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ORIGINAL PAPER

Does body mass index affect outcomes following arthroscopic superior capsular reconstruction using fascia lata autograft for massive irreparable rotator cuff tear?

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Abstract

Purpose This study aimed to evaluate the effect of increased body mass index (BMI) on patient-reported outcomes (PROs) and clinically significant outcomes (CSOs) obtained > two years postoperatively following arthroscopic superior capsular reconstruction (ASCR).

Methods A retrospective study was conducted on patients who underwent ASCR with a minimum two year follow-up. All patients were divided into normal (BMI < 25.0), overweight (BMI 25–30.0), and obese (BMI ≥ 30) according to preoperative BMI. Patients were assessed using the PROs preoperatively and at six months, one year, and two years postoperatively, including the visual analog scale (VAS), American Shoulder and Elbow Surgeons (ASES), and Constant–Murley scores. The time required to achieve each CSO was analyzed and compared. Multivariate analyses evaluated the predictor variables and time required to achieve CSOs.

Results This study included 63 patients with a mean age of 64.8 ± 8.6 years, including 31 normal BMI, 25 overweight, and seven obese patients. Significant improvements in VAS and ASES scores after ASCR were observed in all three groups. Normal and overweight patients had significant improvements in the Constant score; however, no difference was observed in obese patients. No significant difference was observed in the probability distributions of CSOs between the BMI groups. Similarly, no significant differences were observed in the probability distributions of the CSOs, ASES, and Constant scores at each time point, among the BMI groups.

Conclusion Patients in the normal and overweight groups had significant improvements in the VAS, ASES, and Constant scores after ASCR. Patients in the obese group had a significant improvement in VAS score; however, there is no difference for the ASES and Constant scores in the obese group. However, no differences were observed in all PROMs and the likelihood of achieving CSOs among the different BMI groups.

Keywords Body mass index · Superior capsular reconstruction · Patient-reported outcomes · Clinically significant outcomes

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Introduction

Obesity poses a substantial health concern as it closely associates with a higher risk of various health conditions. Furthermore, obesity significantly raises the probability of overall mortality and mortality from cardiovascular disease [1]. Additionally, moderate and severe obesities substantially raise the likelihood of postoperative complications and unplanned hospital admissions following surgical procedures [2].

Obesity presents specific challenges in shoulder arthroscopy. These challenges include difficulty in establishing a portal and accessing the joint and concerns about the diminishment of surgical benefits which is assumed to be caused by obesity [3]. A higher occurrence of rotator cuff diseases was reported to correlate with increasing body mass index (BMI) [4, 5]. Extensive research has consistently shown that elevated body fat has negative implications for rotator cuff health. These implications include enhanced tendon degeneration, more complex tears, and diminished healing capacity [6]. However, limited data is available on the outcomes of rotator cuff repair specifically in individuals with severe obesity [4]. Fares et al. found that the patients with normal weight reached significantly higher clinical outcomes after rotator cuff repair [7]. As found by Linberg et al. [8], patients with severe obesity who underwent shoulder arthroplasty experienced long-term improvements in pain and function. Notably, these positive outcomes were accompanied by the need for more intricate intraoperative and postoperative care, as well as relatively higher rates of unsatisfactory results [8]. However, it is limited in the literature about the influence of BMI on outcomes after arthroscopic superior capsular reconstruction (ASCR).

Furthermore, concerns have been raised that despite patients with obesity may achieve similar outcomes as patients who are not obese, patients with obesity may take longer to reach clinically significant outcomes (CSOs), including the minimum clinically important difference (MCID), substantial clinical benefit (SCB), and patient-acceptable symptom state (PASS) [9]. While previous analyses have investigated the time required to achieve the MCID, SCB, and PASS after ASCR, studies focusing on the impact of BMI on the time required to reach these CSOs are minimal.

Due to the growing population of patients with higher BMI undergoing surgery and the limited available literature on this topic, this study was performed to investigate the impact of increasing BMI on outcomes after ASCR. Specifically, this study investigates differences in the achievement of the MCID, SCB, and PASS following ASCR among patients categorized into different BMI groups. It was hypothesized that patients with normal weight would take a shorter time to achieve CSOs than patients with higher BMIs.

Methods

Study design

Institutional review board approval (Approval number: AMC 2021-1321) was received before this retrospective study was performed. Totally, 110 patients who received ASCR by a single senior orthopaedic surgeon between March 2015 and October 2020 were reviewed. PROs, including the visual analog scale (VAS) score, American Shoulder and Elbow Surgeons (ASES), and Constant–Murley scores, were assessed preoperatively and at postoperative six months, one year, and two years by a clinical nurse specialist (J.H.P.), who contacted the patients periodically to minimize loss to follow-up.

