient demographics and comorbidities were compared between records without and with 30-day readmission, as shown in Table 1. Compared with the non-readmission cohort, the readmission cohort was significantly associated with higher rates of age $\geq$ 75 years (P = .003), BMI $\geq$ 40 kg/m^2 (P = .005), ASA $\geq$ 3 (P < .001), insulin-dependent diabetes (P = .016), and COPD (P = .009).

The patient characteristics significantly associated with 30-day readmission were included in the multivariate analysis to identify the independent predictors of readmission, as shown in Table 2. The multivariate analysis identified age $\geq$ 75 years (OR 3.47, 95% CI 1.42–8.46; P = .006) and BMI $\geq$ 40 kg/m^2 (OR 2.76, 95% CI 1.05–7.25; P = .039) to be independent predictors of readmission after CMC arthroplasty. ASA $\geq$ 3, insulin-dependent diabetes, and COPD were no longer significantly associated with readmission in the multivariate analysis.

The reasons for 30-day readmission are shown in Table 3. Most readmissions were nonsurgical site related (n = 18, 52.9%), with

Table 1
Patient Demographics and Comorbidities for Records Without and With 30-Day Readmission After CMC Arthroplasty*

Characteristics	Readmission Within 30 Days		*P* Value
	No Number (%)	Yes Number (%)	
Total	6,398 (100.0)	34 (100.0)	
Age (y)			
18–39	67 (1.0)	0 (0.0)	.997
40–64	3,621 (56.6)	14 (41.2)	—
65–74	2,060 (32.2)	11 (32.4)	.424
≥75	650 (10.2)	9 (26.5)	**.003**
BMI (kg/m^2)			
<18.5	77 (1.2)	0 (0.0)	.997
18.5–29.9	3,606 (56.4)	16 (47.1)	—
30.0–34.9	1,476 (23.1)	3 (8.8)	.215
35.0–39.9	711 (11.1)	7 (20.6)	.080
≥40.0	528 (8.3)	8 (23.5)	**.005**
Sex			.085
Women	4,788 (74.8)	21 (61.8)	
Men	1,610 (25.2)	13 (38.2)	
Functional status			.998
Independent	6,374 (99.6)	34 (100.0)	
Dependent	24 (0.4)	0 (0.0)	
ASA classification			**<.001**
1–2	4,104 (64.1)	12 (35.3)	
≥3	2,294 (35.9)	22 (64.7)	
Diabetes mellitus			
No	5,620 (87.8)	25 (73.5)	—
Noninsulin	534 (8.3)	5 (14.7)	.130
Insulin	244 (3.8)	4 (11.8)	**.016**
Current smoker			.745
No	5,577 (87.2)	29 (85.3)	
Yes	821 (12.8)	5 (14.7)	
COPD			**.009**
No	6,103 (95.4)	29 (85.3)	
Yes	295 (4.6)	5 (14.7)	
Congestive heart failure			.999
No	6,381 (99.7)	34 (100.0)	
Yes	17 (0.3)	0 (0.0)	
Hypertension			.070
No	3,456 (54.0)	13 (38.2)	
Yes	2,942 (46.0)	21 (61.8)	
Disseminated cancer			.999
No	6,394 (99.9)	34 (100.0)	
Yes	4 (0.1)	0 (0.0)	
Open wound/wound infection			.999
No	6,387 (99.8)	34 (100.0)	
Yes	11 (0.2)	0 (0.0)	
Chronic steroid use			.867
No	6,176 (96.5)	33 (97.1)	
Yes	222 (3.5)	1 (2.9)	
Bleeding disorders			.558
No	6,293 (98.4)	33 (97.1)	
Yes	105 (1.6)	1 (2.9)	
Transfusion before surgery			.999
No	6,398 (100.0)	34 (100.0)	
Yes	0 (0.0)	0 (0.0)	
Surgical duration (min)			
0–49	1,516 (23.7)	4 (11.8)	.275
50–93	3,293 (51.5)	16 (47.1)	—
≥94	1,589 (24.8)	14 (41.2)	.105

* Bold *P* values indicate statistical significance with $P < .05$.

