Factors affecting short- and long-term outcomes of manipulation under anaesthesia in patients with adhesive capsulitis of the shoulder

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Abstract

Background: The present study aimed to evaluate and determine the factors that affect short- and long-term outcome following manipulation under anaesthesia (MUA) of patients with adhesive capsulitis.

Methods: Patients recruited from January 1999 to January 2010 were retrospectively analyzed and classified as having primary or secondary adhesive capsulitis. All patients were assessed for range of movement (ROM) and Oxford Shoulder Scores (OSS) before and immediately postoperatively, as well as for OSS more than 1 year post MUA.

Results: In total, 295 patients (315 shoulders) were sequentially recruited, and information was collected at baseline, as well as at a mean follow-up of 28 days and 3.6 years. A significant improvement in OSS and ROM was noted 1 month post MUA ($p < 0.0001$) with females benefiting more than males ($p < 0.0025$). Long-term follow-up revealed that the improvement in OSS was maintained ($p < 0.0001$). Secondary adhesive capsulitis significantly reduced the efficacy of MUA as assessed by ROM ($p < 0.0001$). Other factors (age, initial ROM and OSS, and length of symptoms prior to MUA) did not significantly affect the outcome over the short- or long-term.

Conclusions: The findings of the present study show that all patient groups had a significantly improved ROM and OSS in the short-term with long-term maintenance of improved OSS.

Keywords

Adhesive capsulitis, frozen shoulder, manipulation, outcome, short-term, long-term, primary, secondary

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Introduction

Adhesive capsulitis of the shoulder is a condition of pain and stiffness with consequent functional impairment. Diagnosis is made clinically as radiological and laboratory investigations are normal. There is a gradual onset of diffuse shoulder pain and progressive restriction in the global range of passive and active movement. It can be primary (idiopathic), in which there are normal radiological findings, or secondary to a known precipitating factor, such as upper limb trauma.¹

Adhesive capsulitis has traditionally been regarded as a self-limiting pathology, usually lasting 1 to 3 years, after which most patients have recovered even in the absence of treatment. The natural history is of three phases: a painful phase that is a result of inflammation,

a painful and frozen phase characterized by stiffness, followed by a thawing phase.¹ However long-term follow-up studies show that 50% of patients treated conservatively still have pain or stiffness of the shoulder after a mean follow-up of 7 years, even though only 11% report functional restriction.²

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Treatment options include pain relief with nonsteroidal anti-inflammatory drugs, physiotherapy, closed manipulation under anaesthesia (MUA), open release of the coracohumeral ligament, hydrostatic capsular distension, and arthroscopic release.³ MUA with a corticosteroid (depo-medrone) and local anaesthetic (bupivacaine) injection is our preferred choice of management.

The present study aimed to identify the factors that affect the short- and long-term outcome of MUA of adhesive capsulitis, and report any adverse outcomes. This will help clinicians when using this treatment modality to advise their patients of the likely outcome. The effects of timing of MUA on outcome⁴ and diabetes⁵ have been published from this group and the findings are mentioned here briefly. In the present study, we looked at age, sex, initial range of movement (ROM) and Oxford Shoulder Scores (OSS), as well as primary or secondary frozen shoulder, as factors that may affect the outcome.

Materials and methods

A retrospective analysis was carried out on prospectively collected, single surgeon (DAW), single institution, consecutive series of patients with adhesive capsulitis between January 1999 and January 2010. All patients were assessed by the senior author (DAW) and the diagnosis was confirmed on the basis of: (i) a history of increasing pain and stiffness in the shoulder, which may have followed a specific event or injury and (ii) examination findings with active and passive loss of movement of the shoulder in one or more planes (abduction, flexion, external or internal rotation) in association with pain. Plain radiography of the shoulder was performed on all patients to exclude other pathology, in particular glenohumeral arthritis. All patients were previously treated within the primary care setting with combinations of conservative management strategies, including simple oral analgesia, intra-articular steroid injection and physiotherapy.

