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Midterm results of chronic anterior instability of the sternoclavicular joint managed using a standardized treatment algorithm

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Aims

There remains a lack of consensus regarding the management of chronic anterior sternoclavicular joint (SCJ) instability. This study aimed to assess whether a standardized treatment algorithm (incorporating physiotherapy and surgery and based on the presence of trauma) could successfully guide management and reduce the number needing surgery.

Methods

Patients with chronic anterior SCJ instability managed between April 2007 and April 2019 with a standardized treatment algorithm were divided into non-traumatic (offered physiotherapy) and traumatic (offered surgery) groups and evaluated at discharge. Subsequently, midterm outcomes were assessed via a postal questionnaire with a subjective SCJ stability score, Oxford Shoulder Instability Score (OSIS, adapted for the SCJ), and pain visual analogue scale (VAS), with analysis on an intention-to-treat basis.

Results

A total of 47 patients (50 SCJs, three bilateral) responded for 75% return rate. Of these, 31 SCJs were treated with physiotherapy and 19 with surgery. Overall, 96% (48/50) achieved a stable SCJ, with 60% (30/50) achieving unrestricted function. In terms of outcomes, 82% (41/50) recorded good-to-excellent OSIS scores (84% (26/31) physiotherapy, 79% (15/19) surgery), and 76% (38/50) reported low pain VAS scores at final follow-up. Complications of the total surgical cohort included a 19% (5/27) revision rate, 11% (3/27) frozen shoulder, and 4% (1/27) scar sensitivity.

Conclusion

This is the largest midterm series reporting chronic anterior SCJ instability outcomes when managed according to a standardized treatment algorithm that emphasizes the importance of appropriate patient selection for either physiotherapy or surgery, based on a history of trauma. All but two patients achieved a stable SCJ, with stability maintained at a median of 70 months (11 to 116) for the physiotherapy group and 87 months (6 to 144) for the surgery group.

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Introduction

The SCJ is one of the most stable joints in the body, accounting for 1% of all joint dislocations and 3% in the upper limb.[1] Posterior SCJ instability may need emergency treatment due to proximity to critical cardiopulmonary structures.[1] However, anterior SCJ instability, while not causing critical local pressure effects, may still cause disability and limit activity if treated inadequately.[1]

There remains no consensus on managing chronic anterior SCJ instability through its rarity and lack of high-quality evidence.[2] Management options include masterly neglect, physiotherapy alone, initial physiotherapy before surgery, or surgery for all patients.[3–9] The

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literature places notable emphasis on surgical management, despite the evidence restricted to small case series.[5-10] Similarly, for nonoperative management, most studies fail to follow standardized treatment algorithms or physiotherapy rehabilitation regimes.[3,4]

SCJ instability has been managed at the Leicester Shoulder Unit (a tertiary referral unit) for the past 20 years. Initially, all patients were offered surgery, irrespective of the presence or absence of trauma or joint laxity,[10] as muscle patterning issues were not previously considered a problem. In 2007, a standardized treatment algorithm (Figure 1) was introduced after observing several hyperlax patients with an overactive pectoralis major (PM), with no associated history of trauma, not improving following surgery, thereafter being successfully treated with structured physiotherapy, augmented (if required) with Botulinum toxin injection (Dysport, UK). Other authors have recently reported that muscle patterning must be addressed first.[11]

No published studies report the outcome of patients with chronic anterior SCJ instability managed with a standardized management algorithm, stratified by aetiology. Consequently, it is difficult to counsel patients and guide decision-making between nonoperative and operative measures. We hypothesized that introducing a standardized treatment algorithm that considers the presence or absence of trauma could successfully reduce the number requiring surgery and improve outcomes. This study aims to address this gap by analyzing and reporting the midterm outcomes of this cohort.

Methods

This study received approval from our institution's audit department (number 9119). This was a retrospective analysis of prospectively collected data of patients with chronic anterior SCJ instability managed by the senior author (ALA) at the Leicester Shoulder Unit. Inclusion and exclusion criteria are presented in Table I.

Patients with a Beighton score[12] of ≥ 4 were considered hyperlax.[13] After the initial clinical assessment of each patient (Table II), the senior author would determine whether the injury was traumatic (as this was not always obvious), the SCJ was lax, or if there was abnormal muscle patterning (and if so, was it correctable). Of note, invariably the patients had a SCJ that was unstable just on lifting the arm occurring multiple times a day.

All patients routinely had a CT scan to assess for associated mediastinal injuries. The presence of anterior SCJ instability on CT was not, on its own, an indication for surgery.

Patients were then allocated to one of two groups. The non-traumatic group was treated with specialist physiotherapy and the traumatic group with surgery (primarily with a sternocleidomastoid (SCM) tendon autograft) (Figure 1). Analysis was on an intention-to-treat (ITT) basis (Figure 2).

A further subgroup analysis was performed based on the presence or absence of trauma and hyperlaxity.

Physiotherapy. Patients with no history of trauma were primarily managed with a written structured physiotherapy programme.[14] Many exhibited poor core and scapular control (i.e. a disturbed scapular rhythm compared to the contralateral side, with the scapula sometimes anteriorly rotated). Physiotherapy aimed to ameliorate core stability and abolish abnormal scapular muscle patterning. In recalcitrant cases, Botulinum toxin was used to temporarily weaken the aberrant muscle groups to assist physiotherapy.[11]

This unit has a catchment population of approximately eight million. To ensure patients residing a long distance away accessed the same quality of physiotherapy, we used a standard programme sent to a network of physiotherapists and kept patients under close review with our lead physiotherapist (HT) providing advice as needed. Patients diverted to non-specialist services required re-referral.

