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Neglected and locked anterior shoulder dislocation: functional outcomes and complications after open reduction and preservation of humeral head

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Background: Neglected and locked anterior shoulder dislocation is a rare problem that presents several treatment challenges. Our study aimed to evaluate the functional outcomes and postoperative complications after open reduction and head preservation surgery in patients with neglected and locked anterior shoulder dislocation.

Methods: Ten patients (age 51 ± 22 years) with a follow-up of 27 months ± 7 months (range 24-40 months) were included in the study. The anteriorly dislocated humeral heads were open and reduced after an average neglect of 10 ± 15 months. The neglected dislocation was classified into two types by the severity of the injury. (1) Type 1: There were no associated severe injuries, and the humeral head was reduced in the glenoid cavity without take-down of the subscapularis (type 1a) (n = 5) or via take-down of the upper half of the subscapularis (type 1b) (n = 2). (2) Type 2: There were associated factors such as a greater tuberosity fracture (n = 2) or a grade 3/4 fatty infiltrated supraspinatus and infraspinatus muscles (n = 1). Complete removal of the subscapularis was necessary to reduce the humeral head.

Results: The pain scores improved from a baseline value of 8 ± 1 to a final value of 1 ± 1 ($P < .001$), the absolute Constant score improved from a baseline value of 13 ± 8 to a final value of 69 ± 21 ($P < .001$), elevation range of motion (ROM) improved from a baseline value of 44° ± 43° to a final value of 123° ± 30° ($P < .001$), external rotation ROM improved from 0° ± 13° to 49° ± 12° ($P < .001$), and internal rotation ROM improved from sacroiliac joint ± 2 vertebra level to thoracic T11 ± 3 vertebrae level ($P < .0001$). The final shoulder subjective value was 77 ± 20 and was excellent in 3 patients, good in 5 patients, fair in 1, and poor in 1 patient. Major complications were observed in 30% (n = 3) of patients: persistent humeral head anterior subluxation in 20% (n = 2) of patients and superior migration of the humeral head in 10% (n = 1) of patients.

Conclusion: Open reduction and head preservation in patients with neglected anterior dislocation led to good functional outcomes in 70% (as per Constant score) to 80% (as per shoulder subjective value) of the patients. However, we observed major complications such as persistent anterior subluxation (n = 2) and superior head migration (n = 1), leading to suboptimal functional outcomes in cases with associated factors such as a greater tuberosity fracture or severe fatty infiltrated cuff muscles.

Neglected anterior shoulder dislocation, defined as chronic and neglected when untreated for more than 3 weeks,[15,19] is an uncommon problem that presents several treatment challenges, such as glenoid bone loss, contracted anterior and posterior capsules, and persistent postoperative instability.[19] Reverse shoulder replacement in older individuals has led to good outcomes,[21] but head-preserving options have not yielded consistently favorable outcomes.[17,19] Hence, the standard of care in open reduction with head preservation of chronic anterior dislocation is not yet established.[19] Additionally, published studies on open reduction are limited and have reported highly variable results on only a few patients.[3,10,19] Moreover, Li et al highlighted an unacceptably high rate of postoperative instability (50%-80%) after open reduction, leading to question the validity of such an intervention.[10] Should

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head preservation be attempted or discarded in favor of supervised neglect and a later replacement procedure? Difficult access to medical care during a pandemic may lead to a shoulder dislocation presenting as a neglected condition even in the present times[11]; hence, it may be essential to understand the challenges associated with treating this complex problem. Therefore, the purpose of our study was (1) to evaluate the improvements in functional outcomes, pain scores, and shoulder range of motion (ROM) and (2) to evaluate the postoperative complications after open reduction and head preservation in patients with neglected and locked anterior shoulder dislocation.

Material and methods

Participants

The Institutional Ethics Committee approved the retrospective study. All patients were operated by the senior author (DS), an orthopedic surgeon specializing in shoulder surgery. Between 2016 and 2021, 12 patients who presented with neglected and locked anterior shoulder dislocation were treated by humeral head preservation surgery. Between 2016 and 2020 (prepandemic), 4 patients were treated by head preservation surgery; 1 died, and 3 were included in the study. Between 2020 and 2021(pandemic period), 8 patients were treated by head preservation surgery; 1 could not be contacted, and 7 were included in the study. Finally, n = 10 (3 from prepandemic and 7 from the pandemic period) patients were included in the retrospective analysis. The inclusion criterion was patients with neglected and locked anterior shoulder dislocation (humeral neck intact) managed by humeral head preservation surgery. The exclusion criterion was patients managed by reverse shoulder replacement and those with neglected 3-part and 4-part fracture-dislocations (humeral neck fractured). Our indications for open reduction were (1) all patients below 55 years of age with neglected anterior dislocation and (2) all patients above 55 with no evidence of humeral head cartilage damage and an intact or reparable cuff tear. Reverse shoulder replacement was performed for patients of more than 55 years of age with neglected anterior dislocation along with an advanced fatty infiltrated and massively torn irreparable rotator cuff or evident severe cartilage degeneration.

Surgical technique

The surgeries were performed in a beach chair position through the deltopectoral approach. The surgical technique was subdivided into the following steps:

(1) Biceps tenotomy and coracoid osteotomy
(2) Subscapularis take-down
(3) Preparation of the glenoid for receiving the humeral head
(4) Preparation of bone tunnels for subscapularis and greater tuberosity (GT) (if fractured)
(5) Reduction of the humeral head and Kirschner-wire (K-wire) fixation
(6) Subscapularis repair and coracoid refixation

Biceps tenotomy and coracoid osteotomy

The biceps tendon was dissected and tenotomized from its glenoid attachment site. If fractured, the GT was identified laterally, osteotomized and dissected from the surrounding fibrosis, and tagged with the help of ethibond number 5 sutures.

