



Predictors of unsatisfactory patient outcomes in primary reverse total shoulder arthroplasty

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Background: Despite favorable clinical and functional results for reverse total shoulder arthroplasty (RSA), there remains a group of patients without postoperative complications who demonstrate poor improvement and overall outcome.

Methods: Using a single surgeon shoulder arthroplasty registry, we identified patients who underwent RSA from 2013 to 2016 with minimum of 2-year postoperative follow-up. Patients with intra- and postoperative complications were excluded. Poor postoperative clinical outcome was defined as those patients within the bottom 30th percentile for American Shoulder and Elbow Surgeons (ASES) score. Poor postoperative improvement was defined as the bottom 30th percentile of ASES improvement, measured preoperatively to the 2-year postoperative mark. Multivariate logistic regression modeling was used to determine preoperative characteristics (e.g., demographics, comorbidities, preoperative ASES score) associated with poor outcome.

Results: A total of 137 patients met the inclusion and exclusion criteria. Multivariable logistic regression modeling found that prior shoulder surgery, the majority (75%) of which were arthroscopic, was the only independent factor associated with both poor improvement (adjusted odds ratio, 2.46 [1.03-5.83]) and outcome (adjusted odds ratio, 4.92 [1.74-14.96]). Preoperative opioid use was associated with poor outcomes only, whereas the high preoperative ASES score was associated with poor postoperative improvement.

Conclusions: Prior ipsilateral shoulder surgery was strongly associated with poor clinical improvement and outcome after RSA. No other factors correlated with both poor improvement and outcome. This association is important to decision making for any shoulder surgery, given the long-term implications.

Level of evidence: Level III; Retrospective Cohort Design; Treatment Study

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Reverse total shoulder arthroplasty (RSA) is an effective treatment for many patients with a wide range of conditions affecting the shoulder^{24,25,27} and has demonstrated marked improvements quantified by patient-reported outcomes. Results, however, are less predictable than those of anatomic total shoulder arthroplasty (TSA),^{13,29} and there remains a poorly defined group of patients who experience

inferior outcomes without any intra- or postoperative complications after RSA. Patients in this group demonstrate greater limitations in range of motion and higher self-reported pain levels, even at the 2-year postoperative follow-up. Evaluating such patients is further complicated by the range of clinical indications for RSA. Primary RSA was traditionally reserved for patients with rotator cuff arthropathy, but indications for RSA have expanded to include massive rotator cuff tears, arthritis with an intact rotator cuff, acute proximal humeral fractures, fracture sequelae, and failed arthroplasty.^{1,21,27} Most patients see significant improvement regardless of indication. However, the degree of preoperative dysfunction may correlate with the degree of improvement,^{15,16,31,34} and thus preoperative diagnosis may play a role in overall outcomes.

Predictive characteristics of poor clinical outcome after RSA are controversial. Studies have correlated both old and young age with poor outcomes,^{4,34} with conflicting results on whether prior rotator cuff repair (RCR), body mass index (BMI), and gender are reliable preoperative indicators.^{1,25,28} Other comorbidities such as preoperative opioid use have complex physical and socioeconomic implications, and are therefore difficult to evaluate.⁹ Further complicating the definition of poor outcome, many studies include patients with intra- and postoperative complications.^{1,28} Few studies have isolated patients without complications who still experience impaired shoulder function after RSA.

The purpose of this study was to determine preoperative predictors (demographics, comorbidities, preoperative diagnosis, and preoperative ASES score) of poor postoperative outcome and improvement, quantified by ASES score and change in ASES score, respectively. We hypothesized that old age, female gender, low preoperative ASES score, and prior surgery would all correlate with poorer postoperative scores.

Methodology

Study population

Using a prospectively collected single surgeon registry of anatomic and reverse total shoulder arthroplasties, patients were selected who underwent primary RSA between 2013 and 2016 for a primary diagnosis of degenerative joint disease (DJD), rotator cuff arthropathy (RCA), or rotator cuff tear (RCT) by the senior author (A.J.). We defined RCT as a Hamada class II tear, whereas we defined RCA as a Hamada class III or above. Patients with chronic dislocation (2 patients), avascular necrosis (5 patients), and fracture sequelae (4 patients) were excluded to better represent the most frequent indications for RSA. Patients without preoperative and minimum 2-year follow-up ASES scores were excluded. Patient characteristics and comorbidities were recorded before surgery and monitored through the follow-up period. Patients with intra- and postoperative complications, defined as intra- and postoperative fractures, infection, nerve injury, dislocation, or hardware failure, were excluded.