The principles of the physiotherapy programme were to assess for abnormal muscle patterning, use improvement tests to assess how movement might be corrected, and provide the patient with ongoing exercises (Figures 3 to 5; Tables III and IV).[14] The frequency of review was dependent on the patient's needs. Once patients achieved a stable SCJ, they were discharged (minimum six-month rehabilitation).

Patients failing to improve were offered surgery (analyzed as ITT; Figure 1).

Surgery. Patients with ongoing functional restriction caused by either a dislocated or unstable SCJ (multiple times per day after movements such as shoulder elevation), a history of trauma, and exhibiting normal scapular control were offered surgery as a structural problem in their SCJ was deemed to be the cause of their instability (with no clear target for physiotherapy to address). However, those patients who exhibited abnormal muscle patterning at presentation and/or ipsilateral frozen shoulder) were offered physiotherapy to address this first, as it was felt that they might predispose the SCJ reconstruction to failure (Figure 1). If the muscle patterning and the SCJ instability both resolved, then surgery was not performed. If only the SCJ instability remained, they proceeded to surgery.

The least invasive reconstructive option (ipsilateral SCM tendon) was preferred. If SCM was inadequate, palmaris longus (PL) was used, followed by semitendinosus (SemiT) tendon as a backup (if no PL) using the previously described method by this unit.[10] With PL or SemiT, the only difference in technique was to drill two holes through the anterior sternal cortex, with the graft passed first through the anterior sternal bone, then

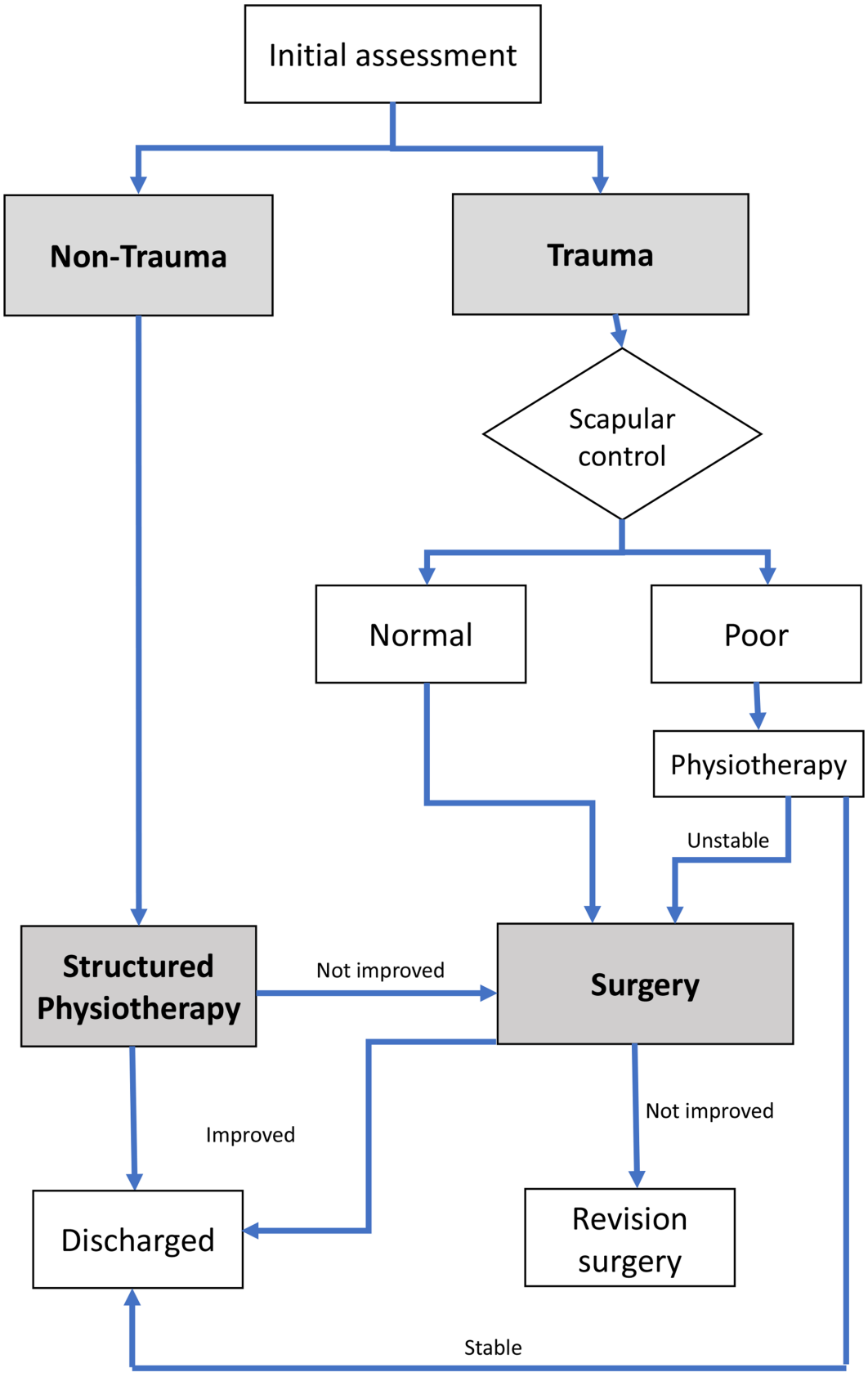

Fig. 1
Standardized treatment algorithm according to the presence of trauma.

