



# Open reduction and rotator cuff repair of irreducible traumatic shoulder dislocation with sleeve-avulsion and glenohumeral interposition of the cuff: a case report and review of the literature



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Traumatic dislocation of the glenohumeral joint is a common injury<sup>16,35</sup> seen in the predominantly young, male, and active population. Among females, elderly women are most likely to suffer a shoulder dislocation after minor trauma.<sup>28</sup> Anterior dislocation makes up 95% of all dislocations.<sup>20</sup> Associated injuries occur frequently and include avulsion of the anterior labrum, fracture of the glenoid, rotator cuff tears, proximal humeral shaft fractures, fractures of tuberosities, and impaction fracture of the humeral head.<sup>2,8,26,36</sup> When occurring in patients older than 60 years, 80% of patients with shoulder dislocation present with concomitant rupture of the rotator cuff.<sup>22</sup> Females over the age of 60 years were most likely to suffer a torn rotator cuff after minor low-energy falls. Healing and clinical outcome of traumatic rotator cuff tears are known to be favorable when treated early.<sup>10</sup>

In general, reduction of the shoulder is easily achieved, but interposed soft or bony tissue may hinder successful reduction, necessitating open reduction and removal of obstructions. This phenomenon was first described by Herbert in 1946.<sup>11</sup>

We report on a rare case of rotator cuff interposition in the glenohumeral joint after a minor fall in a 71-year-old woman who was successfully treated with open reduction and rotator cuff repair. In addition, a review of the current literature was performed.

## Case report

A 71-year-old female was referred to our clinic 10 days after sustaining a traumatic anterior shoulder dislocation in a simple fall, most likely caused by a syncopal episode. Immediate reduction had been performed at a local emergency department. After reduction, pain was eliminated, but the patient complained about significant loss of function. At presentation, active and passive range of motion (ROM) of the shoulder were equally limited (forward flexion [FFL] 40°, external rotation [ER] 10°, and internal rotation [IR] to the greater trochanter). Initial Constant score was 27. X-rays taken upon presentation to our clinic revealed persistent anterior-inferior subluxation of the humeral head, which was easily missed on the initial anteroposterior postreduction x-rays (Fig. 1).

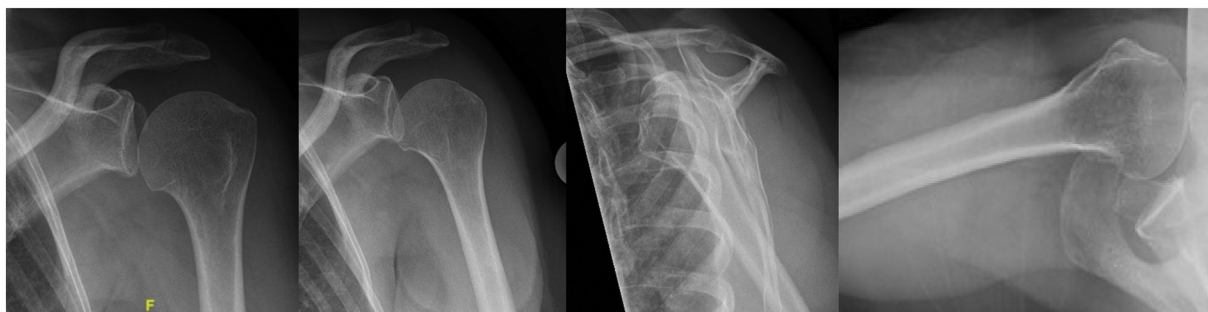
A complementary magnetic resonance imaging (MRI) arthrography had been obtained on the day of the accident and confirmed glenohumeral interposition of the upper two-third of the subscapularis (SSC) muscle and tendon in a total rotator cuff avulsion injury from the humeral head. Only the teres minor tendon was still partially attached to the humerus. The biceps tendon wound posteriorly around the head. The cuff itself remained in continuity. Morphologic appearance of the tendons and musculature as well as the glenohumeral joint status was good to excellent (Fig. 2). Lastly, a potential bony Bankart lesion was suspected (Fig. 3).