Patient selection

The indication for ASCR consisted of (1) diagnosis of irreparable rotator cuff on preoperative magnetic resonance imaging with (a) the largest tear length $>$ 5 cm, (b) complete tear of $>$ two tendons, or (c) medial retraction of $\geq$ Patte grade 3; (2) surgical confirmation of irreparability under arthroscopy as being irreducible to its anatomic footprint; (3) autograft (tensor fascia lata); and (4) no glenohumeral joint arthritis according to the Hamada classification [10]. The exclusion criteria consisted of (1) previous ipsilateral shoulder surgery, and (2) incomplete pre and postoperative PROs. Forty-seven patients were excluded, including 11 patients undergoing revision ASCR, eight patients using allograft, and 28 patients lost to follow-up at any of these three time points. Finally, 59 patients were included in the study. A comparison of baseline variables between the included patients and excluded patients is shown in Table 1. A comparison of baseline variables between the included patients and excluded patients is shown in Table 1. Patients excluded had a higher portion of males ($P = 0.012$). There was no difference in other baseline variables between included patients and excluded patients.

BMI and demographics

Preoperative BMI was used to divide patients into BMI categories regarding the modified World Health Organization categories: normal (BMI $<$ 25.0), overweight (25.0 $\leq$ BMI $<$ 30.0), and obese (BMI $\geq$ 30) [11]. Demographic data were recorded, including age, sex, presence of diabetes, and hypertension.

Table 1 Demographics and preoperative findings

	Included patients (n = 63)	Excluded patients (n = 47)	P-value
Age, y	64.8 ± 8.6	62.9 ± 5.5	0.136
BMI, kg/m^2	25.9 ± 3.6	25.7 ± 3.1	0.887
Sex, male:female, n	21:42	27:20	**0.012**
Diabetes mellitus, n	26:37	23:24	0.500
ASES score	49.7 ± 17.0	50.6 ± 15.9	0.821
Constant score	53.8 ± 11.8	51.8 ± 12.8	0.333
VAS score	5.7 ± 1.9	5.4 ± 1.6	0.543
Acromiohumeral distance	5.6 ± 2.9	5.3 ± 2.2	0.988

[α]Data are presented as mean ± SD unless otherwise specified. Statistical significance is indicated in bold. *BMI*, body mass index; *FL*, fascia lata; *FL/M*, fascia lata with mesh interposed; *ASES*, American Shoulder and Elbow Surgeons; *VAS*, visual analog scale

Surgical technique and rehabilitation protocol

After general anesthesia, patients underwent surgeries in a beach-chair position. The procedure involved the following routine steps: (1) acromioplasty was performed as a preventive measure against postoperative graft attrition; (2) the biceps were tenotomized if necessary, and the defect size was measured with a probe; (3) the ipsilateral fascia lata was harvested, and the assisting surgeon constructed a single-layer polypropylene mesh (Prolene Mesh; Ethicon) inside the folded fascia lata for graft augmentation [12]. The graft margin was secured using a running suturing technique with No. 2-0 polyester sutures (Ethibond; Ethicon). Three suture anchors (JuggerKnot, 2.5 mm; Zimmer Biomet or Helicoil, 4.5 mm; Smith and Nephew) were used to fix the graft at the glenoid site, and two polyetheretherketone (PEEK) threaded anchors (Helicoil, 4.5 mm; Smith and Nephew) were used for medial row fixation. Once the graft was secured, the over-the-top technique was employed to suture the remaining bursal tissue over the graft [13]. Finally, two knotless anchors (Footprint Ultra 4.5 mm; Smith and Nephew) were used to secure the sutures. Patients were advised to begin strengthening exercises after 6 weeks of rehabilitation, incorporating shoulder abduction, and start performing pendulum exercises from 3 weeks [14].

Outcomes measured

Active range of motion (ROM) was measured before surgery, at each follow-up after surgery. A manual goniometer was used to evaluate forward flexion and external rotation. For internal rotation, we determined the highest level that a patient could reach with the thumb and recorded it by using a numbering method as previously described: 1 to 12 for the first to 12th thoracic vertebrae, 13 to 17 for the first to fifth lumbar vertebrae, and 18 for the level below the sacral vertebrae [15]. Achievements of the MCID, SCB, and PASS for the VAS, ASES, and Constant scores were assessed based on established cutoff values investigated by Yoem et al. [9]. The PASS values for the VAS, ASES, and Constant scores were 1.5, 81.0, and 60.5, respectively. The MCID values for the VAS, ASES, and Constant scores were 2.5, 19.0, and −0.5, respectively. The SCB values for the VAS, ASES, and Constant scores were 4.5, 27.5, and 5.5, respectively.