Table I. Study inclusion and exclusion criteria.

Inclusion	Patient aged > 12 years
	Chronic* anterior SCJ instability†
	Treated between April 2007 and April 2019
	Returned the postal questionnaire including PROMs
	Concomitant frozen shoulder‡
Exclusion	Acute§ anterior SCJ instability
	Posterior SCJ instability
	SCJ arthritis
	Medial clavicle fracture (including Salter-Harris II injury in younger patients)
	Pseudoarthrosis of the medial clavicle with the first rib
	Previous surgical reconstruction for chronic anterior SCJ instability

*Defined as > six weeks.
†Patients were initially referred due to recurrent or persistent chronic anterior instability of the SCJ, with varying degrees of functional disability and pain affecting their quality of life. In contrast to patients with glenohumeral joint instability, the SCJ of all patients in this study was reported to either continuously subluxate (dislocatable) when their arm was elevated above 120° daily or remain continuously out of joint (dislocated).
‡These patients were eligible for inclusion once the frozen shoulder was treated.
§Defined as < six weeks.
PROMs, patient-reported outcome measures; SCJ, sternoclavicular joint.

Table II. Key clinical features when assessing patients with sternoclavicular joint instability in clinic.

Clinical history	
Onset of symptoms and relationship to trauma	True trauma patients had a definite date of injury, and the SCJ was painful at the time, or there was clear evidence of dislocation
	True non-trauma patients had no specific injury and noted their SCJ was dislocatable
	For those patients where it was difficult to decide which group to allocate, if it was established that despite a minor injury, they continued with their sporting activity (only to notice a popping sensation the same evening or the next day); these patients were regarded as non-traumatic
Personal history of joint laxity	Including Marfans, Ehlers-Danlos syndrome, and family history
Treatment received already	This was not diagnostic but was helpful to know for a baseline
Clinical examination	
Beighton score	≥ 4 was hyperlax
Look with the patient standing at rest (arms by their side)	Is the SCJ obviously out (i.e. dislocated)
	Look to see in which direction the SCJ is going (anterior or pure anterosuperior)
Look with the patient standing with shoulders in flexion and abduction	In patients with their SCJ reduced at rest, watch for the SCJ clicking in and out (i.e. dislocatable). This is usually observed with the shoulder in 90° to 120° of abduction
	In patients with the SCJ dislocated at rest, assess if they have full shoulder range of motion
	Check for shoulder external and internal rotation to exclude other concomitant shoulder problems (e.g. frozen shoulder). This would be expected to be normal
	Look for chin poke, muscle patterning (i.e. overactive PM or SCM in flexion or abduction), and look at scapular movement from behind
Look and feel with the patient lying on the examination table	Check that the SCJ is reduced at rest
	Grasp the clavicle and assess for anterior translation at rest and 120° degrees of shoulder abduction
Check for muscle patterning and if present	Perform improvement tests such as infraspinatus facilitation and scapular setting to assess if these stabilize the SCJ. These are screening tests to determine the likelihood of success with physiotherapy treatment and show patients that their instability is correctable (which helps patients engage with the concept of physiotherapy as they are likely to have already had non-specialist physiotherapy)
Core stability	Ask the patient to stand on one leg and see how stable they are. This is not diagnostic but helps gauge the duration of physiotherapy rehabilitation. NB: To stabilize the SCJ, core stability must be dealt with first

PM, pectoralis major; SCJ, sternoclavicular joint; SCM, sternocleidomastoid muscle.

through the clavicle, with the tendon held in a figure-of-eight position across the joint.[6] The capsule is double-breasted, as previously described. The tendon, once tensioned, is sutured to itself with a weave.

Postoperatively, patients wore a polysling under their clothes for six weeks, followed by six weeks of activities limited to the front of the body. At three months, unrestricted movement was permitted, but any sport was only allowed at six months. Formal physiotherapy was rarely indicated; for example, if abnormal muscle patterning was noted three months after their operation. Patients failing to improve had revision surgery. A