Surgery was performed 17 days after the incident or 7 days after referral to our clinic. Using a standard deltopectoral approach, dissection was carried out to the level of the clavipectoral fascia. The humeral head partially perforated the fascia and stretched the anterior structures. After completing the fascial incision and freeing the humeral head, the extent of the rotator cuff tear was evaluated

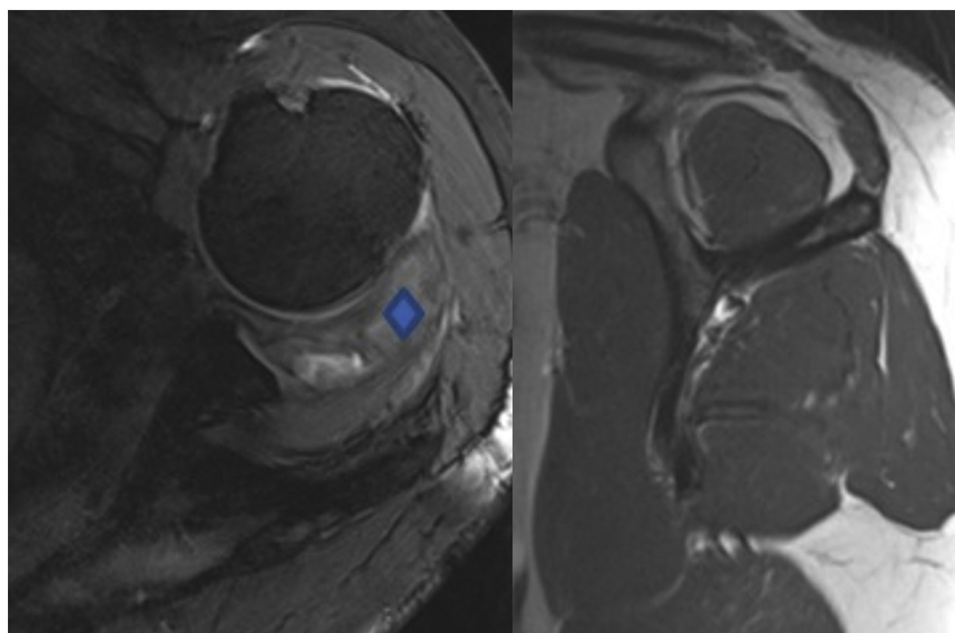
Approval from the local ethical committee was not required for this study.

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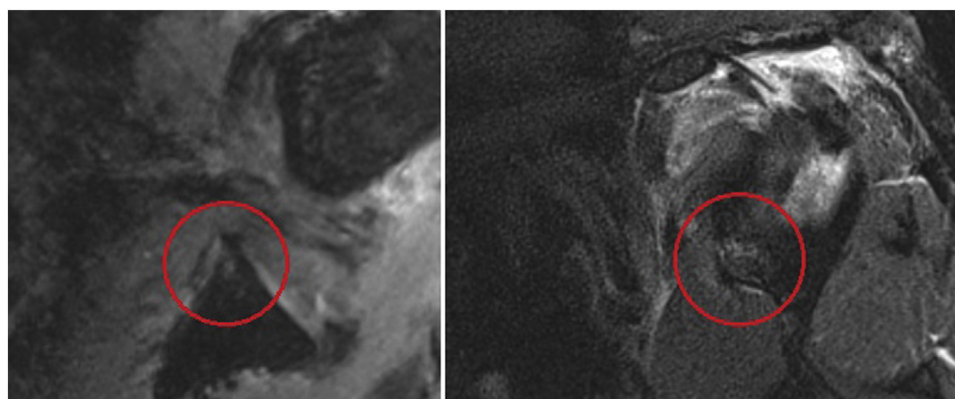
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**Figure 1** AP x-ray showing “reduced” glenohumeral joint and possible bony Bankart lesion. The other preoperative standard x-rays of a left shoulder (AP, Neer, and axial views) show subluxation of the humeral head. On the axial x-ray, subluxation cannot be missed. AP, anteroposterior.