All surgeries were performed by the senior author (A.J.) using the deltopectoral approach. The surgeon switched from a Grammont-style prosthesis with 2.5 mm of lateral offset to an implant with 6 to 10 mm of lateral offset during the study period,²⁰ but all other surgical technique remained consistent. However, we previously reported with 1-year follow-up that there was no clinically important difference in outcomes scores between the 2 prostheses.²⁰ Postoperatively, patients had no formalized physical therapy, but were encouraged to follow a home rehabilitation plan: no external rotation beyond neutral in a sling for 6 weeks, external and internal rotation range of motion exercises after 6 weeks, and strengthening exercises permitted with a return to normal activity at 3 months.

Statistical analysis

Postoperative improvement was defined as the change in ASES score from preoperative consultation to 2-year follow-up. We defined patients with the worst postoperative outcomes as those in the bottom 30th percentile of improvement in ASES score, in accordance with previous comparison studies.¹⁹ Similarly, poor postoperative clinical outcome was defined for patients within the bottom 30th percentile of ASES scores at a minimum 2-year follow-up. Bivariate analysis was employed to compare preoperative characteristics between the poor outcomes group and the remaining 80% of the study population. Independent *t*-tests were employed for continuous variables, and for categorical variables, we employed Pearson chi-square and Fisher exact tests where indicated. Variables identified by $P < .2$ in bivariate analysis were inserted into multivariate logistic regression to identify statistically significant characteristics, reported as odds ratios (OR) with 95 % confidence intervals.

Preoperative factors examined were prior surgery, age at surgery, gender, BMI classification, American Society of Anesthesiologists (ASA) health score, diagnosis (DJD, RCT, and RCA), and comorbid conditions (preoperative opioid use, diabetes, hypertension, hypercholesterolemia, depression, thyroid disease, and rheumatoid arthritis). We defined preoperative opioid use as having an active, daily prescription at the time of preoperative screening.

Results

Outcome

A total of 137 shoulders met the inclusion and exclusion criteria, representing a 78% 2-year follow-up rate. Minimum postoperative follow-up time was 2 years and the maximum was 56 months. Average follow-up (standard deviation) time was 29 (8) months. The average postoperative ASES score for patients in the worst-outcomes group was 64.2, compared with 91.3 for the satisfactory outcomes group (Table 1). Nine patients were excluded from the study due to complication, 3 diagnosed with a postoperative acromial stress fracture, 2 due to nerve injury, and 1 due to an intraoperative fracture. Bivariate analysis indicated that prior ipsilateral shoulder surgery ($P = .002$) and preoperative opioid use ($P = .006$) were significantly

Table I Sample demographics and comorbidities, by ASES score at 2-year follow-up

	ASES score at 2-yr follow-up		<i>P</i>
	Low (bottom 30%)	Normal/high (upper 70%)	
	(n = 39)	(n = 98)	
Postoperative ASES score, μ (sd)	64.2 (12.3)	91.3 (6.3)	<.0001
Age (yr), n (%)			
<65	8 (20.5)	14 (14.3)	.458
65-69	7 (17.9)	27 (27.6)	
70-74	10 (25.6)	30 (30.6)	
≥ 75	14 (35.9)	27 (27.6)	
Sex, n (%)			
Male	14 (35.9)	35 (35.7)	.984
Female	25 (64.1)	63 (64.3)	
Body mass index (kg/m ²), n (%)			
Normal (<25)	10 (25.6)	17 (17.3)	.704
Overweight (25-29.9)	12 (30.8)	36 (36.7)	
Obese (30-34.9)	8 (20.5)	19 (19.4)	
Severely Obese (≥ 35)	9 (23.1)	26 (26.5)	
ASA, n (%)			
1-2	26 (66.7)	66 (67.3)	.939
3	13 (33.3)	32 (32.7)	
Insurance, n (%)			
1 Private	7 (17.9)	22 (22.4)	.497
2 Medicare	28 (71.8)	71 (72.4)	
3 Other	4 (10.3)	5 (5.1)	
Comorbid conditions, n (%)			
Diabetes	8 (20.5)	10 (10.2)	.107
Hypertension	21 (53.8)	57 (58.2)	.645
Hypercholesterolemia	15 (38.5)	39 (39.8)	.885
Depression	13 (33.3)	18 (18.4)	.059
Thyroid disease	7 (17.9)	20 (20.4)	.744
Rheumatoid arthritis	2 (5.1)	5 (5.1)	1.000
Preoperative opioid use	10 (25.6)	8 (8.2)	.006
Preoperative ASES score, μ (sd)	29.4 (14.0)	31.3 (15.1)	.554
Prior shoulder surgery, n (%)	18 (46.2)	20 (20.4)	.002
Primary diagnosis, n (%)			
Degenerative joint disease	19 (48.7)	67 (68.4)	.083
Rotator cuff tear	10 (25.6)	18 (18.4)	
Rotator cuff arthropathy	10 (25.6)	13 (13.3)	