Statistical analyses

Continuous data was compared using the Kruskal–Wallis test, and categorical data was compared using the Chi-square test or Fisher test among the three groups. The Bonferroni correction test was used for pairwise comparisons. The time required to achieve each CSO was analyzed using the Kaplan–Meier survivorship curve and the generalized log-rank test. The predictor variables for the earlier CSOs achievements were evaluated using the multivariate Cox regression. Statistical analysis was performed using the SPSS 27.0 software (IBM, NY, USA) with the statistical significance set at $P < 0.05$.

Results

This study included 63 patients, 21 males, and 42 females, with a mean age of 64.8 ± 8.6 years. The baseline variables are described in Table 2. When stratified by BMI category, 47.6% of patients were observed to have normal weight (23.2 ± 1.3 kg/m^2), 39.7% were overweight (27.2 ± 1.2 kg/m^2), and 11.1% were obese (33.4 ± 3.0 kg/m^2).

No differences were observed regarding age, sex distribution, diabetes, hypertension, as well as the preoperative VAS, ASES, Constant scores, and active ROMs (all P > 0.05) among the three groups (Table 2).

Patient-reported outcomes

As shown in Fig. 1, VAS scores significantly decreased after surgery at all three time points compared with the preoperative baseline in all three groups (all $P < 0.05$).

As shown in Fig. 2, ASES scores have significant improvement after surgery at all three time points compared with the preoperative baseline in the normal and overweight groups (all $P < 0.05$). However, in the obese group, ASES score significantly improved only from the preoperative baseline to the six month and one year follow-up time points, but no difference was observed between the preoperative baseline and two year follow-up.

As shown in Fig. 3, the Constant score significantly improved from the preoperative baseline to two year follow-up

Table 2 Patients demographics

Variable	Normal ($n = 31$)	Overweight ($n = 25$)	Obese ($n = 7$)	P-value
Age	64.9 ± 7.7	65.8 ± 7.4	60.7 ± 14.8	0.792
Sex				0.443
Male	12	6	3	
Female	19	19	4	
BMI	23.2 ± 1.3	27.2 ± 1.2	33.4 ± 3.0	< **0.001**
Diabetes	4	4	1	> 0.999
Hypertension	13	11	2	0.872
Preoperative VAS	5.5 ± 1.8	5.9 ± 2.0	5.7 ± 1.4	0.654
Preoperative ASES	50.6 ± 17.7	49.2 ± 16.4	46.9 ± 17.6	0.892
Preoperative Constant	54.7 ± 9.9	52.6 ± 13.7	53.7 ± 13.2	0.906
Preoperative forward elevation	144.2 ± 26.8	135.0 ± 33.3	150.7 ± 15.9	0.561
Preoperative external rotation	48.2 ± 22.1	35.4 ± 21.5	36.4 ± 11.8	0.053
Preoperative internal rotation	12.4 ± 3.1	11.4 ± 2.5	14.0 ± 2.7	0.091

Data expressed as mean ± standard deviation. Statistical significance is indicated in bold. *BMI*, body mass index; *VAS*, visual acuity scale; *ASES*, American Shoulder and Elbow Surgeons