Table 2
Multivariate Analysis of Patient Demographics/Comorbidities Associated With 30-Day Readmission Following CMC Arthroplasty*

Characteristics	OR	95% CI	*P* Value
Age ≥ 75	3.47	1.42–8.46	**.006**
BMI ≥ 40 kg/m^2	2.76	1.05–7.25	**.039**
ASA classification ≥ 3	1.81	0.81–4.03	.148
Insulin-dependent diabetes	1.74	0.56–5.36	.336
COPD	2.49	0.93–6.66	.070

* Bold *P* values indicate statistical significance with $P < .05$.

Table 3
Reasons for 30-Day Readmission After CMC Arthroplasty

Reasons for Readmission	Number	Percent
Total	34	100.0
Surgical site related	**6**	**17.6**
Surgical site infection	4	11.8
Wound dehiscence	1	2.9
Hemorrhage	1	2.9
Nonsurgical site related	**18**	**52.9**
Pulmonary complication	6	17.6
Cardiovascular complication	4	11.8
Gastrointestinal complication	4	11.8
Thromboembolic complication	2	5.9
Sepsis	2	5.9
Other/unspecified	**10**	**29.4**

Reasons for readmission grouped into sub-categories, as indicated by bolded text.

pulmonary complications being the most common ($n = 6$, 17.6%). Pulmonary complications included pneumonia, acute respiratory failure, and pneumothorax. Of surgical site related reasons ($n = 6$, 17.6%), surgical site infections were the most common ($n = 4$, 11.8%).

The overall rate of reoperation within 30 days after CMC arthroplasty was 0.4%. The number of days from procedure to reoperation is shown in Figure 2. Of the records with reoperation, more than half had reoperation by day 15 after the initial procedure. The most frequent timings for reoperation were days 5 and 14 ($n = 3$).

Patient demographics and comorbidities were compared between records without and with 30-day reoperation, as shown in Table 4. Compared with the nonreoperation cohort, the reoperation cohort was significantly associated with higher rates of age ≥ 75 years ($P = .003$), BMI ≥ 40 kg/m^2 ($P = .005$), ASA ≥ 3 ($P < .001$), insulin-dependent diabetes ($P = .016$), and COPD ($P = .009$).

The patient characteristics significantly associated with 30-day reoperation were included in the multivariate analysis to identify the independent predictors of reoperation, as shown in Table 5. The multivariate analysis did not identify any independent predictors of reoperation after CMC arthroplasty. All significant patient characteristics identified in Table 4 were no longer significant in the multivariate analysis.

Reasons for 30-day reoperation are shown in Table 6. Reasons for reoperation related to the primary procedure accounted for 37.0% ($n = 10$) of the total reoperations. The most common reason for reoperation was revision ($n = 6$, 22.2%), followed by infection ($n = 3$, 11.1%). Reasons for reoperation unrelated to the primary procedure accounted for 40.7% ($n = 11$) of the total reoperations.

Discussion

In this study, we reported on risk factors for readmission and reoperation within 30 days in 6,432 records of CMC arthroplasty. We found a 0.52% rate of readmission and a 0.42% rate of reoperation. Through bivariate analysis, we found both 30-day readmission and reoperation to be associated with age ≥ 75 years, BMI ≥ 40 kg/m^2, ASA ≥ 3, insulin-dependent diabetes, and COPD. Through multivariate analysis, we identified age ≥ 75 years and BMI ≥ 40 kg/m^2 to be independent predictors of 30-day readmission. However, we did not find any independent risk factors for 30-day reoperation after CMC arthroplasty.