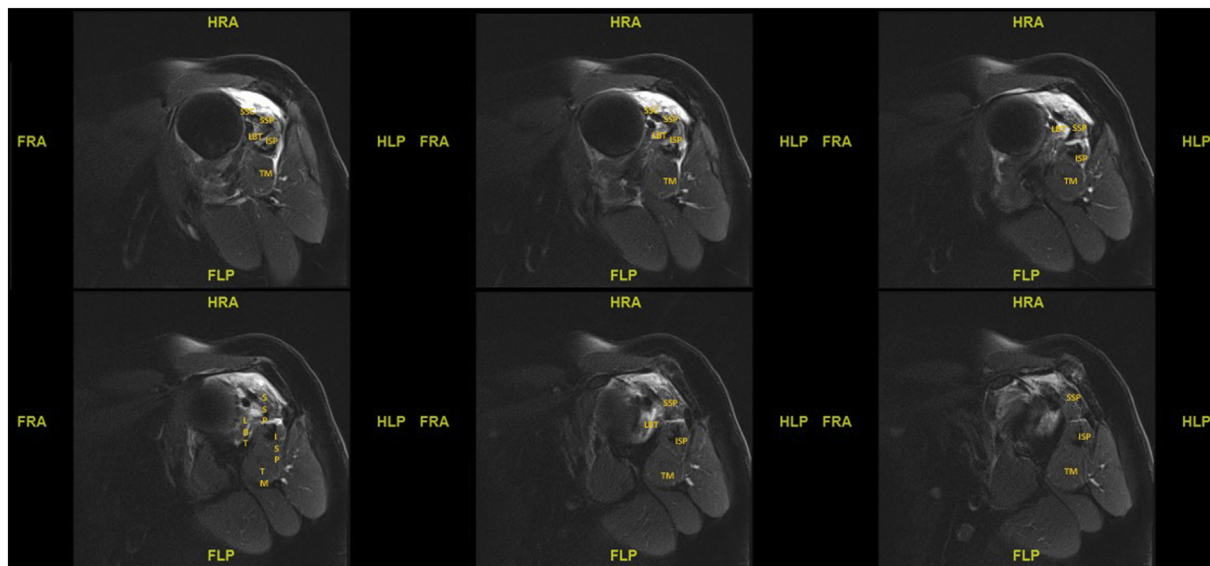
**Figure 2** Preoperative MRI of the left shoulder. *Left image:* ♦ = interposed subscapularis tendon. *Right image:* well-maintained muscle quality and trophy of the rotator cuff. MRI, magnetic resonance imaging.



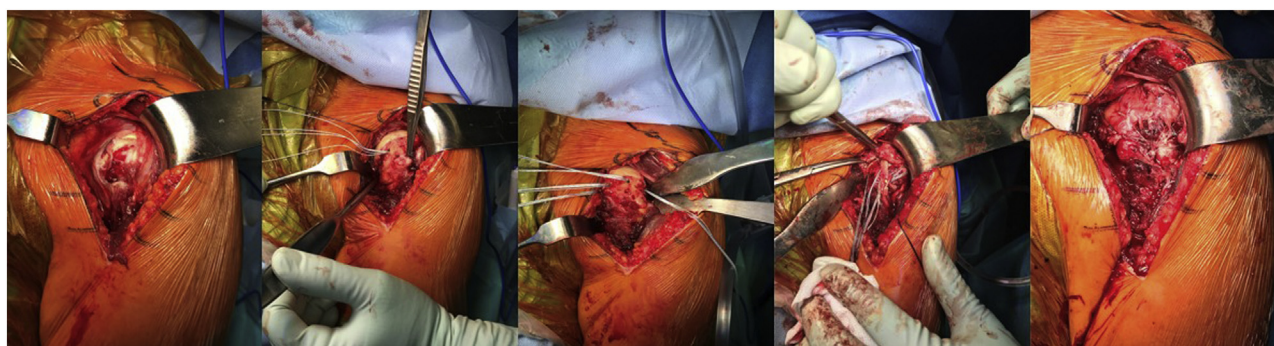
**Figure 3** MRI showing bone marrow edema at the anterior glenoid (*left*) as indicated by the red circles. Possible glenoid fracture (*right*). MRI, magnetic resonance imaging.