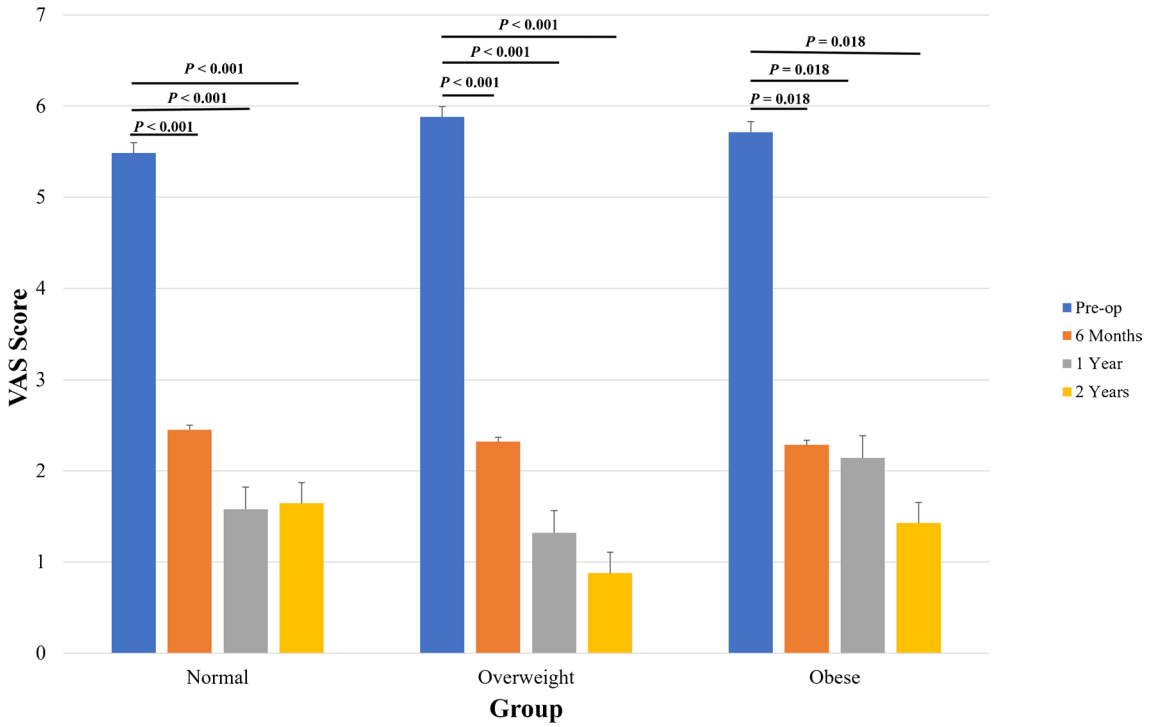

Fig. 1 Comparison of postoperative 6-month, 1-year, and 2-year follow-up VAS score among the three BMI categories. VAS, visual analog scale for pain; BMI, body mass index; Pre-op, preoperative

(all $P < 0.05$) for all patients. In contrast, no improvements were observed at the six month follow-up (all $P > 0.05$). At the one year follow-up, patients in the normal and overweight groups exhibited significant improvements in the Constant scores (all $P < 0.05$); however, no difference was found in the obese group.

ROM

As shown in Table 3, only patients in the obese group had significantly inferior internal rotation than in the normal group ($P = 0.01$). There was no difference in forward

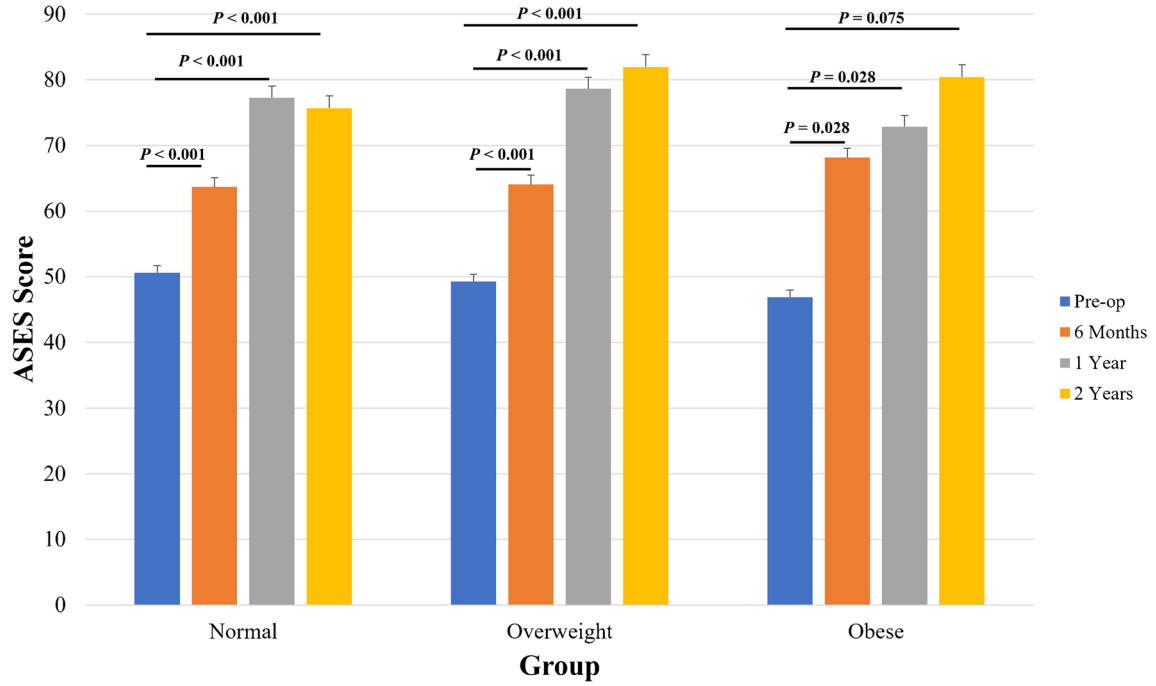

Fig. 2 Comparison of postoperative 6-month, 1-year, and 2-year follow-up ASES score among the three BMI categories. ASES, American Shoulder and Elbow Surgeons; BMI, body mass index; Pre-op, preoperative