Institutional ethical approval for the study was obtained. Management and documentation followed a standard protocol. Patients who were diagnosed to be in the frozen phase were recommended to have MUA on the next available operating list. No patient waited longer than 4 weeks for their procedure and no further conservative management was followed. An explanation of the diagnosis, natural history of the condition and potential treatment options were given to each patient before consent to the procedure was obtained. Information regarding the aetiology was recorded from the outset and ROM and functional outcome using the OSS⁶ were recorded on the day of admission before the operation. Secondary adhesive capsulitis was defined as

those having a clear precipitating factor, such as upper limb trauma or surgery. A history of minor trauma that did not clearly cause the onset of symptoms was deemed primary frozen shoulder.

The procedure was performed as a day case unless the patient lived alone, in which case an overnight stay was arranged. General anaesthetic was administered with the patient supine. The patient's scapula was fixed by gripping across the top of the shoulder and the passive range of glenohumeral motion was recorded. The proximal humerus was held by the surgeon's other hand so as to use a short lever arm to minimize the risk of iatrogenic injury. Manipulation was carried out sequentially through a ROM (abduction, flexion, external rotation, cross body adduction and internal rotation) and repeated until maximal ROM was achieved and recorded. Internal and external rotation was assessed with the elbow in 90° of flexion using the forearm as a pointer. For every type of motion assessed, the angles were estimated to the nearest 5° by the senior author. Finally, the glenohumeral joint was injected via the direct anterior approach 10 mL of 0.5% bupivacaine and 80 mg of depo-medrone (Pharmacia Ltd, Sandwich, UK).

All patients were offered a standard course of physiotherapy, which commenced with hydrotherapy on day 1 postoperatively. Subsequent weekly physiotherapy was performed until there was no further improvement in ROM. The median number of sessions required was three. Reassessment in clinic was scheduled at 3 weeks postoperatively. Patients who were satisfied with their outcome following the initial follow-up were discharged with open access to return should their symptoms recur. Patients with ongoing symptoms or difficulties were offered further treatment, including repeat MUA if desired.

Outcome measures were ROM before and after MUA, OSS assessment before surgery and at each follow-up appointment, and the complication rate. A follow-up postal questionnaire was conducted in 2010 to assess long-term outcome. Attempts were made to contact all nonrespondents by telephone. The factors analyzed were age, sex, duration of symptoms prior to MUA, ROM, OSS, diabetes and whether the aetiology was primary or secondary.

To minimize data collection errors, two clinicians reviewed all case notes. The data were inputted into a secure database (Microsoft Excel 2007; Microsoft Corp., Redmond, WA, USA). Statistical tests were performed using SPSS, version 19.0 (SPSS Inc., Chicago, Illinois). Descriptive statistics are presented as the mean (SD), medians and interquartile ranges. Missing information was highlighted for each variable. A multilevel (repeated measures) hierarchical model was used to assess the effect of MUA. Simple unadjusted and

sex-specific analyses were performed. In addition, analyses controlled for covariates, including gender, age at MUA, length of follow-up, symptom length prior to MUA, diabetic status and aetiology, were performed. The interaction between covariates and MUA was also investigated (i.e. to assess the differential effect of the covariates on the efficacy of MUA). In all analyses, change and 95% confidence intervals are presented, and exact values are presented when $p > 0.0001$.

Results

During the collection period between January 1999 and January 2010, 309 consecutive patients in the 'frozen phase' were referred to the lead author (DAW). Fourteen patients declined MUA, leaving a total of 295 patients with 315 frozen shoulders. There were no complications following MUA; specifically, no fractures, dislocations or neurovascular injuries. No patient was made clinically worse as a result of the procedure.