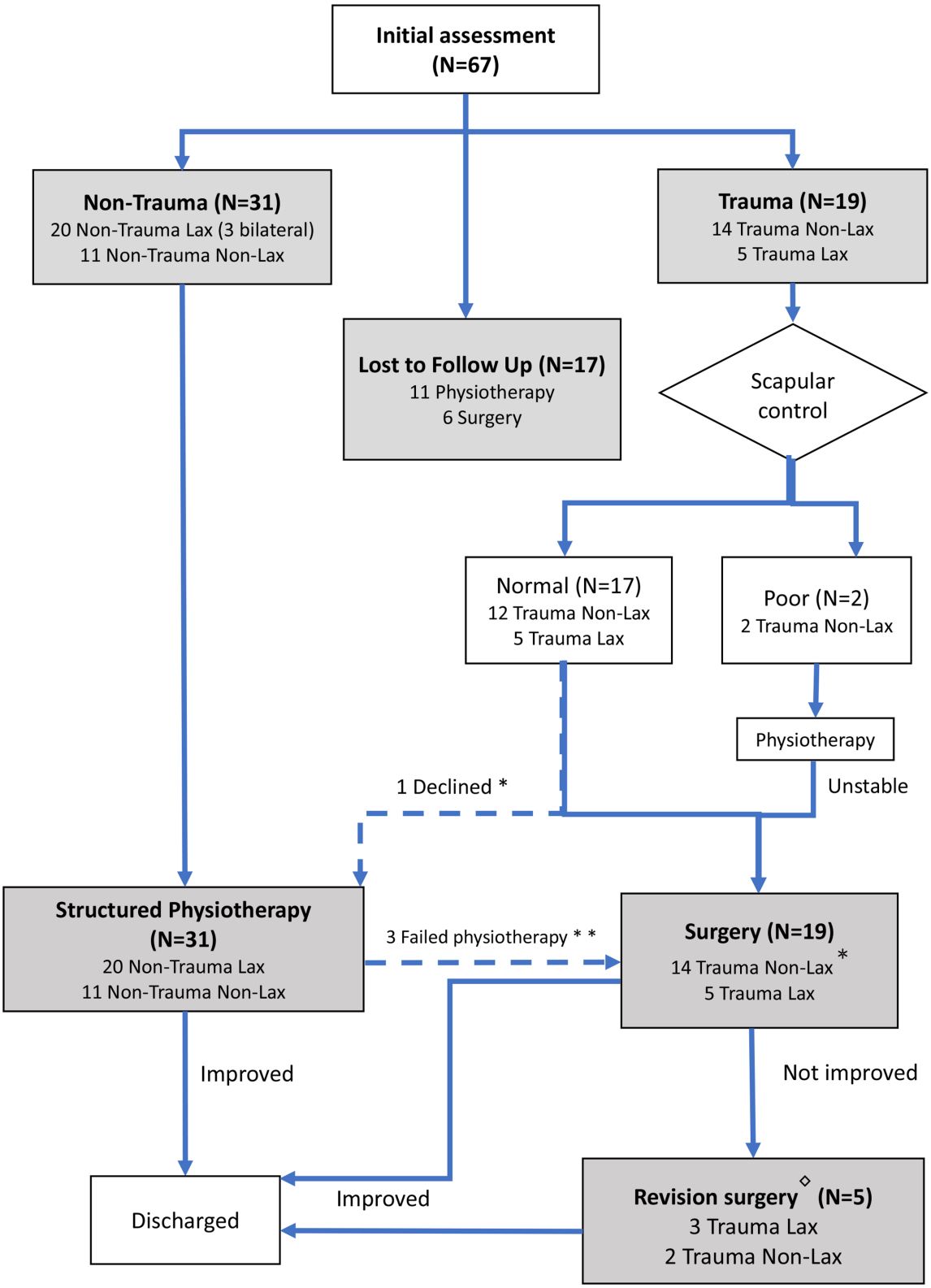

Fig. 2

Flow diagram for enrolled patients according to the presence or absence of trauma and joint laxity (analyzed as intention-to-treat (ITT)). Dashed lines indicate crossed over treatment (analyzed as per ITT). *One non-trauma non-lax patient declined surgery so crossed over to the physiotherapy group (analyzed as surgery group as per ITT). **Three non-trauma non-lax patients failed structured physiotherapy treatment so crossed over to the surgery group (analyzed as structured physiotherapy group as per ITT). ◇Revisions from total surgical series. Five patients were revised out of a total of 27 patients. Data were collected from four of the five patients. One of the five patients did not return the questionnaire.

Fig. 3

Infraspinatus facilitation. This is the most common improvement test leading to correction of anterior sternoclavicular joint instability. The patient stands in a relaxed upright posture with their elbow bent at their side. The physiotherapist asks the patient to gently push against their hand to facilitate activation of the external rotators. The patient is then encouraged to maintain the external rotation force while elevating their arm.

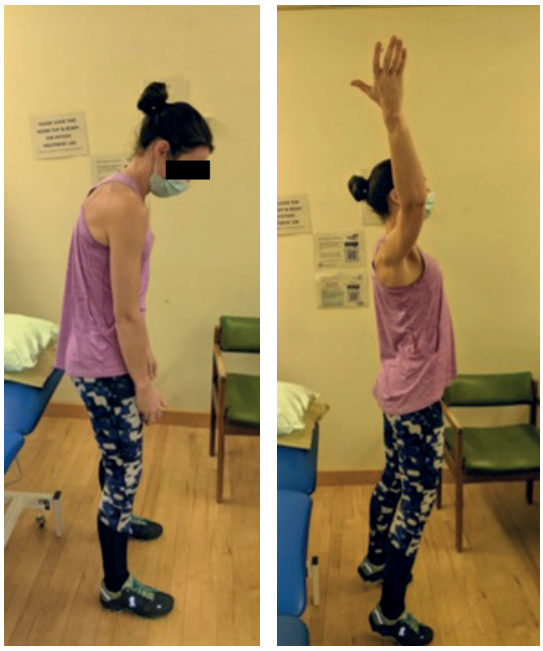

Fig. 4

Scapular setting. The physiotherapist facilitates correction of the patient's chin poke posture and protracted shoulder girdle posture by encouraging scapular/cervical retraction, and abdominal pull-in while elevating the arm.

clinical record review of all patients undergoing surgery (including those not responding to the questionnaire) was performed to identify postoperative complications.