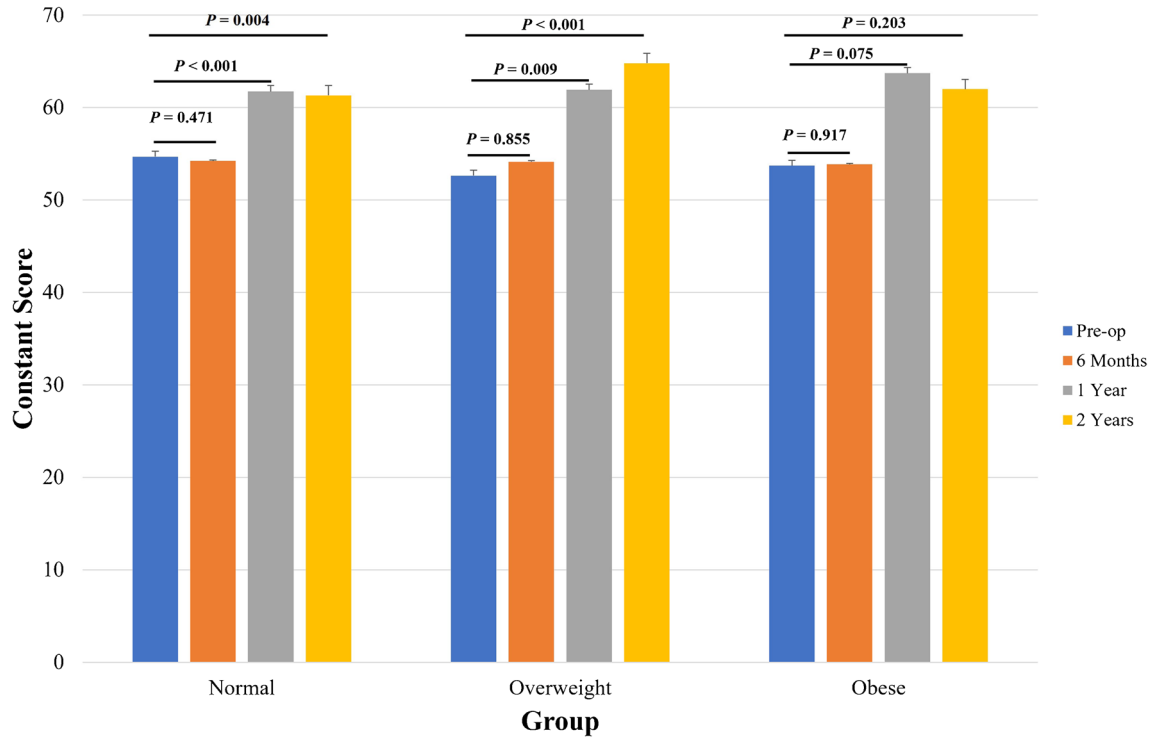

Fig. 3 Comparison of postoperative 6-month, 1-year, and 2-year follow-up Constant score among the three BMI categories. BMI, body mass index; Pre-op, preoperative

Table 3 Patient-reported outcomes, ROM, and survivorship at 2-year follow-up

Variable	Normal ($n = 31$)	Overweight ($n = 25$)	Obese ($n = 7$)	P-value
VAS at 2-year follow-up	1.7 ± 1.7	0.9 ± 1.0	1.4 ± 1.3	0.259
ASES at 2-year follow-up	75.7 ± 18.3	82.0 ± 16.7	80.4 ± 12.3	0.419
Constant at 2-year follow-up	61.3 ± 11.1	64.8 ± 8.0	62.0 ± 7.6	0.324
Forward elevation at 2-year follow-up	151.3 ± 14.4	154.2 ± 11.0	161.4 ± 10.7	0.132
External rotation at 2-year follow-up	42.4 ± 13.9	44.8 ± 18.3	35.0 ± 6.5	0.276
Internal rotation at 2-year follow-up	11.2 ± 3.3	12.3 ± 2.8	14.9 ± 2.2	0.013
Achieved MCID within 2 years				
VAS	29 (93.5%)	23 (92.0%)	7 (100%)	> 0.99
ASES	22 (71.0%)	20 (80.0%)	6 (85.7%)	0.695
Constant	26 (83.9%)	22 (88.0%)	5 (71.4%)	0.489
Achieved SCB within 2 years				
VAS	17 (54.8%)	17 (68.0%)	3 (42.9%)	0.436
ASES	17 (54.8%)	18 (72.0%)	4 (57.1%)	0.406
Constant	22 (71.0%)	17 (68.0%)	5 (71.4%)	> 0.999
Achieved PASS within 2 years				
VAS	24 (77.4%)	21 (84.0%)	5 (71.4%)	0.741
ASES	20 (64.5%)	22 (88.0%)	4 (57.1%)	0.069
Constant	24 (77.4%)	21 (84.0%)	5 (71.4%)	0.716

Data expressed as mean ± standard deviation or percentages. *ROM*, range of motion; *VAS*, visual acuity scale; *ASES*, American Shoulder and Elbow Surgeons; *MCID*, minimum clinically important difference; *SCB*, substantial clinical benefit; *PASS*, patient-acceptable symptom state

elevation and external rotation among the three groups ($P = 0.132$ and 0.276, respectively).