Surgical interventions for CMC arthritis are the third most common hand procedure in the United States, falling just behind carpal tunnel and trigger finger release.[18] Multiple treatment

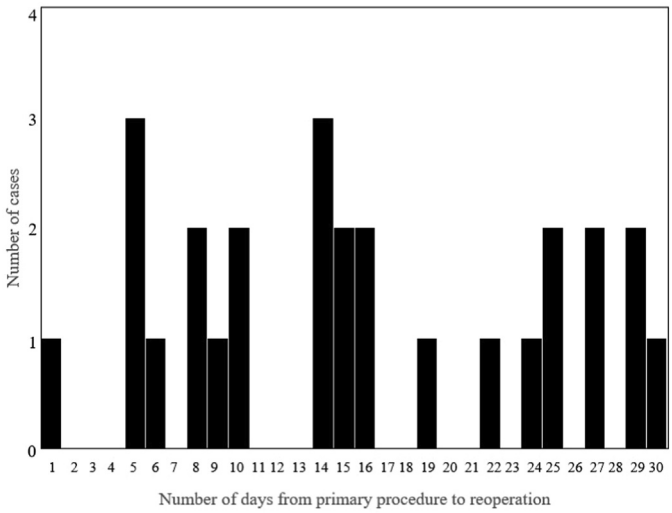

Figure 2. The number of reoperations based on number of days after primary procedure.

approaches have been developed, with ligament reconstruction tendon interposition arthroplasty procedures showing to be an effective option.[8] CMC arthroplasty may result in better functional outcomes, with less disability and comparable pain when compared with simple trapeziectomy, although this remains controversial in practice and the literature.[7] The goal of this study was to investigate major contributors to readmission and reoperation after CMC arthroplasty. The risk factors surrounding readmission and reoperation have been studied in other joint arthroplasty surgeries but are largely underreported for CMC arthroplasty.

30-day readmission

The Hospital Readmission Reduction Program (HRRP) was established under the Affordable Care Act in 2010, placing financial penalties on hospitals in an attempt to prevent unnecessary readmissions and lower cost burdens.[19] For total hip and knee arthroplasties, readmission rates showed a statistically significant decrease after HRRP establishment.[19] Readmission has been well-studied in other areas of orthopedics, as well. Many of these orthopedic studies have shown obesity and older age, among other risk factors, to be associated with postsurgical readmission.[20–24]

Our results, showing BMI $\geq$ 40 kg/m^2 and age $\geq$ 75 years as predictors of readmission, mirror these previous studies. Furthermore, a study by Cogan et al[24] found obesity to be associated with readmission, deep vein thrombosis, pulmonary embolism, superficial infection, and prosthetic joint infection after total knee arthroplasty (TKA). These findings emphasize the relationship between obesity and its associated comorbidities that may increase the likelihood of postsurgical readmission.

Little has been reported regarding CMC arthroplasty and readmission risks. A study by Shah et al[13] that looked at 30-day complications, including readmission and reoperation, after CMC arthroplasty found insulin-dependent diabetes and ASA class 4 to have a strong trend toward complications, whereas renal dialysis was a significant predictor for adverse outcomes. Similarly, our study found insulin-dependent diabetes and ASA class $\geq$ 3 to be associated with readmission after CMC arthroplasty on bivariate analysis. Since patients undergoing CMC arthroplasty are commonly in their seventh decade of life, our findings that age and BMI were independent predictors for readmission may further assist physicians in determining which patients are at high risk.[17]

Table 4
Patient Demographics and Comorbidities for Records Without and With 30-Day Reoperation After CMC Arthroplasty*