Postal questionnaires. To assess midterm outcomes, patients were posted a questionnaire with a pre-paid reply envelope with a second letter if no reply. A structured telephone interview was conducted for those not responding.[17] Patient-reported outcome measures (PROMs) included were a subjective SCJ grading of joint stability

Fig. 5

Kinetic chain. The patient performs a lunge and a trunk rotation while elevating the arm.

(Table V),[10] Oxford Shoulder Instability Score (OSIS),[15] and pain visual analogue scale (VAS).[16]

Statistical analysis. Continuous parameters are presented as mean and range or median and interquartile range (IQR) and categorical parameters as proportions. Statistical analysis included the independent-samples *t*-test for parametric data and the Mann-Whitney U test for non-parametric data. A p-value < 0.05 was considered the threshold of significance. Analysis was performed using SPSS for Windows 2000 (v. 11.0; SPSS, USA).

Results

A total of 67 unstable SCJs in 64 patients (three bilateral) were identified. Of this cohort, 75% (50 SCJs from 47 patients, three bilateral) returned the midterm questionnaires and were included for analysis. At presentation, the mean patient age was 27 years (12 to 71), with a median follow-up of 73 months (IQR 46.25 to 94.75). Patients in the physiotherapy group (mean age 21 years (12 to 49)) were younger than those in the surgery group (mean age 38 years (16 to 71); p = 0.003). The total (time from initial assessment/surgery to questionnaire return) and midterm (time from discharge to questionnaire return) follow-up was longer for the surgery group but not significantly different (p = 0.560 for both, independent-samples *t*-test), whereas the clinic/surgery follow-up was similar (p = 0.610, independent-samples *t*-test).

Physiotherapy group. Overall, 42 SCJs (39 patients, three bilateral) of the total series of 67 SCJs were identified as non-traumatic and were allocated to physiotherapy (Figure 2). Of these, 31 SCJs replied to the questionnaire (28 patients, three bilateral) and were included for

Table III. Patient-reported outcome measures included in the postal questionnaire.

Subjective SCJ grading of joint stability[10]	One-to-five-point patient-reported score. Grades 1 to 3 indicate a stable joint that is better with varying degrees of restriction; grades 4 to 5 indicate an unstable joint that is either no better or worse, respectively.
	This grading system is not validated due to the rarity of this condition. Note invariably the patients' initial disability was such that the SCJ was unstable just on lifting the arm so seriously interfered with both activities of daily living and sport.
OSIS[15]	Grades 0 to 48, with 0 being the worst and 48 being the best. Patients were asked to rate their SCJ (rather than their GHJ), as described previously.[5] The OSIS was divided into four functional grades: 37 to 48 was deemed excellent, 25 to 36 good, 13 to 24 fair, and 0 to 12 poor.
	OSIS is not validated for this condition.
Pain VAS[16]	Grades 0 to 10, with 0 being no pain and 10 being the worst pain.
	Pain VAS is not validated for this condition.

GHJ, glenohumeral joint; OSIS, Oxford Shoulder Instability Score; SCJ, sternoclavicular joint; VAS, visual analogue scale.

Table IV. Principles of the structured physiotherapy programme.

Assess for muscle patterning 1. Assess PM 2. Dynamic assessment of the patient's demeanour, posture, and movement pattern	The key muscle to examine was PM. As this was often overactive, on elevation with the hand gripped into a fist, the upper limb was pulled into internal rotation with the SCJ subluxing at 90° to 120°.
Improvement test 1. Infraspinatus facilitation (Figure 3) 2. Scapular setting (Figure 4) 3. Kinetic chain (Figure 5)	The patient's response to improvement tests allowed the physiotherapist to understand which exercises would help. The immediate improvement in range or stability served as an excellent motivator to indicate symptoms could improve with exercises and helped improve patient compliance. Home exercise programmes were designed using exercises that mimicked these improvement tests. Once the patient can control stability through range, they can progress to functional exercises, recruit the rotator cuff in combined movements involving the whole body, and finally progress to ballistic/plyometric exercises if needed (e.g. sportsperson).
Setbacks during treatment	Patients often have setbacks during treatment, so they should be regressed to their baseline exercises if necessary. How quickly they respond to treatment varies and is heavily dependent on compliance and the patient's understanding of the aim of the exercises.
Length of treatment	The length of treatment varies depending on how quickly the patient adapts and progresses, but generally, at least a six-month course of physiotherapy is required, with appointments initially being every one or two weeks, then three or four weeks, up to six weeks to allow time to master exercises.

PM, pectoralis major; SCJ, sternoclavicular joint.

Table V. Subjective (patient-rated) sternoclavicular joint grading of joint stability.

Stable (better)	
Unrestricted	Grade 1: Stable for all activities Grade 2: Stable except for occasional dislocation (e.g. coughing), but can do everything I want to do
Restricted	Grade 3: Stable most of the time but restricted activity (e.g. sport)
Unstable (no better/worse)	
Restricted	Grade 4: No better after physiotherapy/surgery Grade 5: Worse

analysis, while 11 patients were uncontactable and were excluded (74% return rate). Follow-up times are presented in Table VI.

At final follow-up, 94% (29/31) were stable and better with varying degrees of restrictions (subjective SCJ grades 1 to 3), and 6% (2/31) were unstable and worse (subjective SCJ grade 5) (Table VII).