Table 1 shows the change in functional outcome as measured by OSS pre-operatively, over the short-term

(mean 4 weeks) and over the long-term (mean 3.6 years). Long-term follow-up was performed by telephone interview. Of the 295 patients, 229 participated (78%). In total, 252 shoulders from the 229 patients were followed up over the long-term (80%). Mean time to follow-up was 3.6 years (interquartile range 1.7 to 5.0 years). Note that pre-operative and short-term scores are from 315 shoulders and long-term outcome scores are from 252 shoulders. The OSS scores were stratified into four groups, 0 to 19 severe symptoms, 20 to 29 moderate symptoms, 30 to 39 mild symptoms and 40 to 48 satisfactory symptoms. This stratification has been used online for ease of interpretation.⁷ It can be seen that 36% of patients had mild/satisfactory functional scores prior to MUA and, at short-term follow-up postoperatively, 97% of patients have mild to minimal functional impairment. At long-term follow-up, 92% of patients continue to report mild to minimal functional impairment.

Tables 2 and 3 show the breakdown of the OSS scores over time for primary and secondary adhesive capsulitis, respectively. There were 246 shoulders with primary adhesive capsulitis (Table 2) at pre-operative

Table 1. Overall Oxford Shoulder Scores (OSS) scores pre-operatively, short-term post operatively and long-term outcome.

Combined	OSS	Number of shoulders		
		Pre-operative	Short-term	Long-term
Severe	0 to 19	28 (9%)	3 (1%)	7 (3%)
Moderate	20 to 29	174 (55%)	7 (2%)	13 (5%)
Mild	30 to 39	111 (35%)	60 (19%)	15 (6%)
Satisfactory	40 to 48	2 (<1%)	245 (78%)	217 (86%)
Total		315	315	252

Table 2. Oxford Shoulder Scores (OSS) scores for primary adhesive capsulitis pre-operatively, at short-term and long-term follow-up.

Primary	OSS	Number of shoulders		
		Pre-operative	Short-term	Long-term
Severe	0 to 19	19 (8%)	1 (<1%)	4 (2%)
Moderate	20 to 29	137 (56%)	4 (2%)	10 (5%)
Mild	30 to 39	89 (36%)	42 (17%)	8 (4%)
Satisfactory	40 to 48	1 (<1%)	199 (81%)	177 (89%)
Total		246	246	199

Table 3. Oxford Shoulder Scores (OSS) scores for secondary adhesive capsulitis pre-operatively, at short-term and long-term follow-up.

Secondary	OSS	Number of shoulders		
		Pre-operative	Short-term	Long-term
Severe	0 to 19	9 (13%)	2 (1%)	3 (3%)
Moderate	20 to 29	37 (54%)	3 (2%)	3 (5%)
Mild	30 to 39	22 (32%)	18 (19%)	7 (6%)
Satisfactory	40 to 48	1 (1%)	46 (78%)	40 (86%)
Total		69	69	53

and short-term follow-up with the mild/satisfactory scores increasing from 37% to 98% over the short-term. Long-term follow-up of these 252 shoulders comprised 199 primary and 53 secondary adhesive capsulitis. At long-term follow-up, 93% of the 199 primary shoulders had mild/satisfactory scores. Sixty-nine secondary adhesive capsulitis (Table 3) were compared pre-operatively and over the short-term, with mild/satisfactory scores improving from 33% to 97%. Long-term follow-up comprised 53 secondary capsulitis and 92% had mild/satisfactory scores.

Table 4 shows descriptive statistics of patients' age, duration of pre-operative symptoms and length of short- and long-term follow-up. In addition, baseline outcome (OSS and ROM) data for males and females are also presented. The 295 patients had a mean short-term follow-up of 27.5 days, with an interquartile range of 9 days. The average length of symptoms prior to MUA was 30 weeks. Of the 295 patients, there were 39 diabetics (13.2%), of whom 23 had type 1 (59.0%) and 16 had type 2 (41.0%) diabetes. Of the 315 shoulders, 246 were diagnosed as primary and 69 as secondary adhesive capsulitis.

Male-, female- and sex-adjusted effects on outcome following MUA are shown in Table 5. The mean change is reported and indicates the significant beneficial effects of MUA on OSS, and all shoulder movements for both males and females ($p < 0.0001$). Gender-specific subgroup analysis indicates a significantly greater improvement in OSS for females compared to males ($p = 0.0004$). There is weak evidence that improvement in flexion ($p = 0.052$) and abduction ($p = 0.0432$) is better for females, although there is no evidence of any gender difference in improvement with respect to external rotation ($p = 0.1202$) or internal rotation ($p = 0.1322$).