The decision to perform a coracoid osteotomy was made on preoperative X-rays: a direct conjoint shadow (DCS) line (Fig. 1) was drawn by extending the two parallel lines from the tip of the coracoid obliquely downward (in the direction of the biceps muscle vector). If the lesser tuberosity (LT) shadow lay under the DCS line, no osteotomy was deemed necessary; however, if the LT shadow lay more medially, we preferred to perform a coracoid osteotomy to facilitate access to the subscapularis. In the first few cases, we used a cannulated screw to fix the coracoid osteotomy; hence, a screw track for a 4 mm screw was drilled before the osteotomy. Later we realized that the screw was unnecessary, and a 4.5 mm anchor may suffice; therefore, only the coracoid tip [5-8 millimeters (mm)] was osteotomized. The coracoacromial ligament and pectoralis minor tendon were erased from the coracoid, as much as necessary for performing the coracoid osteotomy. The sub-coracoid adhesions and coracohumeral ligament were also removed. The conjoint tendon and the osteotomized coracoid were retracted medially until the subscapularis tendon was visualized. The subscapularis tendon was tagged with two ethibond sutures.

Subscapularis take-down

The rotator interval was opened by dissecting between the subscapularis and the supraspinatus and removing the coracohumeral ligament. No subscapularis was removed in early neglected cases ($\leq$2 months neglected). In the remaining cases, partial (upper tendinous part) or entire subscapularis was detached from the LT via the subscapularis peel technique.

Preparation of the glenoid for receiving the humeral head

The step of glenoid preparation was performed in cases where several months of neglect and a severe medial migration of the humeral head led to extensive bridging fibrosis between the metaphysis and the glenoid, which obscured any visibility of the native glenoid. The fibrosis was removed with the help of cautery and rongeurs. The posterior capsule was erased from the glenoid because it was contracted and often prevented a stable reduction of the humeral head.

Preparation of bone tunnels for GT and subscapularis

In cases where the subscapularis was partially or entirely removed, the bone tunnels for subscapularis and GT repair (if needed) were prepared before the head was seated in the glenoid cavity. Alternatively, suture anchors could also be used for subscapularis repair. Two-to-three bone tunnels were prepared using a 2-mm drill-bit in a mediolateral direction through the LT; ethibond sutures were passed in the tunnels to enable a subscapularis repair. For enabling a GT repair, three bone tunnels were prepared and ethibond sutures were passed in a posteroanterior direction. The sutures passed in the tunnel for GT repair were also passed around the GT through the posterosuperior rotator cuff tendons.

Reduction of the humeral head and Kirschner-wire fixation

The humeral head was reduced through the rotator interval if no subscapularis split was deemed necessary. The reduction was performed using a broad Cobb's periosteum elevator that could embrace the humeral head, posterior to the subscapularis muscle, to push the head back in front of the glenoid. If the head was unstable in external rotation (ER), 2 K-wires (size 3 mm) were passed from the acromion to the lateral part of the humeral head or the GT, under c-arm guidance to retain the humeral head in the cavity.

Subscapularis repair and coracoid fixation

The subscapularis was repaired to the LT using sutures placed in the bone tunnels through the LT or suture anchors. The GT was reduced, and sutures through the tunnel for the GT were tied. The coracoid was refixed in its original position using a 4 mm cannulated screw in the predrilled hole through the coracoid. Alternatively, a suture anchor in the coracoid, with the sutures passed

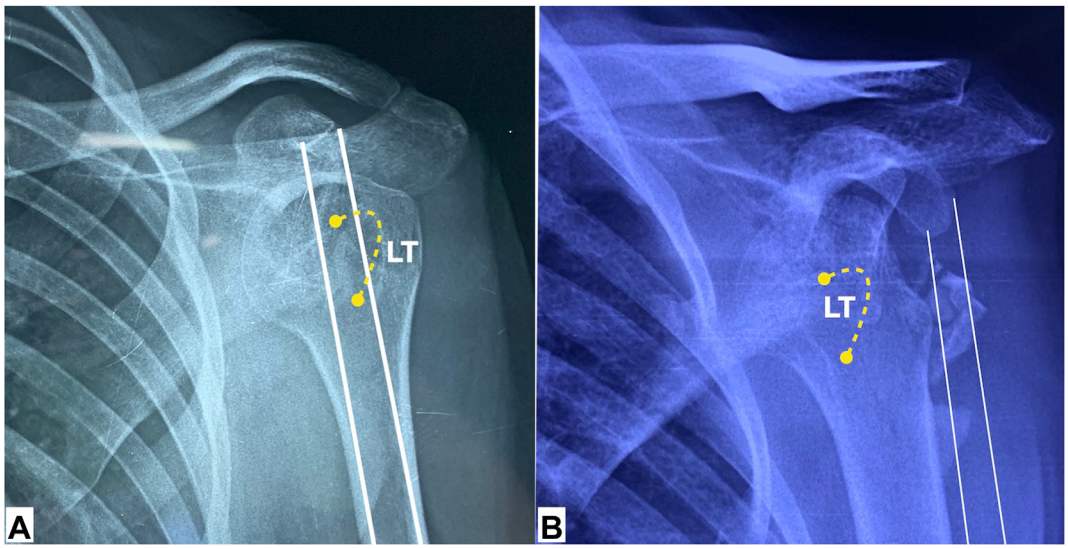

Figure 1 (**A** and **B**) Images show the decision-making for a coracoid osteotomy by drawing a direct conjoint shadow (DCS) line. Two oblique parallel lines (*white lines*) were drawn from the tip of the coracoid downwards in the direction of the conjoint tendon; the shadow of the lesser tuberosity (LT) was marked. (**A**) In the anteroposterior radiograph, the LT shadow lies below the DCS line; hence, no coracoid osteotomy is necessary. (**B**) In this radiograph, the LT shadow lies medial to the DCS line, and therefore the LT osteotomy is needed to expose the subscapularis. *LT*, lesser tuberosity.