ASES, American Shoulder and Elbow Surgeons; μ , mean; *sd*, standard deviation; ASA, American Society of Anesthesiologists.

Bold indicates values with statistical significance.

P values for ASES scores derived from the Wilcoxon rank sum test.

associated with poor outcomes (Table I). Of the 39 poor-outcome patients who had a prior surgery, 15 underwent arthroscopic rotator cuff repair and 3 underwent open rotator cuff repair. Three of the 18 patients underwent multiple rotator cuff repairs (open or arthroscopic) before RSA. Of the 98 patients with satisfactory outcome, 16 underwent rotator cuff repair (13 arthroscopic and 3 open, 4 patients had multiple repairs), 3 patients underwent arthroscopic débridement, and 1 the removal of a lipid tumor. No other predictors or preoperative diagnoses correlated significantly with the low ASES score group. Female sex ($P = .984$), old

or young age ($P = .458$), and lower preoperative ASES score ($P = .504$) were not correlated with poorer outcomes. Similarly, primary diagnosis ($P = .083$) was not significantly associated with worse outcomes.

Multivariable logistic regression modeling found that prior shoulder surgery (adjusted OR, 2.46 [1.03-5.83]) and preoperative opioid use (OR, 3.71 [1.18-12.19]) were independently associated with low postoperative ASES score after RSA (Table II). No diagnosis, age, BMI, or preoperative ASA score correlated significantly with poor outcome (Table II).

Table II Crude and adjusted associations between preoperative patient factors and low ASES score (bottom 30%) at 2-year follow-up, among reverse total shoulder arthroplasty patients at New England Baptist Hospital

	Crude [*] cOR (95% CI)	Multivariate regression aOR (95% CI)
Age, yr		
≤64	Ref	–
65-70	0.53 (0.19-1.49)	–
>70	0.94 (0.32-2.79)	–
Female sex	0.97 (0.45-2.11)	–
Body mass index, kg/m ²		
Normal (<25)	Ref	–
Overweight (25-29.9)	0.57 (0.20-1.61)	–
Obese (≥30)	0.64 (0.25-1.67)	–
ASA classification		
≤2	Ref	–
3	0.96 (0.43-2.17)	–
Preoperative ASES score [†]	0.99 (0.97-1.02)	0.95 (0.72-1.24)
Primary diagnosis		
DJD	Ref	Ref
RCA	1.96 (0.77-4.95)	1.79 (0.66-4.75)
RCT	2.82 (1.06-7.50)	2.21 (0.75-6.37)
Preoperative narcotic use	3.80 (1.35-10.70)	3.26 (1.08-10.07)
Prior shoulder surgery	3.35 (1.50-7.46)	2.46 (1.03-5.83)

ASES, American Shoulder and Elbow Surgeons (ASES); cOR, crude odds ratio; CI, confidence interval; aOR, adjusted odds ratio; ASA, American Society of Anesthesiologists; DJD, degenerative joint disease; RCA, rotator cuff arthropathy; RCT, rotator cuff tear; ROC, receiver operating characteristic.

Bold indicates values with statistical significance.

Area under the ROC curve = 0.619 and 0.726 (respectively).

* "Crude" models adjusted for baseline ASES score only.

† Unadjusted ASES score, in 10-unit increments.