The mean changes in OSS when adjusted for sex, diabetes, age, aetiology, symptom length and follow-

up are shown in Table 6. Again, the results clearly indicate a significant 14.8-point increase in mean OSS score ($p < 0.0001$) for the entire cohort. There is strong evidence to suggest that females have a significant 2.5-point improvement in OSS compared to males when adjusted for diabetes, age, aetiology and the duration of symptoms ($p < 0.0025$). However, in isolation, there is no significant effect of diabetes, whether the aetiology of adhesive capsulitis was primary or secondary, age or symptom length prior to MUA on the efficacy of MUA assessed by OSS.

Table 7 shows the average change in ROM adjusted for sex, diabetes, age, aetiology, symptom length and follow-up. The results indicate a significant improvement ($p < 0.0001$) in all ROMs, with an improvement of 90° flexion, 95° abduction, 40° external rotation and 40° internal rotation. The effect of covariates on the efficacy of MUA is indicated by varying each covariate, at the same time as holding all other covariates constant. Patients with primary adhesive capsulitis do significantly better than secondary ones for all ROM ($p < 0.0001$), although there is only weak evidence of this when OSS is compared ($p = 0.0952$). When comparing diabetic with nondiabetic patients, there is significantly less improvement in external rotation ($p < 0.039$), with a strong suggestion that this is mirrored by internal rotation ($p < 0.0869$). Flexion and abduction improvements are not affected. Sex, diabetes, age or symptom length prior to MUA have no effect on the efficacy of ROM parameters after adjustment for multiple testing.

Initial analysis of the raw data for long-term outcome showed a further 2-point improvement of the OSS in both the primary and secondary groups at this point when compared with the 4-week postoperative scores. However when comparing the effect of covariates as confounding factors, less of a sustained improvement in the OSS was noted. Table 8 shows the results of long-term functional outcome post-MUA. Both primary and secondary adhesive capsulitis groups failed to maintain the initial improvements (initial change in OSS of 15.5 and 14.0 compared to 8.3 and 7.0 over the long-term), although the long-term improvement in OSS from the initial MUA was maintained ($p < 0.0001$). Comparing the effect of covariates on the change in OSS score compared to pre-MUA adjusted for confounding variables indicates that females benefited more from MUA than males, whereas both sexes had significant gains in OSS. No significant differences were observed in other groups.

In total, 56 patients requested a second manipulation, of whom 14 were diabetic, representing 35.9% of the total diabetics in the cohort compared to 13.3% for nondiabetics. Further subgroup analysis of redo manipulations is not discussed in the present study.

Table 4. Crude data for pre-manipulation under anaesthesia.

	Sex	n	Mean	(SD)	25th percentile	50th percentile	75th percentile	Missing
Age	Male	151	51.6	(7.92)	46.59	50.82	57.16	0
(years)	Female	164	52.19	(8.84)	46.53	51.43	56.88	
Length of pre-operative symptoms (weeks)	Male	151	28.93	(20.90)	16	26	34	0
	Female	164	31.49	(26.69)	16	23	39	
Length of follow-up (short-term, days)	Male	148	26.62	(17.06)	18	21	27.5	3
	Female	164	28.43	(29.77)	18	22	27	
Length of follow-up (long-term, years)	Male	118	3.77	(2.33)	1.89	3.04	5.41	33
	Female	135	3.51	(2.21)	1.65	2.94	4.74	29
OSS	Male	151	28.17	(6.60)	25	29	32	0
	Female	164	25.41	(6.15)	22	26	30	
Flexion (°)	Male	151	71.29	(30.09)	50	70	90	0
	Female	164	65.18	(30.45)	40	70	90	
Abduction (°)	Male	151	67.68	(27.69)	45	70	90	0
	Female	164	62.32	(29.78)	30	70	80	
External rotation (°)	Male	151	17.02	(16.45)	10	10	20	0
	Female	164	18.54	(15.74)	10	10	30	
Internal rotation (°)	Male	135	17.22	(15.29)	10	10	20	21
	Female	159	18.71	(15.59)	10	10	30	

OSS, Oxford Shoulder Scores.