around the coracoid tip and conjoint tendon, was used to fix the osteotomized coracoid tip. The tenotomized biceps tendon was repaired to the pectoralis major tendon with the help of interrupted ethibond sutures.

Postoperative care and rehabilitation

The shoulder was immobilized for 4 weeks. K-wires, if inserted, were removed at 4 weeks, and assisted exercises were started at 4 weeks. Radiographs at 6-weeks, 12-week, and 1–2-year follow-up were performed and evaluated. Rehabilitation was performed as per our published exercise regimen.[18] After the removal of K-wires, assisted elevation (Elev) exercises in supine and sitting positions were started. At 6-week follow-up, internal rotation and active ER (adducted elbow) exercises were begun. Active ER (90° abduction) exercises were initiated at the 2-month follow-up. These exercises were followed until maximum ROM was achieved or until 1-year postsurgery.

Demographics, patient characteristics, and injury classification

Ten patients (age 51 ± 22 years) with a follow-up of 27 months ± 7 months (range 24-40 months) were included in the study (Tables I and II). There were 6 (60%) women and 4 (40%) men with the right dominant side affected in 9 (90%) patients. The average duration of neglect was 10 ± 15 months (range 3 weeks-4 years). The injuries were treated after neglect of 3 weeks in 1 (10%) patient, 6-8 weeks in 4 (40%) patients, 3 months in 3 (30%) patients, 1.5 years in 1 (10%) patient, and 4 years in 1 (10%) patient. computed tomography scans were done for 6 patients, but magnetic resonance imaging (MRI) could be done for 5 patients (1 patient underwent both a computed tomography scan and an MRI scan). Some patients were severely painful and did not consent for an MRI scan. Two patients had preoperative glenoid defects of 25%, 1 patient had a preoperative glenoid defect of 40%, and 7 patients had no prior glenoid defect. Two patients had coexisting GT fractures; GT was ununited in one patient and partially united (malunited) in the other. One patient (no. 2) had severe (grade 3/4) fatty infiltration of the supraspinatus and infraspinatus. Another patient's MRI showed grade 2 fatty infiltration of the supraspinatus and the infraspinatus, but no significant tear was evident. Finally, one patient (patient number 10) had a completely reparable supraspinatus and partial infraspinatus tear with no fatty infiltration in the MRI.

The neglected dislocation was classified into 2 types by the severity of the injury (Table III).

(1) Type 1- In the type 1 classification, there were no associated severe injuries, and the humeral head was reduced in the joint cavity without take-down of the subscapularis (type 1a) or via take-down of the upper half of the subscapularis (type 1b).

    Type 1a: The humeral head was reduced in the joint cavity, through the rotator interval, and without cutting any part of the subscapularis. The eventual reduction was stable, and no K-wire fixation was deemed necessary. There were 5 patients in the grade 1 category, all presented within the first 2 months of injury. One patient underwent an arthroscopic reduction of the dislocation and cuff repair by an earlier published technique, but no subscapularis tenotomy was performed.[16] Although a slightly different technique was performed in this patient, we followed the same principles as have been outlined: the reduction was achieved by pushing the humeral head laterally through the rotator interval via a periosteal elevator, and no subscapularis was taken down. Arthroscopy was performed because of the need for a concurrent rotator cuff repair along with the neglected dislocation. Hence, this patient was included in the current series.

    Type 1b: The humeral head was reduced by take-down and later repair of the subscapularis's upper half (tendinous part). In the type 1b classification, there were two patients: one patient (neglected for 3 months) did not need any K-wire fixation (Fig. 2), and the second patient (neglected for 4 years) needed acromio-humeral fixation (from the acromion to the GT) using two K-wires (Fig. 3).

(2) Type 2- The type 2 injury represented the more complicated injury as compared to type 1, because there were associated factors such as a GT fracture (n = 2) or a severe (grade 3/4) fatty infiltrated supraspinatus and infraspinatus muscles (n = 1) (Fig. 4). Complete removal of the subscapularis was

Table I
Clinical features at baseline of patients who presented with a diagnosis of neglected dislocation shoulder.