Rates for MCID, SCB, and PASS achievements at 2 years postoperatively are shown in Table 3. In all the three groups, ≥ 70% of patients achieved MCID, with no difference in the MCID achievement rate (all $P > 0.05$). The rates of SCB achievement were lower across all the groups compared to the MCID rates; however, no significant differences were observed in the SCB achievement rates (all $P > 0.05$). In all the three groups, ≥ 50% of the patients achieved PASS, with no difference in the rates of PASS achievement between the groups (all $P > 0.05$).

Time required to achieve MCID, SCB, and PASS

The probability of MCID, SCB, and PASS achievements for VAS is shown in Table 4. No significant difference was observed in the probability of MCID among these groups

Table 4 Probability of achieving MCID, SCB, and PASS for VAS at each follow-up time point

CSOs and follow-up time for VAS	Normal ($n = 31$)	Overweight ($n = 25$)	Obese ($n = 7$)	P-value
Achieving MCID				
6 months	54.8	68.0	57.1	NORM vs OW, 0.446 NORM vs OB, 0.805 OW vs OB, 0.845
1 year	77.4	84.0	57.1	
2 years	74.2	84.0	85.7	
Achieving SCB				
6 months	22.6	40.0	28.6	NORM vs OW, 0.261 NORM vs OB, 0.628 OW vs OB, 0.249
1 year	48.4	52.0	28.6	
2 years	48.4	68.0	42.9	
Achieving PASS				
6 months	12.9	24.0	28.6	NORM vs OW, 0.472 NORM vs OB, 0.989 OW vs OB, 0.619
1 year	58.1	56.0	28.6	
2 years	54.8	72.0	57.1	

CSOs, clinically significant outcomes; *VAS*, visual acuity scale; *MCID*, minimum clinically important difference; *SCB*, substantial clinical benefit; *PASS*, patient-acceptable symptom state; *NORM*, normal BMI group; *OW*, overweight BMI group; *OB*, obese BMI group

(log-rank: all $P > 0.05$), SCB (log-rank: all $P > 0.05$), and PASS (log-rank: all $P > 0.05$), indicating that times required to achieve these CSOs were comparable among these three groups. Similarly, for the probability of achieving MCID, SCB, and PASS for the ASES (Table 5) and Constant scores (Table 6) at each time point, no significant differences were observed in the probability distributions between the BMI groups ($P > 0.05$).

Furthermore, in the multivariate Cox regression analyses, the BMI group was included as a predictor. Hazard ratios for the BMI group for early achievement of MCID, SCB, and PASS for the VAS, ASES, and Constant scores are shown in Tables 7, 8, and 9, respectively. No variable was observed that significantly contributed to the early achievement of MCID, SCB, and PASS for any score.

Discussion

The most important finding of our study was that (1) nearly all patients divided by BMI reach the significant improvements in PROs; (2) no differences were evident among the three BMI groups in terms of the rate and time required to achieve MCID, SCB, and PASS. Patients with obesity had significantly improved pain scores at all three follow-up time points. Although these patients exhibited significant improvements for ASES from the preoperative baseline to six month and one year follow-up, no difference was observed in the Constant score across the different time points, and no difference was observed in the ASES score between the preoperative baseline and two year follow-up.

Table 5 Probability of achieving MCID, SCB, and PASS for ASES at each follow-up time point

CSOs and follow-up time for ASES	Normal ($n = 31$)	Overweight ($n = 25$)	Obese ($n = 7$)	*P*-value
Achieving MCID				
6 months	35.5	36.0	57.1	NORM vs OW, $P = 0.575$ NORM vs OB, $P = 0.336$ OW vs OB, $P = 0.558$
1 year	67.8	72.0	71.4	
2 years	54.8	72.0	85.7	
Achieving SCB				
6 months	19.4	24.0	42.9	NORM vs OW, $P = 0.275$ NORM vs OB, $P = 0.739$ OW vs OB, $P = 0.672$
1 year	48.4	48.0	28.6	
2 years	38.7	64.0	57.1	
Achieving PASS				
6 months	16.1	12.0	14.3	NORM vs OW, $P = 0.326$ NORM vs OB, $P = 0.697$ OW vs OB, $P = 0.252$
1 year	54.8	44.0	28.6	
2 years	51.6	76.0	57.1	