Discussion

From the literature, it is evident that not all patients with adhesive capsulitis make a full recovery, raising doubts as to whether this condition is self-limiting. Nevasier's 5-year follow-up of 46 patients showed that all patients achieved their 5-year follow-up level of ROM within 6 months of MUA except diabetic patients.⁸ Reichmister and Friedman followed up 38 shoulders, which were manipulated, for an average of 58 months, with 97% of patients reporting pain relief and almost full range of motion.⁹ Farrell reported long-term results in 26 idiopathic cases that had failed non-operative treatment and were subsequently manipulated.¹⁰ Their study showed a significant improvement that was maintained over a mean follow-up of 15 years, with an improvement of 70 in flexion and 53 in external rotation and a final mean simple shoulder test score of 9.5 out of 12 (12 being

the best). Flannery followed up 145 patients over an average of 62 months and found that 90% were satisfied with the procedure and would chose the same procedure if the problem arose in the opposite shoulder.¹¹ Flannery also reported a significantly better OSS in those patients who had MUA less than 9 months from onset of symptoms.¹¹

Hydrodilatation is an alternative to operative intervention because it can be carried out in the outpatient setting without the need for general anaesthesia, thus making it a cheap and easily performed procedure. It involves injecting fluid to expand the capsular volume until rupture of the capsule. In a level II randomized control trial comparing MUA (18 shoulders) against hydrodilatation (20 shoulders), it was found that the latter had significantly better visual analogue and Constant scores at 2 and 6 months of follow-up.¹² There was no difference in the ROM between the two

Table 5. Crude data and sex-specific effects 1 month post-manipulation under anaesthesia.

Measure	Sex	n	Change	95% CI	p	p(sex difference)
OSS	Male	315	14.04	(12.90 to 15.18)	<0.0001	<0.0004
	Female	315	16.9	(15.81 to 18.00)	<0.0001	
	All	315	15.53	(14.73 to 16.33)	<0.0001	
Flexion (°)	Male	315	94.87	(89.58 to 100.16)	<0.0001	<0.052
	Female	315	102.13	(97.06 to 107.21)	<0.0001	
	All	315	98.65	(94.97 to 102.33)	<0.0001	
Abduction (°)	Male	315	97.55	(92.38 to 102.72)	<0.0001	<0.0432
	Female	315	104.94	(99.98 to 109.90)	<0.0001	
	All	315	101.4	(97.80 to 104.99)	<0.0001	
External rotation (°)	Male	315	43.87	(40.91 to 46.84)	<0.0001	<0.1202
	Female	315	47.13	(44.29 to 49.98)	<0.0001	
	All	315	45.57	(43.51 to 47.63)	<0.0001	
Internal rotation (°)	Male	294	43.19	(40.00 to 46.37)	<0.0001	<0.1322
	Female	294	46.51	(43.58 to 49.44)	<0.0001	
	All	294	44.98	(42.82 to 47.14)	<0.0001	

OSS, Oxford Shoulder Scores; CI, confidence interval.

Table 6. Adjusted analyses of 1 month post-manipulation under anaesthesia Oxford Shoulder Scores.

Comparison	Adjusted	Change	95% CI	p	p(difference)
Average	Sex, DM, Age, Aet, SL, FU	14.81	(13.48 to 16.14)	<0.0001	
Male	DM, Age, Aet, SL, FU	13.55	(12.11 to 14.98)	<0.0001	<0.0025
Female		16.08	(14.39 to 17.76)	<0.0001	
Nondiabetic	Sex, Age, Aet, SL, FU	15.19	(14.18 to 16.19)	<0.0001	<0.5492
Diabetes		14.44	(12.08 to 16.80)	<0.0001	
Primary AC	Sex, DM, Age, SL, FU	15.54	(14.26 to 16.82)	<0.0001	<0.1416
Secondary AC		14.08	(12.13 to 16.03)	<0.0001	
Average age	Sex, DM, Aet, SL, FU	14.81	(13.48 to 16.14)	<0.0001	<0.4996
Average age + 10 years		14.48	(12.77 to 16.19)	<0.0001	
Average SL	Sex, DM, Age, Aet, FU	14.81	(13.48 to 16.14)	<0.0001	<0.6122
Average SL + 8 weeks		14.74	(13.41 to 16.08)	<0.0001	

Aet, Aetiology; DM, diabetes mellitus; FU, follow-up; AC, adhesive capsulitis; SL, symptom length; CI, confidence interval.