Serial no.	Age	Sex	Affected side	Duration of neglect (mo)	Glenoid bone loss	Associated pathologies	Range of motion						CS	VASfor pain
							Elev (°)	Elev deficit (°)	ER (°)	ER deficit (°)	IR (vertebrae level)	IR deficit (vertebrae)		
1	39	M	R	3	25%	Greater Tuberosity fracture	90	70	0	50	GT	16	23	7
2	51	W	R	18	0	Advanced (grade 3/4) fatty infiltration of supraspinatus & infraspinatus	90	70	−20	90	SI	11	14	8
3	17	M	L	3	0	none	80	80	−10	75	GT	14	10	9
4	30	M	R	3	0	Comminuted fracture of Greater Tuberosity	70	90	−10	90	L1	6	10	9
5	26	M	R	48	40%	none	90	50	30	52	L1	6	33	9
6	72	W	R	1.5	25%	none	0	140	0	50	GT	19	8	8
7	71	W	R	2	0	Grade 2 fatty infiltrated supraspinatus and infraspinatus	0	155	0	60	GT	19	8	8
8	65	W	R	2	0	none	0	130	0	50	GT	19	8	9
9	70	W	R	2	0	Small chip fracture of posterolateral humeral head	0	155	0	45	GT	19	8	8
10	71	W	R	0.75	0	Reparable rotator cuff tear	20	140	10	50	GT	11	8	9

M, Men; *W*, Women; *L*, Left; *R*, Right; *Elev*, Elevation; *ER*, Deficit- Calculated by subtracting the ER, of the affected shoulder from that of the opposite normal shoulder; *IR*, Internal Rotation; *IR*, Deficit- Calculated by subtracting the IR, of the affected shoulder from that of the opposite normal shoulder; *CS*, Constant score; *VAS*, visual analog scale for pain; *SI*, Sacroiliac joint; *GT*, Greater Trochanter; *L*, Lumbar Vertebrae; *NR*, Not registered.

Table II
Clinical features at final follow-up of patients who presented with a diagnosis of neglected dislocation shoulder.

Serial no.	Follow-up (mo)	Range of motion						Constant score	Relative Constant score*	VAS for pain	SSV (%)	Complications
		Elevation (°)	Elevation deficit (°)	External rotation (°)	External rotation deficit (°)	Internal rotation (vertebrae level)	Internal rotation deficit (vertebrae)					
1	25	65	95	30	20	T9	5	22	68	2	30	Severe superior migration of the humeral head
2	24	90	70	60	10	L4	9	42	38	1	65	Anterior subluxation
3	24	160	0	60	10	T10	5	86	6	0	90	
4	24	120	40	70	42	L1	6	70	22	1	70	Anterior subluxation
5	40	110	30	42	10	T10	3	86	6	1	80	Grade 2 arthritis
6	24	130	10	40	10	T12	4	75	5	0	100	
7	24	150	5	50	0	L1	3	75	6	2	80	
8	40	110	20	50	10	T7	0	75	5	0	80	Mild superior head migration
9	24	140	15	35	10	T8	1	80	6	1	75	Grade 1 arthritis
10	24	155	5	50	10	T7	3	80	6	1	99	

VAS, visual analog scale for pain; *SSV*, subjective shoulder value; *T*, thoracic vertebrae; *L*, lumbar vertebrae.
External Rotation Deficit- Calculated by subtracting the ER, of the affected shoulder from that of the opposite normal shoulder.
Internal Rotation Deficit-Calculated by subtracting the IR, of the affected shoulder from that of the opposite normal shoulder.
*Relative Constant score was calculated by subtracting the Constant score of the affected shoulder from that of the opposite normal shoulder.

Table III
Classification of the neglected anterior shoulder dislocation according to the severity of the injury.

Type	Description	Surgical approach	No. of patients, n = 10
1			
1a	No associated severe injuries	Subscapularis not cut; reduction achieved through the rotator interval	n = 5
1b		Only superior tendinous part of the subscapularis cut and later repaired.	n = 2
2	Associated Greater Tuberosity fracture (n = 2), or severe (grade 4) fatty infiltration of the supraspinatus and infraspinatus (n = 1)	Complete subscapularis cut and later repaired.	n = 3