Improvement

Bivariate analysis indicated that prior ipsilateral shoulder surgery ($P = .001$), higher preoperative ASES score ($P \leq .001$), and DJD diagnosis ($P = .046$) were significantly associated with poor improvement (Table III). Of the 18 patients with prior surgery in the poor-improvement group, 17 had previous rotator cuff repairs (13 arthroscopic and 4 open, 2 patients had multiple prior repairs) and 1 patient had an arthroscopic débridement. Eighteen of the 100 patients in the satisfactory improvement group underwent rotator cuff repair (16 arthroscopic, 1 open, and 5 patients underwent multiple repairs), 1 had a previous arthroscopic débridement, and 1 patient had a lipoma removal. No other predictors or preoperative diagnoses correlated significantly with the poor improvement group, including female sex ($P = .267$), age ($P = .374$), and preoperative opioid use ($P = .572$). The average postoperative ASES score of the worst-improvement patients was 70.9, compared with 88.8 for the satisfactory-improvement group (Table III).

Multivariable logistic regression modeling found that prior shoulder surgery (adjusted OR, 5.28 [1.77-17.42]) and high preoperative ASES score (OR, 2.81 [1.88-4.57]) were independently associated with poor improvement in ASES

score after RSA (Table II). No diagnosis, including DJD (OR, 0.8 [0.22-2.66]), age (OR, 1.25 [0.32-5.08]), obesity (OR, 1.13 [0.15-1.69]), or sex (OR, 0.94 [0.32-2.87]), was correlated significantly with poor outcome (Table IV).

Discussion

Our objective was to examine preoperative characteristics of patients with poor outcomes after RSA for DJD, RCA, and RCT without intra- or postoperative complications. We found that prior ipsilateral shoulder surgery and preoperative opioid use were significantly correlated with scoring in the bottom 30th percentile of ASES score 2 years postoperatively (Table II). Other previously reported risk factors, including female gender, age, BMI, and preoperative rotator cuff tear, were neutral in predicting low postoperative ASES score (Tables I and II).

The principal strengths of this study are the large patient population (137 shoulders; 78% follow-up rate) and 2-year minimum follow-up (average clinical follow-up of 27 months). Furthermore, this study looks at absolute postoperative ASES score, as well as change in ASES score. We believe that the patient group with poor outcomes and the group with subpar improvement are both significant and

Table III Sample demographics and comorbidities, by ASES score improvement between preoperative and 2-year follow-up assessments

	2-year improvements in ASES score		<i>P</i>
	Lowest improvement (bottom 30%) (n = 40)	Satisfactory improvement (upper 70%) (n = 97)	
Postoperative ASES score, μ (sd)	70.9 (17.6)	88.8 (9.6)	<.0001
Age (yr), n (%)			
<65	6 (15.0)	16 (16.5)	.420
65-69	8 (20.0)	26 (26.8)	
70-74	10 (25.0)	30 (30.9)	
≥ 75	16 (40.0)	25 (25.8)	
Sex, n (%)			
Male	18 (45.0)	31 (32.0)	.148
Female	22 (55.0)	66 (68.0)	
Body mass index (kg/m ²), n (%)			
Normal (<25)	7 (17.5)	20 (20.6)	.464
Overweight (25-29.9)	18 (45.0)	30 (30.9)	
Obese (30-34.9)	7 (17.5)	20 (20.6)	
Severely obese (≥ 35)	8 (20.0)	27 (27.8)	
ASA, n (%)			
1-2	31 (77.5)	61 (62.9)	.098
3	9 (22.5)	36 (37.1)	
Insurance, n (%)			
1 Private	7 (17.5)	22 (22.7)	.504
2 Medicare	29 (72.5)	70 (72.2)	
3 Other	4 (10.0)	5 (5.2)	
Comorbid conditions, n (%)			
Diabetes	7 (17.5)	11 (11.3)	.332
Hypertension	21 (52.5)	57 (58.8)	.501
Hypercholesterolemia	20 (50.0)	34 (35.1)	.104
Depression	12 (30.0)	19 (19.6)	.185
Thyroid disease	5 (12.5)	22 (22.7)	.173
Rheumatoid arthritis	2 (5.0)	5 (5.2)	1.000
Preoperative opioid use	7 (17.5)	11 (11.3)	.332
Preoperative ASES score, μ (sd)	42.2 (14.8)	26.0 (11.9)	<.0001
Prior shoulder surgery, n (%)	18 (45.0)	20 (20.6)	.004
Primary diagnosis, n (%)			
Degenerative joint disease	20 (50.0)	66 (68.0)	.066
Rotator cuff tear	9 (22.5)	19 (19.6)	
Rotator cuff arthropathy	11 (27.5)	12 (12.4)	

ASES, American Shoulder and Elbow Surgeons (ASES); μ , mean; *sd*, standard deviation; ASA, American Society of Anesthesiologists.