Table 7. Adjusted analyses of post-manipulation under anaesthesia range of motions.

	Comparison	Adjusted	Change	95% CI	p	p(difference)
Flexion (°)	Average	Sex, DM Age, Aet, SL, FU	93.48	(87.42 to 99.53)	<0.0001	
	Male	DM, Age, Aet, SL, FU	90.54	(84.01 to 97.07)	<0.0001	<0.1222
	Female		96.42	(88.77 to 104.06)	<0.0001	
	Nondiabetic	Sex, Age, Aet, SL, FU	92.22	(87.65 to 96.79)	<0.0001	<0.6587
	Diabetes		94.74	(84.01 to 105.47)	<0.0001	
	Primary AC	Sex, DM, Age, SL, FU	103.9	(98.11 to 109.73)	<0.0001	<0.0001
	Secondary AC		83.04	(74.17 to 91.90)	<0.0001	
	Average age	Sex, DM, Aet, SL, FU	93.48	(87.42 to 99.53)	<0.0001	<0.8013
	Average age + 10 years		92.92	(85.15 to 100.69)	<0.0001	
	Average SL	Sex, DM, Age, Aet, FU	93.48	(87.42 to 99.53)	<0.0001	<0.3642
	Average SL + 8 weeks		92.91	(86.83 to 99.00)	<0.0001	
Abduction (°)	Average	Sex, DM, Age, Aet, SL, FU	95.87	(89.89 to 101.86)	<0.0001	
	Male	DM, Age, Aet, SL, FU	93.01	(86.56 to 99.47)	<0.0001	<0.128
	Female		98.73	(91.18 to 106.29)	<0.0001	
	Nondiabetic	Sex, Age, Aet, SL, FU	96.57	(92.05 to 101.09)	<0.0001	<0.8056
	Diabetes		95.18	(84.57 to 105.79)	<0.0001	
	Primary AC	Sex, DM, Age, SL, FU	104.4	(98.68 to 110.17)	<0.0001	<0.0001
	Secondary AC		87.32	(78.56 to 96.09)	<0.0001	
	Average age	Sex, DM, Aet, SL, FU	95.87	(89.89 to 101.86)	<0.0001	<0.9263
	Average age + 10 years		95.67	(87.99 to 103.35)	<0.0001	
	Average SL	Sex, DM, Age, Aet, FU	95.87	(89.89 to 101.86)	<0.0001	<0.3542
	Average SL + 8 weeks		95.3	(89.29 to 101.32)	<0.0001	
External rotation (°)	Average	Sex, DM, Age, Aet, SL, FU	39.35	(36.04 to 42.66)	<0.0001	
	Male	DM, Age, Aet, SL, FU	38.55	(34.98 to 42.12)	<0.0001	<0.4418
	Female		40.15	(35.96 to 44.33)	<0.0001	
	Nondiabetic	Sex, Age, Aet, SL, FU	42.57	(40.07 to 45.07)	<0.0001	<0.039
	Diabetes		36.12	(30.25 to 41.99)	<0.0001	
	Primary AC	Sex, DM, Age, SL, FU	45.78	(42.60 to 48.96)	<0.0001	<0.0001

(continued)

Table 7. Continued.