after mobilization of the conjoint tendon. In addition, the dislocated long head of the biceps tendon (LHBT) was identified at the inferior sulcus intertubercularis, running posteriorly around the humeral head. As seen on MRI results, the upper two-third of the

SSC was interposed between the humeral head and the glenoid with a remnant of the muscular part at the minor tuberosity. The tendons of the upper two-third of the SSC, the supraspinatus, infraspinatus, and part of the teres minor were completely avulsed



**Figure 4** Parasagittal MRI series illustrating the “diving” mechanism of the humeral head and the intact tendons of the cuff. MRI, magnetic resonance imaging; HRA, head right anterior; FRA, feet right anterior; SSC, subscapularis; SSP, supraspinatus; LBT, long head of biceps tendon; ISP, infraspinatus; TM, teres minor; HLP, head left posterior; FLP, feet left posterior.



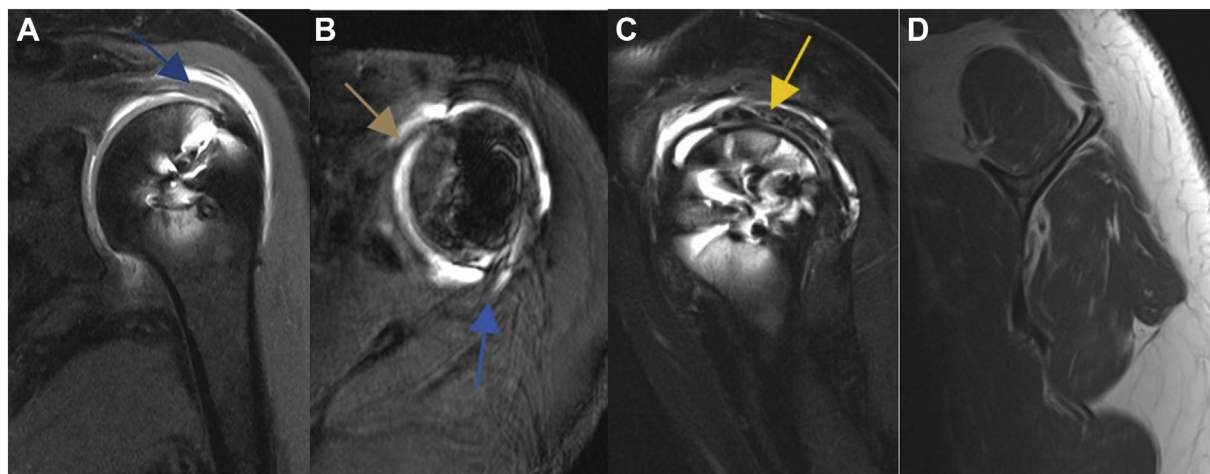
**Figure 5** Intraoperative photographs of humeral head reduction and rotator cuff reconstruction showing the perforation of the clavicular fascia by the humeral head and the peeled off rotator cuff with bare tuberosities. The forceps is placed in the empty sulcus, anchors set for refixation of the cuff. Relocated head and rotator cuff are later augmented with fiber wires. The definitive suture bridge reconstruction of the fully intact rotator cuff “sleeve” is visible.



**Figure 6** Functional outcome at 2 years postoperatively.



**Figure 7** X-rays at 3 months postoperatively showing a centered glenohumeral joint on AP, Neer, and axial views. AP, anteroposterior.



**Figure 8** Arthro-MRI of the left shoulder at 12 months postoperatively. (A) Shows intact supraspinatus tendon (→) with centered humeral head. (B) Shows intact subscapularis (→) and teres minor tendon (→). (C) Presents intact supraspinatus and infraspinatus tendon (→). Quality and trophicity of the muscles of the rotator cuff are still well maintained as shown on (D). MRI, magnetic resonance imaging.

en bloc from the tuberosities and located behind the humeral head. It appeared that the humerus had dislocated through the muscular-tendinous junction of the lower SSC muscle, resembling a “diving injury” underneath the tendinous part of the SSC, with the cuff and LHBT resting in the normal position (Fig. 4).