Bold indicates values with statistical significance.

P values for ASES scores derived from the Wilcoxon rank sum test.

worth investigating. Defining overlapping and distinct predictors for both outcomes groups improves surgical planning and patient expectations. By examining excluding diagnoses other than DJD, RCA, and RCT, this study better characterizes outcomes of the most frequent indications for RSA. Further investigation with a larger patient population could examine other diagnoses, including fracture sequelae and chronic dislocation.

There are several limitations of this study. We evaluated outcomes solely based on postoperative ASES score, rather than using a variety of measures. We did not have access to state-wide prescription drug reporting, and thus relied only

on patient-reported opioid use. Furthermore, we are unable to accurately report the interval between the index RSA and any prior ipsilateral procedures. Lastly, although the study population size is relatively large, certain preoperative diagnoses were too uncommon to compare. Proximal humeral fracture, nonunion, and avascular necrosis are all indications for RSA, but were excluded from analysis to focus on the most prominent indications for RSA. A larger future study population would be appropriate to evaluate outcomes of patients with these indications.

This study identifies a segment of patients who undergo RSA but experience inferior outcomes without obvious

Table IV Crude and adjusted associations between preoperative patient factors and low pre-to-postoperative ASES score improvement (bottom 30%, <42-point change), among reverse total shoulder arthroplasty patients at New England Baptist Hospital

	Crude* cOR (95% CI)	Multivariate regression aOR (95% CI)
Age, yr		
≤64	Ref	–
65-70	0.58 (0.17-2.04)	–
>70	1.26 (0.35-4.79)	–
Female sex	0.64 (0.26-1.58)	–
Body mass index, kg/m ²		
Normal (<25)	Ref	–
Overweight (25-29.9)	1.28 (0.38-4.49)	–
Obese (≥30)	1.06 (0.34-3.62)	–
ASA classification		
≤2	Ref	–
3	0.85 (0.31-2.23)	–
Preoperative ASES score [†]	2.50 (1.81-3.66)	2.96 (2.04-4.62)
Primary diagnosis		
DJD	Ref	Ref
RCA	1.76 (0.57-5.37)	1.43 (0.44-4.53)
RCT	3.31 (1.05-10.80)	2.42 (0.67-8.83)
Preoperative narcotic use	4.42 (1.26-15.97)	3.38 (0.90-12.75)
Prior shoulder surgery	5.04 (1.90-14.43)	3.77 (1.34-11.23)

ASES, American Shoulder and Elbow Surgeons (ASES); cOR, crude odds ratio; CI, confidence interval; aOR, adjusted odds ratio; ASA, American Society of Anesthesiologists; DJD, degenerative joint disease; RCA, rotator cuff arthropathy; RCT, rotator cuff tear; ROC, receiver operating characteristic.

Bold indicates values with statistical significance.

Area under the ROC curve = 0.825 and 0.857 (respectively).

* "Crude" models adjusted for baseline ASES score only.

† Unadjusted ASES score, in 10-unit increments.

complications. The pattern is clinically observed, but to date poorly described. Few previous studies have sought to define predictors of unexplained poor outcomes, and instead include complications in analysis. Although the correlation between intra- and postoperative complications is well documented, and demands further investigation, it is important to consider other etiologies of pain and poor function after RSA.