A total of 16 SCJs had an overactive PM at initial assessment. After completing a course of specialist physiotherapy, three SCJs (one lax patient with bilateral instability and one non-lax) remained recalcitrant and required Botulinum toxin injection to the PM. The patient with bilateral instability who did not complete their physiotherapy had an OSIS of 11 and pain VAS of 7 for both joints. The remaining non-lax patient who completed their physiotherapy had an OSIS of 31 and a VAS of 3. Both patients had a subjective SCJ stability score of 3 Table VIII.

Overall, 3/31 (10%) SCJs treated with physiotherapy failed to improve and crossed over to surgery (all non-trauma non-lax patients who had a SCM tendon autograft reconstruction) (Figure 2). Two of these three SCJs had an OSIS of 46 and 48, pain VAS of 0, and a subjective SCJ stability score of 3 and 1, respectively. The remaining patient had an OSIS of 1, pain VAS of 10, and a subjective SCJ stability score of 5.

Table VI. Comparison of patient demographics based on treatment modality of chronic anterior sternoclavicular joint instability.

Variable	Total (n = 50)	Physiotherapy (n = 31)	Surgery (n = 19)	p-value*
Mean age, yrs (range)	27.4 (12 to 71)	20.7 (12 to 49)	38.2 (16 to 71)	0.003
Median clinic/surgery follow-up, mths (IQR)†	12 (6.0 to 16.5)	12 (6.0 to 15.5)	11 (7 to 18)	0.610
Median midterm follow-up, mths (IQR)‡	52.5 (31.75 to 82.75)	52 (28.5 to 75.0)	80 (44.0 to 103.5)	0.560
Median total follow-up, mths (IQR)§	73 (46.25 to 94.75)	70 (39 to 83)	87 (59 to 120)	0.560

*Independent-samples *t*-test.
†From initial assessment/surgery to discharge.
‡From discharge to questionnaire return.
§From initial assessment/surgery to questionnaire return.
IQR, interquartile range.

Table VII. Outcomes after treatment based on aetiology of anterior sternoclavicular joint instability.

Variable	Total (n = 50)	Physiotherapy (n = 31)	Surgery (n = 19)	p-value*
Median SCJ Stability score (IQR)	2 (1.3 to 3)	2 (2 to 3)	2 (1 to 3)	0.590
SCJ Stability score, n (%)				
Better/stable unrestricted (Grade 1 or 2)	30 (60)	20 (64.5)	10 (52.6)	
Better/stable restricted (Grade 3)	18 (36)	9 (29)	9 (47.4)	
Worse/unstable (Grade 5)	2 (4)	2 (6.5)	0	
Median OSIS (IQR)	37 (26 to 44)	37 (27 to 43)	37 (25 to 46)	0.820
OSIS, n (%)				
37 to 48 Excellent	29 (58)	18 (58)	11 (58)	
25 to 36 Good	12 (24)	8 (25.8)	4 (21)	
13 to 24 Fair	4 (8)	2 (6.5)	2 (10.5)	
0 to 12 Poor	5 (10)	3 (9.7)	2 (10.5)	
Median VAS (IQR)	1 (0 to 4)	2 (0 to 4.5)	1 (0 to 3)	0.340

*Mann-Whitney U test.
IQR, interquartile range; OSIS, Oxford Shoulder Instability Score; SCJ, sternoclavicular joint; VAS, visual analogue scale.

Table VIII. Outcomes after treatment based on aetiology (subgroup analysis) of anterior sternoclavicular joint instability.

Variable	Non-trauma lax (n = 20)	Non-trauma non-lax (n = 11)	Trauma non-lax (n = 14)	Trauma lax (n = 5)
Treatment, n				
Physio	20	8	1	0
Surgery	0	2	13	5
Median SCJ Stability score (IQR)	2 (2 to 3)	2 (1 to 3)	2 (1 to 3)	3 (2 to 3)
SCJ Stability score, n (%)				
Better/stable unrestricted (Grade 1 or 2)	14 (70)	6 (54.6)§	8 (57)	2 (40)
Better/stable restricted (Grade 3)	6 (30)	3 (27.2%)¶	6 (43)‡	3 (60)
Worse/unstable (Grade 5)	0	2 (18.2)†	0	0
Median OSIS (IQR)	37 (27 to 41)	43 (33 to 45)	41 (25 to 47)	32 (25 to 37)
OSIS, n (%)				
37 to 48 Excellent	11 (55)	7 (64)	9 (64.3)	2 (40)
25 to 36 Good	6 (30)	2 (18)	2 (14.3)	2 (40)
13 to 24 Fair	1 (5)	1 (9)	1 (7.1)	1 (20)
0 to 12 Poor	2 (10)*	1 (9)†	2 (14.3)‡	-
Median VAS (range)	1.5 (0 to 5.3)	2 (0.5 to 3.5)	1 (0 to 3)	1 (1 to 3)

*Outlier patient with bilateral SCJ instability failing to complete physiotherapy despite developing recalcitrant overactive pectoralis major and scapular dysrhythmia for which they had a Botox injection.
†Includes outlier who failed to improve with initial physiotherapy, crossed over to surgery and developed postoperative overactive pectoralis major for which they had physiotherapy augmented with Botox injection.
‡Outlier declined surgery and failed to attend physiotherapy.
§Five physio, one surgery.
¶Two physio, one surgery.
IQR, interquartile range; OSIS, Oxford Shoulder Instability Score; SCJ, sternoclavicular joint; VAS, visual analogue scale.