First, both tuberosities were prepared for later rotator cuff repair, and a medial row of suture anchors was placed (1 × 5.5 mm Titan Corkscrew (Arthrex, Naples, FL, USA) minor tuberosity, 3 × 5.5 mm Titan Corkscrew greater tuberosity).

Next, reduction was attempted by introducing a “De Quervain” Elevatorium (Ulrich, St. Gallen, Switzerland) through the SSC tear into the glenohumeral space to lift the torn cuff including the biceps tendon over the dislocated head, reversing the traumatic “dive” mechanism. After several failed attempts, the LHBT was tenotomized, and the muscular remnant of the lower SSC at the minor tuberosity was released to reduce overall tension and eliminate the LHBT as a potential factor impeding successful reduction.

With these measures, en bloc reduction of the humeral head back into the sleeve was achieved by lifting the interposed SSC tendon up and manipulating the humeral head back into the joint, putting the torn cuff sleeve back in place. The bony Bankart lesion

proved stable and nondisplaced. Therefore, no additional measures were necessary. Rotator cuff repair was then completed with a double-row suture bridge technique (SSC/ supraspinatus/infraspinatus/teres minor). All sutures from the medial row were secured laterally with two 4.5-mm PushLock anchors (Arthrex, Naples, FL, USA), creating a “hot air balloon” construct (Fig. 5). Finally, soft-tissue tenodesis of the LHBT was performed, following irrigation and standard wound closure.

Postoperative rehabilitation consisted of initial immobilization of the extremity in a neutral wedge brace in 15° of ER and 15° of abduction (ABD) for 6 weeks after surgery. For the first 3 weeks, only passive ROM was allowed with FFL or ABD limited to 60° and IR to 30°. Starting from week 4, assisted mobilization was extended to FFL or ABD up to 90° and IR to 60°. No active ER was permitted until week 6. Because of the LHBT tenodesis, no active elbow flexion or supination was allowed before week 5. This was followed by free ROM and coordination exercises until 12 weeks after surgery. By 3 months after the surgery, incremental load-bearing and strengthening exercises were undertaken.

An initial weakness of the delta muscle visible as inferior eccentricity of the humeral head at 6 weeks subsided at the follow-up