Our findings showed that patients with prior ipsilateral shoulder surgery were significantly more likely to have poor outcomes 2 years postoperatively. The majority of prior surgeries were RCR, and the surgical technique (open or arthroscopic) did not appear to influence outcomes. However, only 6 patients underwent open rotator cuff repair, and we were not able to generate reliable statistics with such a small sample size. Matsen et al¹⁷ found using the Simple Shoulder Test as a metric that prior surgery of any type did correlate with poorer outcomes. Although the study did not differentiate between RSA and other types of arthroplasties, the results indicate that postsurgical changes before RSA may impede postoperative improvement. Only 3 previous studies look directly at the correlation between prior ipsilateral surgery and poor outcomes in RSA, but all include patients with complications.^{1,25,28} Boileau et al¹ did show significantly worse outcomes in patients with prior RCR, but did not include outcome data for the control

group in their publication, and thus the conclusions are difficult to interpret.

Sadoghi et al²⁵ found that patients did equally well after RSA regardless of prior RCR. However, the study analyzed a smaller population of 68 shoulders, and the surgeries reported were performed between 2002 and 2007. RSA was introduced in the United States during that time period, and since then implants and protocols have progressed significantly.^{3,10} Similarly, the volume of RCR performed has also increased significantly in the last 2 decades, and the procedure has transitioned from an open to arthroscopic surgery.^{2,8,22} Changes in surgical factors for both RSA and RCR combined with the sizable patient population of the present study may help explain the discrepancy in results. More recently, Shields et al²⁸ did show in a large study population that prior ipsilateral surgery is correlated with worse outcomes; however, patients with complications were included in the study. Our results agree with established literature but still help to characterize a yet undefined group of patients.

The correlation between preoperative opioid use and inferior postoperative outcome is well documented. In agreement with the present study, the existing literature has linked chronic opioid use with inferior outcomes in a variety of orthopedic procedures.^{9,11,35} We previously reported that opioid use at the time of surgery was correlated

with increased postoperative pain in both anatomic and reverse total shoulder arthroplasty.¹⁸

Several studies have linked female gender, young age, high ASA score, and workers compensation insurance, all contradicted by the present study.^{6,17,33} The significantly larger sample (137 shoulders), focus on only RSA without complication, and high follow-up rate (78%) of this study all help explain our conclusions. Our results do agree with several other studies, which showed that gender and age are neutral in predicting outcomes,^{12,28} and there remains significant debate regarding the correlation of these factors with surgical outcomes. Future research should incorporate multiple institutions and longer follow-up data to help create more robust, generalizable conclusions.

There is also significant debate over the treatment of patients with high BMI.²⁶ Previous studies of arthroplasty procedures disagree on surgical outcomes of high-BMI patients, with some studies suggesting that high BMI increases the incidence of infection, readmission, and poor outcome without formal complications,^{5,30} whereas others show no significant disadvantages.^{7,14,23} However, there are few studies that specifically investigate the impact of high BMI on RSA patients, and no previous studies that exclude complications. Our results indicate that BMI category is not significantly correlated with poor outcomes. Patients with a high BMI can expect similar outcomes to low-BMI surgical candidates, excluding the influence of intraoperative complication.

This study also demonstrates limited improvement after RSA in patients with high preoperative function. This phenomenon is well documented in anatomic TSA literature, but has yet to be demonstrated in RSA with minimum 2-year postoperative data.^{15,16,31,34} Mahoney et al described a ceiling effect after TSA, where patients with high preoperative function did not reach significant clinical improvement, but still achieved self-reported satisfactory outcomes. In this study, patients in the poor improvement cohort scored, on average, 16 points higher before RSA than other patients, representing a clinically and statistically significant difference.³² Understanding the influence of high preoperative function is important information for surgical decision making and patient expectations. High-functioning surgical candidates may experience satisfactory outcome after RSA, but still show limited postoperative improvement.

Conclusion

Despite widespread clinical improvement after RSA procedures, there remains a subset of patients who still experience poor outcomes without complications. Prior ipsilateral surgery and preoperative opioid use were significantly associated with poor outcomes. However, the existing literature shows that RSA is still an effective

treatment for painful shoulders after failed previous surgeries, and thus this study should not exclude patients from treatment. Rather, our results should help inform both patients and physicians when discussing treatment options, in advance of RCR, RSA, and other surgeries.

Disclaimer

Andrew Jawa has been a paid speaker and consultant for DJO Global, a designer for Ignite Orthopedics, and has equity in Boston Outpatient Surgical Suites. All the other authors, their immediate families, and any research foundations with which they are affiliated have not received any financial payments or other benefits from any commercial entity related to the subject of this article.

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