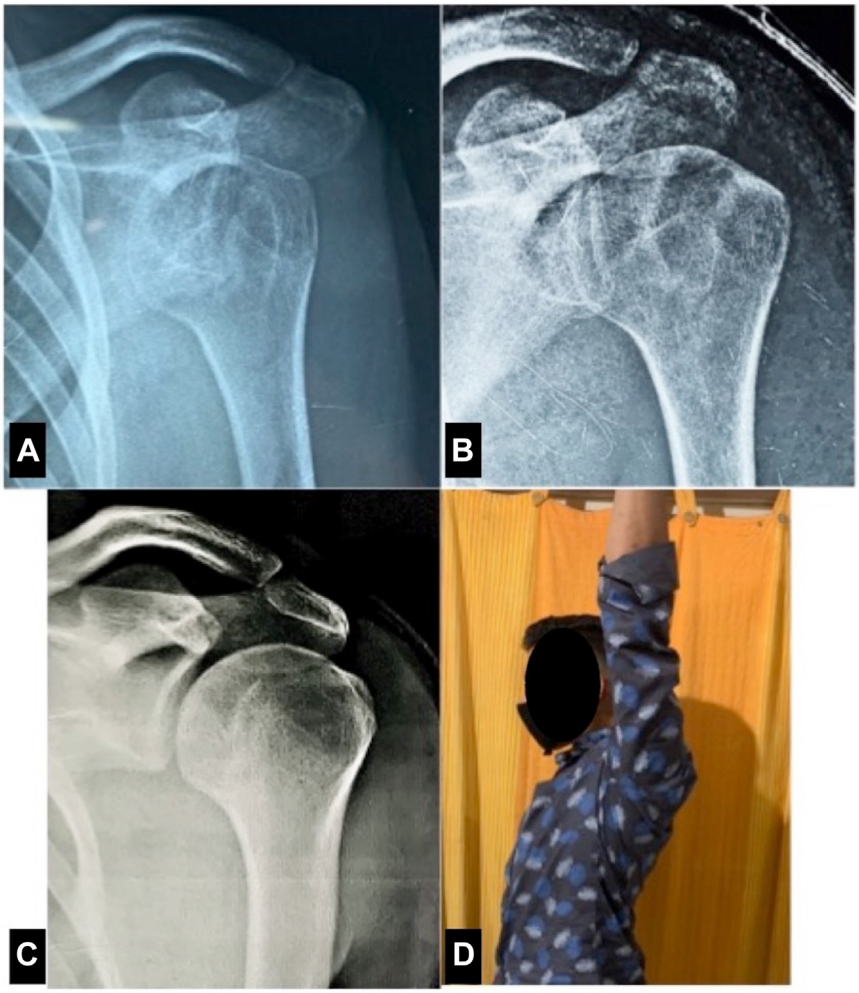

Figure 2 (**A-D**) Radiographs and clinical image of a 17-year-old patient with a 3-month neglected dislocation. (**A**) Preoperative anteroposterior (AP) radiograph shows a dislocated humeral head (**B**) Postoperative AP radiograph shows a reduced humeral head. (**C**) A 2-year follow-up shows a concentrically reduced humeral head. (**D**) The image shows the patient achieved full elevation at 2 years of follow-up.

necessary to reduce the humeral head, and coracoid osteotomy was required in all three cases. All 3 patients needed acromio-humeral K-wire fixation to stabilize the humeral head in the glenoid cavity.

Outcome variables

Preoperative variables that were collected were: ROM, visual analog scale (VAS) pain scores, and Constant scores. The associated glenoid defect was calculated in the computed tomography (CT) scans (n = 6) or MRI (n = 4) by the best-fit-circle area method. At the final follow-up, we evaluated the absolute and relative (calculated as a difference in the score compared to the opposite normal limb's score) Constant scores, shoulder subjective value (SSV), residual pain VAS scores, and shoulder ROM. An independent research assistant uninvolved in the surgeries evaluated the ROM and Constant scores. Elev and ER (with elbow adducted by the side of the body) were evaluated for both sides with the help of a long-arm goniometer, and internal rotation ROM was evaluated by the extended thumb reaching the highest vertebrae at the back. ROM deficits were calculated by subtracting the ROM of the affected side from that of the opposite normal limb. The postoperative ROM improvements were compared to published

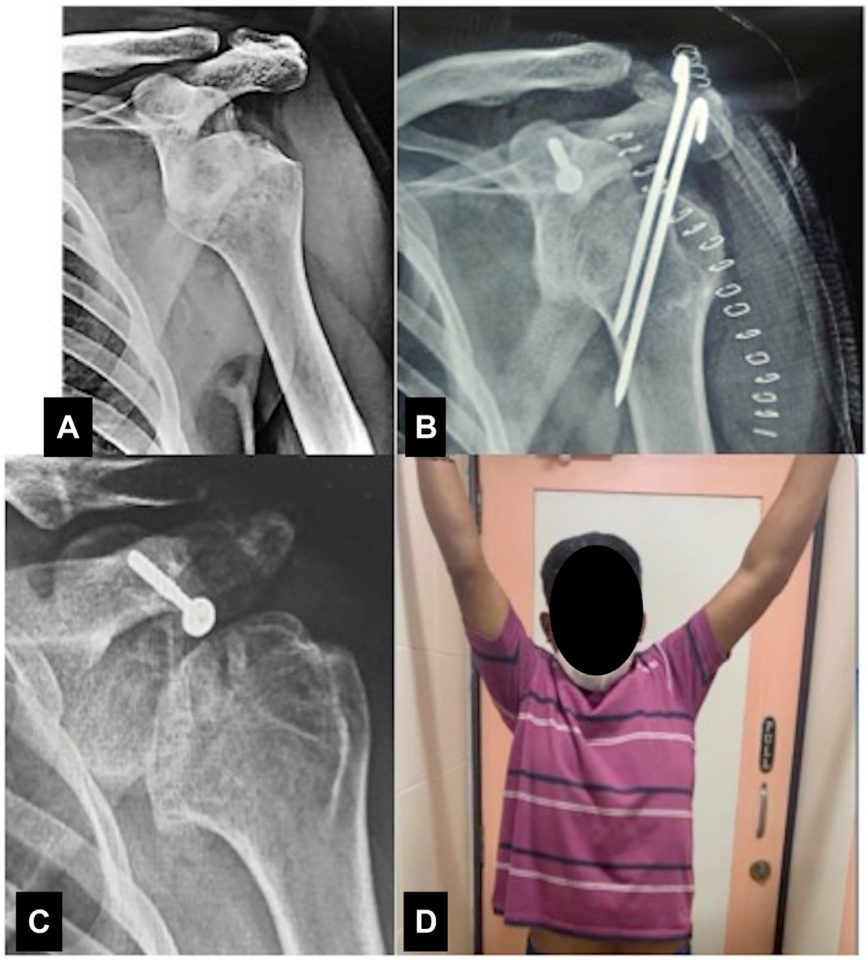

Figure 3 (**A-D**) Radiographs and clinical image of a 26-year-old patient with 4-year neglected dislocation. (**A**) Preoperative anteroposterior (AP) radiograph shows an anterior dislocated humeral head (**B**) Postoperative AP radiograph shows a reduced humeral head, acromiohumeral K-wire fixation, and coracoid osteotomy fixed with a screw. (**C**) At the 40-month follow-up, an anteroposterior radiograph shows a concentrically reduced humeral head and grade 2 glenohumeral arthritis. (**D**) Image at the final 40-month follow-up shows the patient achieved good elevation.