**Table 1**  
Synopsis of studies.

No.	Study	Year	Age	Sex	Direction	Tendons involved	Trauma mechanism	Days till diagnosis	Type of study
1	Tietjen et al, <sup>31</sup> JBJS Am	1982	19	m	Unknown	Unknown	Motorcycle	12 d	Case report
2	Bridle and Ferris, <sup>4</sup> JBJS B	1990	55	m	Anterior	SSC	Heavy fall	None	Case report
3	Inao et al, <sup>13</sup> JBJS Br	1990	53	m	Anterior	SSC, SSP, ISP, BT	MV accident	Unknown	Case report
4	Ogawa et al, <sup>23</sup> J Trauma	1997	21	m	Posterior	ISP	MV accident	Unknown	Case report
5	Walch et al, <sup>32</sup> J Shoulder Elbow Surg	2001	49	m	Anterior	SSC, SSP	MV accident	Unknown	Case report
6	Walch et al, <sup>32</sup> J Shoulder Elbow Surg	2001	58	m	Anterior	SSC, BT	Skiing	8 mo	Case report
7	Walch et al, <sup>32</sup> J Shoulder Elbow Surg	2001	46	m	Posterior	ISP	Unknown	4 mo	Case report
8	Walch et al, <sup>32</sup> J Shoulder Elbow Surg	2001	29	f	Posterior	SSP, ISP	MV accident	18 mo	Case report
9	Walch et al, <sup>32</sup> J Shoulder Elbow Surg	2001	13	m	Posterior	SSC, SSP, ISP	Contact sports	6 mo	Case report
10	Rickert and Loew, <sup>25</sup> Arch Orthop Trauma Surg	2006	20	m	Unknown	RC, BT	Motorcycle	72 d	CR and review
11	Connolly et al, <sup>6</sup> Skelet Radiol	2008	87	m	Anterior	SSC	Fall	17 d	Case report
12	Dodson et al, <sup>7</sup> J Shoulder Elbow Surg	2010	32	m	Unknown	SSC, SSP, ISP, BT	Motorcycle	5 weeks	Case report
13	Ilaslan et al, <sup>12</sup> Skeletal Radiol	2013	48	m	Posterior	SSC, BT	Seizure	Unknown	Case report
14	Ilaslan et al, <sup>12</sup> Skeletal Radiol	2013	12	m	Posterior	SSP, ISP	Motorcycle	8 mo	Case report
15	Gudena et al, <sup>9</sup> Ortho Trauma Surg Res	2011	62	m	Anterior	SSP, ISP, TM	Fall down stairs	None	Case report
16	Luenam and Kosiyatrakul, <sup>18</sup> Musculoskelet Surg	2013	36	m	Posterior	SSP, ISP	MV accident	3 d	CR and review
17	Luenam and Kosiyatrakul, <sup>18</sup> Musculoskelet Surg	2012	55	m	Posterior	SSC, SSP, ISP, TM	Motorcycle	Unknown	CR and review
18	Miles et al, <sup>21</sup> Open J Ortho	2012	64	m	Anterior	SSC, BT	Heavy fall	6 weeks	Case report
19	Lin et al, <sup>17</sup> Korean J Radiol	2012	17	m	Superolateral	SSC, SSP	Bicycle fall	None	Case report
20	McArthur et al, <sup>19</sup> Musculoskelet Radiol	2013	69	m	Anterior	BT	Unknown fall	None	Case report
21	Wortley et al, <sup>33</sup> Bone Joint J	2014	44	m	Anterior	BT	Motorcycle	None	CR and review
22	Bruce-Brand et al, <sup>5</sup> BMJ Case Rep	2014	51	m	Anterior	SSC	Fall from height	3 weeks	Case report
23	Wyatt et al, <sup>34</sup> Skelet Radiol	2015	53	m	Superolateral	SSC, SSP, ISP, BT	Fall out of driving car	None	Case report
24	Agnolitto et al, <sup>1</sup> J Radiol Brasl	2016	27	f	Unknown	SSC, SSP, ISP	Motorcycle	15 d	Case report
25	Soon et al, <sup>29</sup> Journal Ortho Case Reports	2017	34	m	Posterior	SSC, SSP, BT	Fall from bicycle	3 d	Case report
26	Pantazis et al, <sup>24</sup> Open Ortho Journal	2017	57	m	Anterior	BT	Motorcycle	None	Case report
27	Seo et al, <sup>27</sup> Jour Orthopaedics	2020	57	m	Posterior	BT	Motorcycle	None	Case report
28	Javier et al, <sup>14</sup> J Shoulder Elbow Surg Int	2021	15	m	Posterior	SSP, ISP, BT	Motorcycle	4 d	Case report

m, male; SSC, subscapularis; SSP, supraspinatus; ISP, infraspinatus; BT, biceps tendon; MV, motor vehicle; f, female; RC, rotator cuff; CR, case report.

at 3 months with x-rays indicating a centered humeral head. Early shoulder movement was limited as expected following this extended surgical procedure with shoulder stiffness in the early months. This proved to be almost completely reversible over the course of the first year. Active ROM reached near-normal values with FFL up to 160°, ABD of 150°, ER 30°, and IR reaching L3. All movements were performed without any pain (Fig. 6).

Imaging, consisting of x-rays (Fig. 7) and sonography after 6 months as well as an MRI arthrography after 12 months (Fig. 8), confirmed intact rotator cuff repair, without muscular atrophy or fatty infiltration.

Function was evaluated using the Constant score with excellent results as the score steadily improved from 27 preoperatively via 50 after the surgery up to 79 at 24 months of follow-up.