	Comparison	Adjusted	Change	95% CI	p	p(difference)
	Secondary AC		32.92	(28.07 to 37.76)	<0.0001	
	Average age	Sex, DM, Aet, SL, FU	39.35	(36.04 to 42.66)	<0.0001	<0.0299
	Average age + 10 years		36.7	(32.45 to 40.95)	<0.0001	
	Average SL	Sex, DM, Age, Aet, FU	39.35	(36.04 to 42.66)	<0.0001	<0.5402
	Average SL + 8 weeks		39.14	(35.81 to 42.47)	<0.0001	
Internal rotation (°)	Average	Sex, DM, Age, Aet, SL, FU	39.05	(35.50 to 42.61)	<0.0001	
	Male	DM, Age, Aet, SL, FU	37.98	(34.09 to 41.87)	<0.0001	<0.3324
	Female		40.12	(35.70 to 44.55)	<0.0001	
	Nondiabetic	Sex, Age, Aet, SL, FU	41.91	(39.23 to 44.60)	<0.0001	<0.0869
	Diabetes		36.19	(29.90 to 42.48)	<0.0001	
	Primary AC	Sex, DM, Age, SL, FU	45.23	(41.88 to 48.58)	<0.0001	<0.0001
	Secondary AC		32.87	(27.63 to 38.11)	<0.0001	
	Average age	Sex, DM, Aet, SL, FU	39.05	(35.50 to 42.61)	<0.0001	<0.0502
	Average age + 10 years		36.55	(32.04 to 41.05)	<0.0001	
	Average SL	Sex, DM, Age, Aet, FU	39.05	(35.50 to 42.61)	<0.0001	<0.5293
	Average SL + 8 weeks		38.82	(35.25 to 42.39)	<0.0001	

Aet, Aetiology; DM, diabetes mellitus; FU, follow-up; AC, adhesive capsulitis; SL, symptom length; CI, confidence interval.

Table 8. Adjusted analyses of long-term post-manipulation under anaesthesia Oxford Shoulder Scores.

Comparison	Adjusted	Change	95% CI	p	p(difference)
Average	Sex, DM, Age, Aet, SL, FU	7.68	(6.50 to 8.85)	<0.0001	
Male	DM, Age, Aet, SL, FU	7.1	(5.86 to 8.34)	<0.0001	<0.0559
Female		8.26	(6.87 to 9.65)	<0.0001	
Nondiabetic	Sex, Age, Aet, SL, FU	8.11	(7.38 to 8.84)	<0.0001	<0.4286
Diabetes		7.24	(5.11 to 9.37)	<0.0001	
Primary AC	Sex, DM, Age, SL, FU	8.3	(7.21 to 9.38)	<0.0001	<0.0952
Secondary AC		7.06	(5.43 to 8.69)	<0.0001	
Average age	Sex, DM, Aet, SL, FU	7.68	(6.50 to 8.85)	<0.0001	<0.1423
Average age + 10 years		7.15	(5.72 to 8.58)	<0.0001	
Average SL	Sex, DM, Age, Aet, FU	7.68	(6.50 to 8.85)	<0.0001	<0.1512
Average SL + 8 weeks		7.53	(6.35 to 8.70)	<0.0001	

Aet, Aetiology; DM, diabetes mellitus; FU, follow-up; AC, adhesive capsulitis; SL, symptom length; CI, confidence interval.

groups. However given the small sample size, the results should be taken with caution. A Cochrane review on arthrographic distension for adhesive capsulitis found only five trials with 196 patients in total.¹³ Because of the small number of studies with few patients and varying methodology, it was not possible to conclude that it was better than any other intervention.

Arthroscopic capsular release is more expensive and invasive than MUA and can on occasion be difficult to achieve as a result of the restricted space in the glenohumeral joint when trying to avoid damage to the articular cartilage.³ Ogilvie-Harris¹⁴ showed arthroscopic release to have significant improvement in pain, function and movement at 1- to 5-year follow-up and Pearsall¹⁵ showed significant improvement in pain and range of motion in 43 patients with primary and secondary adhesive capsulitis who had an average duration of symptoms of 1 year, despite at least 12 weeks of conservative therapy. However, with open surgery, it is technically more difficult to achieve complete posterior release and this can be associated with greater postoperative pain, longer hospital stay and a reduced range of motion.¹⁶

Further investigations using arthroscopy after MUA in other groups have revealed iatrogenic pathology such as capsular rupture, tendon, ligament and labral tears and one small osteochondral defect.¹⁷ However, it is not possible to attribute all these features to MUA because the pathologies may have been unrecognized prior to MUA. Further study is certainly warranted to establish any potential causation.