minimum clinically important difference (MCID) values of shoulder ROM for pathologic shoulders. We did not find any disease-specific (neglected injuries, dislocation, or fracture) MCID values for ROM in the literature. Force measurement for the Constant score was done with the help of hand-held spring balance and was marked zero if the patient could not elevate the hand till 90° of abduction in the scapular plane. The final SSV scores were graded as excellent (85-100), good (70-84), fair (55-69), or poor (<55).[7,8] The final Constant score was graded as very good (86-100), good (71-85), fair (56-70), or poor (<56).[22] Postoperative X-rays were evaluated for humeral head subluxation, humeral head superior migration, and arthritis as per the Samilson-Prieto classification system.[20]

Statistical analysis

All data were analyzed using SPSS version 27.0 (IBM Corp., Armonk, NY, USA). Numerical data were presented as mean ± standard deviation, and nominal data were expressed as percentages. Paired or unpaired t-test, as appropriate, was used to analyze the numerical data. Fisher's exact test (for less than 10 occurrences) and chi-square test were used to analyze the categorical data. *P* value <.05 was considered significant.

Results

Improvements in pain, functional outcomes, and shoulder range of motion

After an average follow-up of 27 months ± 7 months (range 24-40 months), VAS scores for pain improved from a baseline value of 8 ± 1 to a final value of 1 ± 1 ($P < .001$), absolute and relative Constant scores (as compared to opposite normal side) improved from a baseline value of 13° ± 8° and 73° ± 7° to a final value of 69° ± 21° ($P < .001$) and 17 ± 21 ($P < .001$) respectively, Elev ROM improved from a baseline value of 44° ± 43° to a final value of 123° ± 30° ($P < .001$), ER ROM improved from 0 ± 13° to 49° ± 12° ($P < .001$), and internal rotation ROM improved from sacroiliac joint ± 2 vertebra level to T11 ± 3 vertebrae level ($P < .0001$) (Table IV). Final Elev ROM deficits, ER ROM deficits, and internal rotation ROM deficits also improved significantly (Table IV). Final SSV was 77 ± 20 and was excellent in 3 patients, good in 5 patients, fair in 1, and poor in 1 patient. The final Constant score was graded as very good in 2, good in 5, fair in 1, and poor in 2 patients. VAS pain scores improved more than the MCID value (1.5) in all 10 (100%) patients. Elev ROM improved more than the MCID value (14°)[12] in 8 (80%) patients, did not change in 1 (10%) patient, and worsened in 1 (10%) patient; ER ROM improved more than the