Surgery group. From the total series of 67, 27 patients had surgery and six were lost to follow-up (Figure 2): 16

Table IX. Comparison of patient characteristics based on aetiology of anterior sternoclavicular joint instability.

Variable	Non-trauma lax (n = 20)	Non-trauma non-lax (n = 11)	Trauma non-lax (n = 14)	Trauma lax (n = 5)
Mean age, yrs (range)	21.5 (13 to 49)	19.2 (12 to 39)	43 (21 to 71)	25 (16 to 51)
Median clinic/surgery follow-up, mths (IQR)*	10 (6 to 14)	13 (7.5 to 18)	9 (7 to 11.75)	29 (26 to 30)
Median midterm follow-up, mths (IQR)†	48 (31 to 72.75)	52 (19 to 82.5)	76.5 (48.25 to 106)	90 (40 to 94)
Median total follow-up, mths (IQR)‡	63.5 (39 to 81)	77 (37.5 to 96)	85.5 (57.5 to 116)	116 (62 to 124)

*From initial assessment/surgery to discharge.
†From discharge to questionnaire return.
‡From initial assessment/surgery to questionnaire return.
IQR, interquartile range.

SCJs had a SCM tendon autograft reconstruction and five SCJs had a PL tendon autograft. Three were initially allocated to physiotherapy but failed to improve, so crossed over to surgery (ITT analysis). One patient declined surgery (crossed over to physiotherapy, ITT analysis).

A total of 19 SCJs were included in the surgical group (76% return rate). Follow-up times are presented in Table VI. ll Postoperatively, all SCJs were better and stable with varying degrees of restrictions (Table VII). Median OSIS was 37 (IQR 26 to 46), and pain VAS was 1 (IQR 0 to 3).

Two non-lax patients were found to have an overactive PM (one with a concurrent frozen shoulder) after initial assessment, requiring physiotherapy (Figure 2). Despite the resolution of the muscle patterning and frozen shoulder, their SCJ instability failed to resolve, so they proceeded to surgery. Three out of 19 patients developed an overactive PM postoperatively. One improved with physiotherapy alone, whereas the remaining two needed a Botulinum toxin injection (one after their initial procedure and the other following revision surgery, both with good results). The patient declining surgery (failed to attend physiotherapy) had an OSIS of 3, pain VAS of 1, and subjective SCJ stability score of 2.

Surgical complications. To ensure no postoperative complications were missed, we retrospectively reviewed the clinical records of all patients, including the six SCJs who failed to return their questionnaire. Five SCJs required revision surgery (Figure 2): three were revised with a PL autograft, one a SCM autograft augmented with PL, and one a SemiT autograft. Four of these five patients returned their questionnaire; all achieved stability after revision with one having a subjective SCJ grade of 2, and the remaining three with a subjective SCJ grade of 3. Median OSIS was 40 (IQR 32 to 43), and pain VAS was 0.5 (IQR 0 to 2.5). These outcomes were comparable to the cohort that did not require revision surgery who reported a median subjective SCJ stability score of 2 (IQR 1 to 3), OSIS of 37 (IQR 25 to 47), and pain VAS of 1 (IQR 0 to 3).

Three SCJs (11%) developed postoperative ipsilateral frozen shoulder. One resolved with physiotherapy alone, one had physiotherapy followed by steroid injection, and one had an arthroscopic interval release seven months following the index procedure. The patient who had physiotherapy alone was stable for all activities, and the remaining two patients were stable with restrictions. The median OSIS for all three patients was 46, and pain VAS was 0.

One SCJ (4%) developed scar sensitivity, which resolved 13 months postoperatively.

Subgroup analysis. Table IX summarizes the demographic details and Table VIII the outcomes of the four subgroups. Due to small numbers, statistical analysis could not be performed. While the management of patients with trauma (± laxity) was surgery (apart from one who refused), and patients with non-trauma/lax was physiotherapy, the most challenging subgroup to treat was the non-trauma/non-lax, where more patients crossed over. Despite this, their results were comparable with the other subgroups.

Midterm outcomes. Follow-up times are presented in Table VI. A comparison of SCJ stability scores of the whole cohort at discharge and final follow-up demonstrated that five out of 50 SCJs improved over time, 25 remained the same, and 20 worsened. All five SCJs that improved belonged to the physiotherapy group (two increased by two grades and three by one grade). Of the 20 that worsened (11 physiotherapy/nine surgery), eight dropped one grade, 11 dropped two grades, and one dropped four. At final follow-up, four (three physiotherapy/one surgery) were grade 2; 14 (seven physiotherapy/seven surgery) were grade 3, and two (one physiotherapy/one surgery) were grade 5.

Discussion

Patients with chronic anterior instability of the SCJ managed using the presented treatment algorithm achieved good to excellent results, maintained at midterm follow-up. Most patients had a stable joint, with many reporting unrestricted function. The majority reported good to excellent OSIS and low pain VAS scores. Of those treated surgically, there was a 19% revision rate to attain stability.

Adherence to a structured physiotherapy programme (which requires considerable commitment from both patient and physiotherapist) were key to success.

Engaging and motivating patients in a lengthy physiotherapy course (especially the younger patient cohort) was a challenge, alongside ensuring that those residing a long distance away from the treating unit accessed the same quality of physiotherapy programme (some diverted to non-specialist services, requiring re-referral and a longer rehabilitation). Improved outcomes were achieved with specialist physiotherapists with our lead physiotherapist providing remote advice.