**Discussion and review of the literature**

This case report describes the radiological and functional outcomes after successful open reduction and rotator cuff repair of an elderly woman with a rare injury pattern sustained after traumatic shoulder dislocation following minor trauma. This type of injury is predominantly seen in younger males and usually associated with high-energy trauma, as outlined in the following literature review. Early presentation of the patient and feasibility of reconstruction made a complete repair worth a try. Due to the completely disturbed anatomy as shown on the preoperative MRI, arthroscopic surgery was considered to be technically demanding. With the lack of a capsuled joint space, the surrounding soft-tissue envelope was prone to rapid and extensive swelling, possibly hampering arthroscopic and potential later open surgeries, even in the case of

early transition. Reduction was only achieved with substantial effort during the open approach, making it even less likely for arthroscopic approaches to succeed in a rational time frame. Therefore, open surgery seemed to be the best treatment option with an expected reasonable outcome. Withholding surgery would have rendered the woman’s arm useless for any future activity.<sup>15</sup> Even though it was tempting to try to visualize this particular injury pattern arthroscopically, the authors suggest arthroscopic repair may not be possible. When advanced imaging techniques are unavailable or surgery is performed before further diagnostics are obtained, an injury of similar extent must be suspected in cases of failed closed reduction combined with open reduction being hindered by soft-tissue tension. The bare humeral head breaking through the clavipectoral fascia gives another hint on the severity of the soft-tissue injury.

We scanned databases (PubMed, Cochrane) for the following queries: “interposed”, “rotator cuff”, “shoulder”, “glenohumeral”, and “dislocation” from 1946 to 2021. After identifying relevant literature, we crosschecked references and were able to retrieve additional literature. We excluded cases in which bony fragments hindered reduction as they are usually identified on plain x-rays.

Several case reports and case series have a variety of different injury patterns and causes of persistent subluxation after failed attempts of closed reduction following glenohumeral dislocation. In total, 28 patients could be identified from 1982 to 2021.<sup>1,3-7,9,12-14,17-19,21,23-25,27,29,31-34</sup> All but 2 patients were male. Age ranged from 13 to 87 years. The vast majority (24 out of 28) of patients were younger than 60 years when suffering the accident. In 2 cases, the mechanism of injury remained unknown, the rest resulted from high-energy trauma (motor vehicle accidents, motorcycle or bicycle crashes, falls from height (stairs/

roof), seizure, or similar). Especially in the earliest published cases, persistent subluxation was often diagnosed with significant delay.<sup>25,32</sup> In 66% of cases, multiple tendons were injured and interposed in the glenohumeral joint. The long biceps tendon was hindering reduction in almost half of the cases (13/28). Only in 4 cases, 4 or more tendons were affected, resulting from motorcycle or motor vehicle accidents. All 4 patients older than 60 years were involved in major falls (stairs/roof) (Table 1). Advanced imaging was obtained in 22 cases (19× MRI, 3× CT), and arthrography in 3 cases. In 3 patients, persistent subluxation was diagnosed on plain radiographs leading to an immediate open surgery without further imaging. Most patients underwent an open surgery (26/28) with the deltopectoral approach used in 13 cases. An arthroscopic procedure was attempted in 6 cases, but 4 of those needed transition to open surgery. Successful arthroscopic repair was performed on an isolated displacement of the long head of biceps tendon and a young patient (15 years old) in a very recent report.<sup>14,27</sup>

The patient reported in this case report thus differs from the majority of cases regarding trauma mechanism and extent of injury. Special attention should be paid to postreduction x-rays to detect or rule out persistent dislocation/subluxation, which should prompt further diagnostic imaging if necessary.

**Conclusion**

Tissue interposition after closed reduction of a dislocated shoulder must be suspected if persistent subluxation is present. Delay in diagnosis is avoidable by taking postreduction x-rays in at least 2 or, better, 3 planes, including 1 axial view. Irrespective of age and injury pattern, we strongly recommend rotator cuff repair whenever feasible in terms of muscle and joint condition. Surgery should be performed as soon as possible to achieve the best possible results, for example, avoiding joint replacement surgery.<sup>30</sup> In regard to the surgical approach, the deltopectoral incision seems favorable over the delta-split in terms of joint reduction and visualization.

For future cases, the authors suggest that the treating surgeons attempting arthroscopic procedures should be prepared for transition to a deltopectoral approach.

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