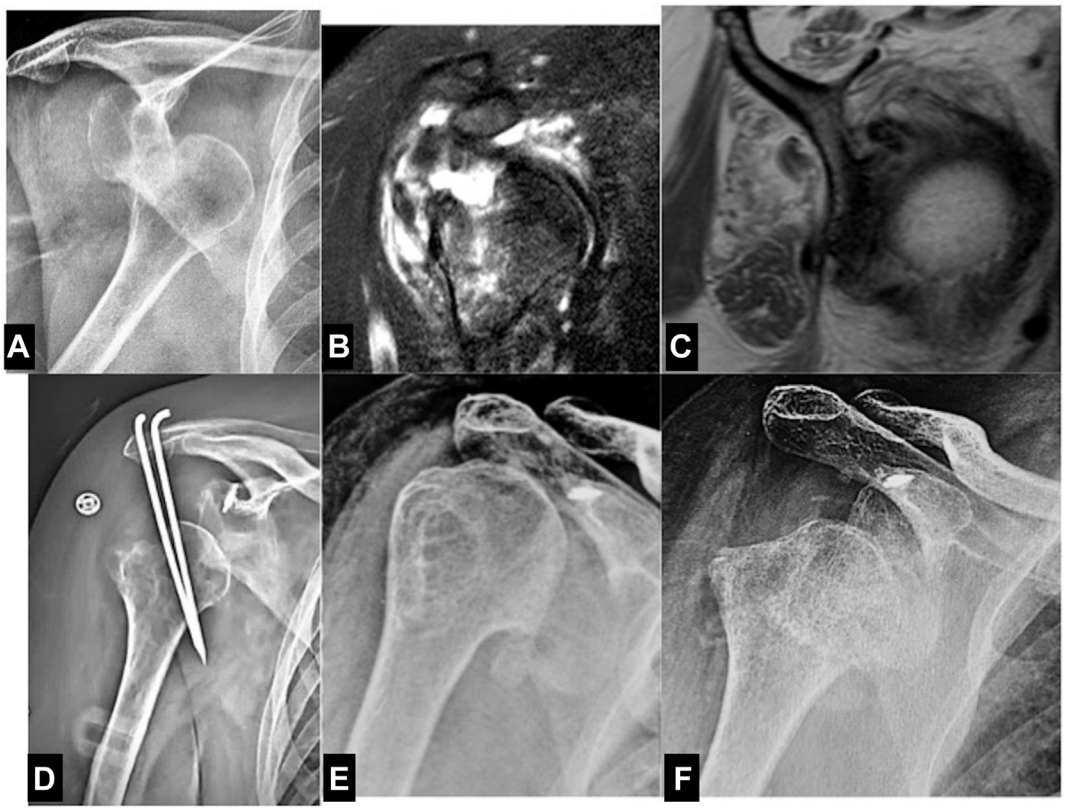

Figure 4 (**A-F**) Radiographs of a 51-year-old patient with 18-month neglected dislocation. (**A**) Preoperative anteroposterior (AP) radiograph shows an anterior dislocated and medially migrated humeral head. (**B**) MRI T2 image demonstrates a dislocated humeral head (**C**) MRI T1 images show grade 4 fatty infiltration of supraspinatus and infraspinatus. (**D**) Postoperative AP radiograph shows the humeral head with inferior subluxation (probably due to deltoid atonia), acromiohumeral K-wire fixation, and coracoid osteotomy fixed with an anchor. (**E**) At the 2-year follow-up, an anteroposterior radiograph with the arm in external rotation shows a concentrically reduced humeral head. (**F**) An anteroposterior radiograph with the arm in internal rotation shows a subluxated humeral head. *MRI*, magnetic resonance imaging.

Table IV
Clinical features at baseline and at final follow-up of patients who presented with a diagnosis of neglected dislocation shoulder.

Variable	Baseline	Final follow-up	*P* value
Pain VAS scores, mean (SD)	8 (1)	1 (1)	<.001*
Elevation (°), mean (SD)	44 (43)	123 (30)	<.001*
Deficit in Elevation (°), mean (SD)	108 (40)	29 (31)	<.001*
External Rotation (°), mean (SD)	0 (13)	49 (12)	<.001*
Deficit in External Rotation (°), mean (SD)	61 (17)	13 (11)	<.001*
Internal Rotation (vertebral level), mean (SD)	SI (2)†	T11 (3)‡	<.001*
Deficit in Internal Rotation (vertebrae), mean (SD)	−5 (10)	4 (3)	.01*
Constant score, mean (SD)	13 (8)	69 (21)	<.001*
Relative Constant score (Comparison with opposite normal limb)	73 (7)	17 (21)	<.001*

VAS, visual analog scale for pain; *SD*, standard deviation.
*Significant difference with $P < .05$.
†Sacroiliac joint.
‡Thoracic Vertebrae.

MCID value (15°)[12] in 9 (90%) patients and less than the MCID value but more than the measurement error (5°) in 1 (10%) patient (improvement of 12°); internal rotation ROM improved by least 3 vertebra level in 9 (90%) patients and did not improve in 1 (10%) patient.

Complications

We noted major complications in 3 (30%) patients. Those 3 patients belonged to the type 2 classification category. One of these three patients had a persistent anterior subluxation (patient no. 4). He had a final SSV of 70%, a final Constant score of 70, a final active Elev of 120°, ER of 70°, and IR of L1 vertebrae. The second patient's (patient no. 2) follow-up X-rays' with the arm in internal rotation showed anterior subluxation of the humeral head, but X-rays with the arm in ER showed a congruent and reduced glenohumeral joint (Fig. 4). She had a preoperative advanced fatty infiltration of the supraspinatus and infraspinatus muscles. The final ROM was an Elev of 90°, ER of 60° and IR of L4. Her final SSV was 65%, and Constant score was 42. The third patient's (patient no. 1) follow-up X-rays showed a complete superior migration of the humeral head (humeral head touching the acromion and acromio-humeral interval 0 mm) and migration of the osteotomized and refixed coracoid; he had a poor final SSV (30%). His final Elev (65°) was

worse than the preoperative Elev value (90°); his final ER (30°) and internal rotation (T9 vertebrae) were better than the baseline values (0° and GT, respectively) (Table II).

Additionally, minor complications were noted in 30% (n = 3) patients at the final follow-up. One patient had grade 2 glenohumeral arthritis (final SSV of 80%), 1 patient had grade 1 glenohumeral arthritis (final SSV of 75%), and 1 patient had a mild superior migration (acromio-humeral interval 5 mm)[4] of the humeral head (final SSV of 80%).

Discussion

The main findings of our study are that patients with neglected anterior shoulder dislocation but without associated severe factors of GT fracture or severe fatty infiltration of rotator cuff muscles showed good to excellent functional outcomes and good ROM recovery after open reduction and head preservation. No neurovascular complications were noted in our studies. We found that the SSV was good to excellent in 8 (80%) patients, and the Constant score was good to very good in 7 (70%) patients. Additionally, pain significantly improved in 100% of patients. Notably, pain improved in the 3 patients with postoperative complications. The ER ROM improved more than the MCID value in 90% (n = 9) of patients and more than the measurement error in 10% (n = 1) of patients. Elev ROM had improved in 80% of the patients. Notably, pain and ER significantly improved in both patients with postoperative anterior subluxation; additionally, Elev significantly improved in one patient with postoperative anterior subluxation. The reason may have been because preoperatively, the humeral head had severely migrated medially, and though postoperatively there was subluxation, the pressure on the brachial plexus had reduced, and muscles may have had better vectors for externally rotating the shoulder.