CSOs, clinically significant outcomes; *ASES*, American Shoulder and Elbow Surgeons; *MCID*, minimum clinically important difference; *SCB*, substantial clinical benefit; *PASS*, patient-acceptable symptom state; *NORM*, normal BMI group; *OW*, overweight BMI group; *OB*, obese BMI group

Table 6 Probability of achieving MCID, SCB, and PASS for the Constant score at each follow-up time point

CSOs and follow-up time for Constant	Normal ($n = 31$)	Overweight ($n = 25$)	Obese ($n = 7$)	*P* Value
Achieving MCID				
6 months	48.4	56.0	71.4	NORM vs OW, $P = 0.570$ NORM vs OB, $P = 0.975$ OW vs OB, $P = 0.731$
1 year	71.0	72.0	71.4	
2 years	74.2	88.0	71.4	
Achieving SCB				
6 months	19.4	28.0	28.6	NORM vs OW, $P = 0.986$ NORM vs OB, $P = 0.779$ OW vs OB, $P = 0.801$
1 year	58.1	56.0	71.4	
2 years	54.8	64.0	71.4	
Achieving PASS				
6 months	9.7	32.0	71.4	NORM vs OW, $P = 0.175$ NORM vs OB, $P = 0.990$ OW vs OB, $P = 0.428$
1 year	61.3	60.0	57.1	
2 years	64.5	76.0	71.4	

CSOs, clinically significant outcomes; *MCID*, minimum clinically important difference; *SCB*, substantial clinical benefit; *PASS*, patient-acceptable symptom state; *NORM*, normal BMI group; *OW*, overweight BMI group; *OB*, obese BMI group

Table 7 Multivariate Cox regression of variables associated with MCID, SCB, and PASS achievement for VAS score

Time to achieve CSOs and predictor variable for VAS	Hazard ratio	95% CI	*P*-value
Time to achieve MCID			
Overweight vs normal	1.154	0.666–1.999	0.610
Obese vs normal	1.075	0.471–2.445	0.863
Time to achieve SCB			
Overweight vs normal	1.381	0.705–2.709	0.347
Obese vs normal	0.755	0.221–2.579	0.654
Time to achieve PASS			
Overweight vs normal	1.172	0.652–2.105	0.596
Obese vs normal	0.856	0.378–2.614	0.989

CSOs, clinically significant outcomes; *VAS*, visual acuity scale; *MCID*, minimum clinically important difference; *SCB*, substantial clinical benefit; *PASS*, patient-acceptable symptom state

Table 8 Multivariate Cox regression of variables associated with MCID, SCB, and PASS achievement for ASES score

Time to achieve CSOs and predictor variable for ASES	Hazard ratio	95% CI	*P*-value
Time to achieve MCID			
Overweight vs normal	1.144	0.624–2.097	0.663
Obese vs normal	1.426	0.577–3.524	0.441
Time to achieve SCB			
Overweight vs normal	1.366	0.704–2.650	0.357
Obese vs normal	1.160	0.390–3.452	0.790
Time to achieve PASS			
Obese vs normal	1.320	0.711–2.386	0.393
Overweight vs normal	0.829	0.283–2.426	0.732

CSOs, clinically significant outcomes; *ASES*, American Shoulder and Elbow Surgeons; *MCID*, minimum clinically important difference; *SCB*, substantial clinical benefit; *PASS*, patient-acceptable symptom state

Table 9 Multivariate Cox regression of variables associated with MCID, SCB, and PASS achievement for the Constant score

Time to achieve CSOs and predictor variable for Constant	Hazard ratio	95% CI	*P*-value
Time to achieve MCID			
Overweight vs normal	1.119	0.634–1.975	0.698
Obese vs normal	0.995	0.381–2.599	0.992
Time to achieve SCB			
Overweight vs normal	0.998	0.530–1.880	0.995
Obese vs normal	1.113	0.421–2.940	0.829
Time to achieve PASS			
Overweight vs normal	1.354	0.753–2.435	0.311
Obese vs normal	0.851	0.381–2.618	0.997

CSOs, clinically significant outcomes; *ASES*, American Shoulder and Elbow Surgeons; *MCID*, minimum clinically important difference; *SCB*, substantial clinical benefit; *PASS*, patient-acceptable symptom state