There is limited evidence on the treatment of SCJ instability with physiotherapy alone. De Jong et al[4] published a series of ten patients with traumatic anterior SCJ instability treated mainly with physiotherapy, but no specific regime was described. Seven patients reported no complaints and returned to sport, while three were restricted. Recently, Moreels et al[3] reported on 29 non-traumatic SCJs with instability treated with masterly neglect. After a mean of 46 months' follow-up, they found all patients reporting subluxations, albeit less frequent in 19 (83%). The mean pain VAS score was 1.6 (similar to our physiotherapy cohort), and the mean Oxford Shoulder Score was 44. In contrast, the patients who went through this study's structured physiotherapy programme achieved stability faster, being discharged at a median of 12 months. At a median follow-up of 52 months, they had largely maintained it, with 93% (29/31) being stable with various activities (median OSIS 37, pain VAS 2).

Uri et al[5] offered initial physiotherapy (adapted from unstable GHJ regimes) to all patients (irrespective of aetiology) with SCJ instability. They reserved surgery for those who failed to improve but did not specifically report the proportion that improved with physiotherapy alone. Outcomes of our physiotherapy regime for SCJ instability are comparable to those reported from similar regimes for instability of the GHJ.[18]

Surgical techniques using tendon autografts described to treat chronic anterior SCJ instability include SCM,[5,10] PL,[6] SemiT,[8,9] and Gracillis.[8] The published literature does not provide evidence of an advantage of either SCM, PL, or SemiT. SCM has the advantage of allowing PL to be retained for revision surgery if required. PL and SemiT have increased donor-site morbidity.

Most published series on the surgical management of SCJ instability are small, with a comparison of outcomes difficult as indications for patient selection are not specified. Furthermore, most do not report whether trauma was the initial cause of the instability nor the degree of any underlying joint laxity. Uri et al[5] reported the outcomes at 44 months of a series of 32 patients with chronic anterior SCJ instability, similarly reconstructed with SCM autograft after a failure of an initial trial of physiotherapy, pain relief, up to three steroid injections, and (in three cases) failed Botulinum toxin injection. The presence or absence of trauma (or laxity) was not described. Excluding 11 patients with degenerative instability and seven patients with spontaneous instability (due to generalised hyperlaxity), of the remaining 14 post-traumatic instability patients, 12 (86% SCJs) were reported to achieve stability at final follow-up, with similar final OSIS and pain VAS scores as our cohort.

Several small surgical case series report the outcomes of PL,[6] SemiT,[9] and suture anchors,[7] with varying success. These include Bae et al[9] (15 patients; 60% stable pain-free joint, 87% some sporting activity limitation), Crichton et al[6] (five patients; 60% stable, one scar problem), and Abiddin et al[7] (seven patients, 86% stable, two revisions in the same patient for pain and instability).

Unlike our series, other small series have not recorded many complications other than instability. Our frozen shoulder rate of 11% (3/27) is comparable with another series on shoulder surgery;[19] all fully resolved after treatment. It could be argued that frozen shoulder may occur due to excessive SCJ rigidity, but the site of pain for this cohort of patients was different (in the shoulder as opposed to the SCJ), their stiffness was in external rotation with the shoulder in neutral (placing no stress on the SCJ), and all patients improved after treatment. A frozen shoulder is a known complication of upper limb surgery.[19]

This study has several limitations. Although all patients were followed up to discharge from initial treatment, we acknowledge the high loss of midterm follow-up (25% questionnaire failure to return rate) due to a young patient population who had moved addresses during the follow-up period, which may have introduced non-response bias, although our response rate was acceptable for questionnaire studies.[20] Sample sizes in each group were small, a challenge for all SCJ studies due to the rarity of this pathology. Initial pre-intervention PROMs data was unavailable for comparison, mainly due to referrals originating from other units across the country. Given the lack of validated PROMs for the treatment of SCJ instability and heterogeneity of published outcomes, we modified the OSIS, a strategy adopted by other authors.[5] It is unknown how valid this scoring system is for this condition, potentially limiting meaningful comparison between cohorts. Finally, the four categories of patients (presence or absence of trauma, with or without hyperlaxity) create disparate cohorts for which the lack of other similar published outcomes limits comparisons.

To our knowledge, this is the largest midterm case series to evaluate the comprehensive outcomes of chronic anterior SCJ instability managed according to a standardized algorithm. All but two patients improved and were stable after treatment, with stability largely

maintained at midterm follow-up (median 70 and 87 months following physiotherapy and surgery, respectively). The majority of patients had good to excellent OSIS and pain VAS scores. Of those assigned to surgery, there was a revision rate of 19% (all subsequently stable and with comparable outcomes to patients not requiring revision surgery), 11% postoperative ipsilateral frozen shoulder (all resolved) and 4% scar sensitivity (resolved).

In conclusion, this study has demonstrated the benefits of a standardized treatment algorithm that considers the presence or absence of trauma, successfully treats patients with physiotherapy and surgery alike, and reduces the number of patients requiring surgery. Our main recommendation is that appropriate initial patient selection for a structured physiotherapy programme or surgical treatment is key to ensuring good outcomes and directing patients to the programme most likely to be successful the first time.

Take home message

- Appropriate initial patient selection for a structured physiotherapy programme or surgical treatment is key to ensuring good outcomes and directing patients to the programme most likely to be successful the first time.

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