Characteristics	Reoperation Within 30 Days		*P* Value
	No Number (%)	Yes Number (%)	
Total	6,405 (100.0)	27 (100.0)	
Age (y)			
18–39	67 (1.0)	0 (0.0)	.997
40–64	3,621 (56.5)	14 (51.9)	—
65–74	2,064 (32.2)	7 (25.9)	.424
≥75	653 (10.2)	6 (22.2)	**.003**
BMI (kg/m^2)			
<18.5	77 (1.2)	0 (0.0)	.997
18.5–29.9	3,611 (56.4)	11 (40.7)	—
30.0–34.9	1,474 (23.0)	5 (18.5)	.215
35.0–39.9	713 (11.1)	5 (18.5)	.080
≥40.0	530 (8.3)	6 (22.2)	**.005**
Sex			.085
Women	4,792 (74.8)	17 (63.0)	
Men	1,613 (25.2)	10 (37.0)	
Functional status			.998
Independent	6,381 (99.6)	27 (100.0)	
Dependent	24 (0.4)	0 (0.0)	
ASA classification			**<.001**
1–2	4,105 (64.1)	11 (40.7)	
≥3	2,300 (35.9)	16 (59.3)	
Diabetes mellitus			
No	5,625 (87.8)	20 (74.1)	—
Noninsulin	534 (8.3)	5 (18.5)	.130
Insulin	246 (3.8)	2 (7.4)	**.016**
Current smoker			.745
No	5,582 (87.2)	24 (88.9)	
Yes	823 (12.8)	3 (11.1)	
COPD			**.009**
No	6,107 (95.3)	25 (92.6)	
Yes	298 (4.7)	2 (7.4)	
Congestive heart failure			.999
No	6,388 (99.7)	27 (100.0)	
Yes	17 (0.3)	0 (0.0)	
Hypertension			.070
No	3,457 (54.0)	12 (44.4)	
Yes	2,948 (46.0)	15 (55.6)	
Disseminated cancer			.999
No	6,401 (99.9)	27 (100.0)	
Yes	4 (0.1)	0 (0.0)	
Open wound/wound infection			.999
No	6,394 (99.8)	27 (100.0)	
Yes	11 (0.2)	0 (0.0)	
Chronic steroid use			.999
No	6,182 (96.5)	27 (100.0)	
Yes	223 (3.5)	0 (0.0)	
Bleeding disorders			.558
No	6,300 (98.4)	26 (96.3)	
Yes	105 (1.6)	1 (3.7)	
Transfusion before surgery			.999
No	6,405 (100.0)	27 (100.0)	
Yes	0 (0.0)	0 (0.0)	
Surgical duration (min)			
0–49	1,516 (23.7)	4 (14.8)	.578
50–93	3,297 (51.4)	12 (44.4)	—
494	1,592 (24.9)	11 (40.7)	.126

* Bold *P* values indicate statistical significance with $P < .05$.

30-day reoperation

Understanding potential demographics and comorbidities associated with reoperation may help minimize adverse outcomes and unnecessary hospital costs. Our study found a relatively low reoperation rate of 0.42%. Other studies on hand reoperation rates have also found similarly low results.[13,16,25] A study by Lane et al[17]

Table 5
Multivariate Analysis of Patient Demographics/Comorbidities Associated With 30-Day Reoperation After CMC Arthroplasty*

Characteristics	OR	95% CI	*P* Value
Age ≥ 75	2.42	0.88–6.65	.088
BMI ≥ 40 kg/m^2	2.96	0.97–9.05	.057
ASA classification ≥ 3	1.65	0.69–3.92	.260
Insulin-dependent diabetes	1.21	0.27–5.51	.803
COPD	1.22	0.28–5.32	.788

* Bold *P* values indicate statistical significance with $P < .05$.