The existing literature on shoulder arthroscopy outcomes in patients with obesity presents a nuanced perspective. Namdari et al. were the first to examine surgical outcomes after rotator cuff repair in patients with obesity and found that obesity did not exert a substantial impact on early postoperative outcomes [16]. In contrast, Warrender et al. [17] observed that obesity had adverse effects on functional outcomes after repair, resulting in prolonged hospitalization and increased surgical time. However, these two studies both primarily examined outcomes with short-term results [16, 17]. In an extensive study focusing on open repairs with 26-month follow-up, patients revealed that BMI had no significant impact on the Constant–Murley or VAS scores [18]. Additionally, according to the findings of Kessler et al., patients with obesity who underwent rotator cuff repair did not report any significant differences in surgical outcomes, over a three year period, when compared to nonobese counterparts [1]. However, Fare et al. reported significantly better outcomes in the VAS and ASES scores of normal-weight group than those of the overweight group at two year follow-up [7]. It seems that follow-up time had an influence on the effect of BMI after rotator cuff repair. In this cohort, there were no differences in the VAS, ASES, and Constant scores at the two year follow-up among the groups. It was found that patients undergoing ASCR require a much longer time to achieve clinical benefits from surgery compared to those undergoing rotator cuff repair [19]. Further studies with longer follow-up need to be performed to evaluate the mid- and long-term effect of BMI on clinical outcomes and ROMs after ASCR.

Contrary to previous findings on musculoskeletal surgical outcomes, our research revealed that participants with obesity did not exhibit worse outcomes. Notably, a study on revision total hip arthroplasty demonstrated inferior outcomes among patients with obesity, after five years of surgery. This outcome is understandable because the hip is a weight-bearing joint, which may contribute to inferior outcomes in individuals with obesity [20]. However, Linberg et al found that severe obesity patients undergoing shoulder arthroplasty revealed a higher rate of unsatisfactory results, despite the non-weight-bearing nature of shoulder [8]. Notably, in our study, the number of patients with a BMI of ≥ 30 was relatively small (11.1%), making it challenging to reach definitive conclusions regarding the impact of severe obesity on ASCR. Nevertheless, consistent functional improvements were found among patients with obesity, which aligns with previous findings from a study on shoulder osteoarthritis [8].

In the context of ASCR, our results are consistent with previous studies, indicating that obesity does not affect

functional outcomes following rotator cuff repair [16, 18]. The lack of influence of obesity on patient-reported outcomes is proposed to be because the shoulder is not a weight-bearing joint. Therefore, although obesity may negatively affect the potential for healing, favourable clinical outcomes have been found, such as pain reduction and improved range of motion [21]. Another possible explanation for patients with higher BMI demonstrating comparable scores to that of control groups is that individuals with obesity exert less demand on their shoulders. Furthermore, studies have shown that obese patients with no shoulder pathology tend to have similar ranges of motion compared with the nonobese patients [22].

In addition to evaluating functional scores, the likelihood of experiencing surgical benefits was evaluated based on MCID, PASS, and SCB for all PROs. Comparing the overweight and obese groups with the normal BMI group, we observed similar probabilities of MCID, PASS, and SCB achievement in both the groups. The available literature suggests that patients with obesity can still experience significant improvements after shoulder arthroscopic surgeries and show comparable outcomes to that of individuals with normal weight. Our study shows similar results as rates of MCID and SCB achievements across are comparable among different BMI groups. Similarly, Fare et al. also reported that differences in outcomes between the normal-weight and overweight groups did not meet the thresholds for MCID and PASS following rotator cuff repair [7].

To our knowledge, this is the first study to evaluate the effect of BMI on the clinical outcomes and rates of achieving MCID, SCB, and PASS in different BMI subgroups, demonstrating a similar likelihood of achievements regardless of BMI. However, this study had certain limitations. Firstly, our outcome data were interval-censored to assess the time required to achieve MCID, SCB, and PASS, which resulted in reporting mean cumulative probabilities instead of median survival times typically used in conventional survival analyses. Secondly, we solely define obesity based on BMI. BMI has been demonstrated to underestimate the prevalence of obesity [1]. Additionally, the sample size for the obese group was relatively small; further studies with larger sample sizes are warranted. Furthermore, our results may have potential nonresponse bias as only patients who were followed up at all three time points were included, possibly leading to selection bias. It is possible that patients with obesity with poor outcomes were not captured because of loss to follow-up. However, the baseline variables were comparable between included patients and excluded patients (Table 1), which was thought to increase the confidence of the results. Moreover, the thresholds used for MCID, SCB, and PASS were established from patients receiving ASCR, but not specifically established from obese patients. As a result, satisfactory states may differ in this group.

Conclusion

Patients in the normal and overweight groups had significant improvements in the VAS, ASES, and Constant scores after ASCR. Patients in the obese group had a significant improvement in VAS score; however, there is no difference for the ASES and Constant scores in the obese group. However, no differences were observed in all PROMs and the likelihood of achieving CSOs among the different BMI groups.

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Data availability Not applicable.

Code availability Not applicable.

Declarations

Conflict of interest The authors declare no competing interests.

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