We also found that joint reduction could be achieved through a partial subscapularis removal, and good to excellent functional outcomes (SSV of 80 and 90) could be demonstrated in a 3-month-neglected and a 4-year-neglected anterior shoulder dislocation. We could also show that humeral head relocation and concentric stable reduction may be obtained through the rotator interval, without cutting the subscapularis, if the patients presented within the first 2 months of the injury. Alternatively, an upper subscapularis removal may be done if necessary. The cases where relocation and stable reduction were achieved through the rotator interval or via an upper subscapularis split also represent the cases that achieved good to excellent functional outcomes. Li et al also found that the rate of postoperative instability was 50% if the subscapularis was removed and repaired, but the head was found to be stable if the head was reduced without cutting the subscapularis.[10]

However, major complications were noted in 30% of the patients, and the prognosis for functional improvement may be guarded in patients with an associated GT fracture or an associated severe cuff disease along with a neglected shoulder dislocation. Persistent humeral head anterior subluxation occurred in 2 patients, and superior migration of the head occurred in 1 patient; these 3 patients had additional associated injuries, such as an associated GT fracture (n = 2) or a preexisting severe fatty infiltration (n = 1) and belonged to the type 2 neglected dislocation classification. These three patients may have had less than optimum functional improvement because of the loss of posterior stabilizing force needed to balance the shoulder and keep it stable.

The factors responsible for persistent instability after open reduction have not been elucidated, but it is the author's conjecture that the status of the rotator cuff tendons may not be reliably evaluated in the MRI (Fig. 4, *B*) and may be missed in some cases because of the improper orientation of the tendons when the head is anteriorly dislocated. Moreover, performing an MRI on an old patient with a painfully dislocated shoulder may be a difficult proposition. The presence of a rotator cuff tear or fatty infiltration was noted in 30% (n = 3) of patients; one other patient who had mild superior migration on follow-up (but good clinical outcome) and could not be evaluated by a preoperative MRI may have had an undetected preoperative fatty infiltrated rotator cuff. Thus, there was a 40% incidence of rotator cuff pathology in the setting of a neglected dislocation. Hence, we recommend evaluating the T1 sagittal image, wherever possible, to assess the fatty infiltration before undertaking a head-preserving surgery.

A severe medial head migration may occur in patients with type 2 injuries because of a loss of ER forces, resulting in an unbalanced force couple. A complete subscapularis tenotomy was needed in these patients because the humeral head was far-medially migrated. Anatomic shoulder replacement has a high incidence of postoperative instability[21] in neglected anterior shoulder dislocation; hence, is not preferred.[17] Reverse shoulder replacement has led to good functional outcomes but has been noted to have an increased incidence of complications in cases of neglected shoulder dislocations.[9,13,17,21] We have not performed reverse shoulder replacement in patients under 55 years of age because of longevity concerns and a higher rate of complications noted in the younger age group.[5]

Only a few published case series on open reduction after neglected anterior dislocation exist. Two recent studies stated that the outcomes of open reduction are variable and may have an increased rate of postoperative instability.[10,19] Few studies on open reduction in neglected anterior dislocation have reported a complication rate of 20%-50%, including high rates of postoperative instability, superior migration of the humeral head, early arthrosis, and persistent severe pain.[10,14,19] Comparable improvements in the shoulder ROM after open reduction have been published. The reported postoperative average Elev and average ER have varied from 88° and 11° in the study (n = 10) by Akinci et al[2] to 145° and 46° in the study (n = 6) by Abdelhady et al.[1]

Latarjet coracoid transfer procedure in neglected anterior dislocation has been reported in an earlier study but has failed to provide postoperative stability,[10] and is contraindicated, according to Walch and colleagues.[6] In our series, in the cases where reduction could be achieved without a subscapularis take-down or partial take-down, the humeral head was stable and hence did not need a coracoid transfer. The cases (n = 3) where the full subscapularis was cut and repaired were unstable postoperatively. Latarjet in the setting of subscapularis removal-and-repair is ineffective because of the loss of the sling effect[10]; additionally, it may also lead to early arthritis due to the contact between the humeral head and the coracoid-screw block in case of any postoperative subluxation.[10] Hence, we do not recommend performing a Latarjet procedure with the available osteotomized coracoid in neglected anterior shoulder dislocation.

Non-operative treatment in neglected anterior dislocation has often led to poor functional outcomes.[3] The alternative option of a reverse shoulder replacement for the younger age group (<40 years) may not be feasible. Although it is difficult to draw firm conclusions from our small number of patients, we recommend that if the patients are severely painfully limited in their functional activities, an open reduction procedure may be offered and may lead to good pain relief and reasonable restoration of ROM. But, a persistent subluxation or superior head migration due to a preexisting fatty infiltrated rotator cuff may be a potential complication. Hence patients without an associated GT fracture or advanced cuff disease may have a more reliable outcome. Additionally, treating a patient around 50 years of age with an advanced fatty infiltration or

a concomitant GT fracture is a challenging problem; however, reverse shoulder arthroplasty may be a better option in patients with advanced fatty infiltration.

Limitations

Our study has several limitations. We evaluated only a limited number of patients. However, neglected anterior dislocation is a rare problem. Furthermore, only a few reports have studied the head-preserving option, especially in the younger age group. A recent systematic review on open reduction of neglected dislocation could extract around 50 patients from all published papers because most are case report studies.[19] The other limitation is that our study has a minimum follow-up of 24 months, and a longer follow-up may be needed to determine the incidence of arthrosis. The study's strength is that most patients (70%) were operated within a short period (2020-2021 because of the pandemic), even though this problem is rare. Hence, the surgical technique and evaluation were done in a uniform manner.

Conclusion

Open reduction and head preservation in patients with neglected anterior dislocation led to good functional outcomes and ROM restoration in 70% (as per Constant score) to 80% (as per SSV) of the patients. However, major complications such as persistent instability and superior head migration leading to suboptimal functional outcomes were observed in cases with associated factors such as a GT fracture or severe fatty infiltrated cuff muscles.

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