Table 6
Reasons for 30-Day Reoperation After CMC Arthroplasty

Reasons for Reoperation	Number	Percent
Total	27	100.0
Related to primary procedure	**10**	**37.0**
Revision	6	22.2
Infection	3	11.1
Wound complication	1	3.7
Unrelated to primary procedure	**11**	**40.7**
Fracture	3	11.1
Urological	3	11.1
Gastrointestinal	2	7.4
Ophthalmologic	2	7.4
Thromboembolism	1	3.7
Other/unspecified	**6**	**22.2**

Reasons for readmission grouped into sub-categories, as indicated by bolded text.

that looked at 43,607 surgeries for more than 19 years reported an increased reoperation rate of 3.84% after CMC arthroplasty, which was the highest reoperation rate of all thumb surgeries. Furthermore, this study found that patients were 2.5 times more likely to undergo revision after CMC arthroplasty with ligament reconstruction when compared with simple trapeziectomy.[17] Although arthroplasty has shown significantly greater odds of complications and revisions, it also may result in better joint functional outcomes.[7] However, as mentioned previously, this remains controversial in practice. As surgical options expand and surgical volumes continue to increase, it is increasingly important to investigate what risk factors can lead to reoperations.

Previous reoperation rates have been reported to range from 0.15% to almost 5%.[13–17,25,26] The variation in reported reoperation rates after CMC arthroplasty can also be related to the differences in the length of patient follow-up. The average time from surgery until the revision procedure has been reported to range from 9.6 to 23 months after CMC arthroplasty.[25,26] Another study reported most revisions to occur within the first year postoperatively.[15] Additionally, patients who underwent unplanned readmission have a significantly higher chance of reoperation.[12] Our study demonstrates a reoperation that coincides with the lower rates identified in the literature, as the data only analyze the early 30-day postsurgical period, as opposed to an extended 23-month follow-up. However, these data may help us determine when acute surgical intervention is necessary based on the identified risk factors.

Our study found age ≥ 75 years, BMI ≥ 40 kg/m^2, ASA ≥ 3, insulin-dependent diabetes, and COPD to be associated with reoperation following CMC arthroplasty, with high BMI showing the strongest trend on multivariate analysis ($P = .057$). Reoperations after orthopedic surgeries have been well-documented in other joint replacement procedures. A study by De Martino et al[27] looking at the effects of morbid obesity (BMI ≥ 40 kg/m^2) after TKA found obesity to be associated with increased reoperation rate and superficial infection, along with longer surgical times and higher complication rates. Reoperation after total shoulder arthroplasty was found to be more likely following malunion than osteoarthritis.[28]

After CMC arthroplasty, Wilken et al[15] found surgeon inexperience and index type procedure to be associated with unplanned reoperation. Furthermore, some studies have suggested younger age as a risk factor for reoperation.[15,26] Although the younger patient population is generally healthier, this finding could be influenced by increased joint use after surgery and a longer time for potential complications to develop. Finally, presurgical steroid injections have been shown to more than double the likelihood of postsurgical revision due to wound complications or infection.[29] Wound complications after CMC arthroplasty are relatively low, reported by Shah et al[13] to be 0.66%. This could account for the overall low rate of reoperation. Other commonly reported reasons for reoperation include mechanical pain, radial neuropathy, and concomitant arthritis.[14,25]

Limitations

This study was limited to the information that was available through the ACS-NSQIP database. Our data were limited to 30-day complications after surgery, and therefore, we could not account for complications outside of this 30-day period. This eliminates the possibility of describing long-term outcomes that may commonly occur outside of this period, such as reoperation. Additionally, the use of this database did not allow us to account for other potentially influencing factors including physician experience/skill, location of surgery, or disease severity. Despite these limitations, we used a large national database to investigate the comorbidities- and demographics-associated readmission and reoperation after CMC arthroplasty. Moreover, this study identified BMI ≥ 40 kg/m^2 and age ≥ 75 years to be significant independent risk factors for 30-day readmission after CMC arthroplasty.

Given the low risk of 0.52% readmission and 0.42% reoperation, we believe that these findings should not deter patients who meet these criteria from undergoing surgery. Rather, these patients should be made aware of their increased risk profile and consider lowering their BMI before surgery. Those who choose to undergo surgery should know that they are at increased risk for readmission unrelated to the procedure and reoperation for revision surgery.

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