There are few studies of MUA for adhesive capsulitis with a long-term follow-up or with large patient numbers; from the literature review, it appears that we have the largest cohort size. A 10-year follow-up study by Reeves of 41 patients showed that 25 had a permanent loss of movement, although only three had a functional loss.¹⁸ Hill and Bogumill followed up 17 patients with manipulated shoulders for a mean of 22 months and found that 70% were able to return to work in less than 6 months with improved ROM and no complications.¹⁹ Placzek *et al.* followed up 31 patients who had undergone translational manipulation over 14 months and reported an improvement of flexion by 63°, external rotation by 58° and internal rotation by 47°. ²⁰ Shaffer's mean follow-up of 7 years on the natural history of 62 patients with objective and subjective assessments showed that 50% had either mild pain or stiffness of the shoulder or both, whereas 60% showed some restriction of motion compared to control values.² External rotation was most affected when restriction of movement was present.

Our study shows that MUA resulted in clinically relevant and statistically significant improvements in both functional (OSS) and ROM measures in patients with

adhesive capsulitis over the short- and long-term. Differences in the efficacy of MUA as a result of covariates only resulted in small changes, suggesting that MUA was beneficial to all. The long-term outcome as measured by OSS at a mean follow-up of just over 3.5 years shows persistent improvement, although the natural history of this condition (i.e. resolution) within this time frame will also contribute to this. Furthermore, we observed no adverse effects with MUA, and a small revision rate, suggesting that this is a safe and effective treatment for primary and secondary adhesive capsulitis. Although no routine ultrasound scan was performed pre- or post-MUA, clinical examination of the shoulders was our screening tool for further imaging, if warranted.

Crude data from Tables 1 to 3 show that there is a substantial improvement in functional scores over the short-term (97%) compared to pre-operatively (36%) and that this improvement is sustained (92%). Indeed, the patients who are minimally affected functionally increased at the long-term follow-up from 78% to 86%. With such a high proportion of patients at the satisfactory end of the OSS scale, a ceiling effect is reached, making discrimination among subjects very difficult. The breakdown of the results into primary and secondary adhesive capsulitis shows that both achieved substantial improvement over the short-term and that this was sustained over the long-term follow-up, thus confirming the efficacy of the MUA for both causes of adhesive capsulitis.

Sex differences in the efficacy of MUA as measured by OSS and ROM were observed in minimally adjusted analyses of OSS and flexion and extension in ROM. However, ROM sex differences were attenuated after more complete adjustment for covariates.

Patients with a secondary adhesive capsulitis reported slightly smaller functional (OSS) improvement following MUA than those with primary causation. Although these results are not statistically significant, they are approaching significance. Correspondingly, differences between primary and secondary adhesive capsulitis and change in ROM (Table 7) indicate less favourable outcomes in all planes of movement. It is currently unclear why patients with secondary causes of adhesive capsulitis have slightly worse functional outcomes. This difference may be attributed to a different pathological process in primary versus secondary frozen shoulder or perhaps the speed of symptom progression, which may be related to a trauma-based aetiology. Further subgroup analysis of the secondary capsulitis may reveal one aetiology causing more severe symptoms, although the numbers involved in the present study are too small to enable sufficient power to allow accurate statistical analysis of this position.

Diabetes is strongly associated with adhesive capsulitis. In the present study, the prevalence of diabetes

was 12.4%, which is in keeping with previously published studies.^{21–24} Diabetics are reported to account for 42% of patients with bilateral adhesive capsulitis and they tend to have more severe forms, which are difficult to treat.^{25,26} However, in this cohort, there was no difference in the improvement in OSS but a significantly decreased improvement in rotation between diabetics and nondiabetics, which is consistent with other reports²⁷ and suggests that diabetes is not a contraindication for MUA. A further analysis into the effect of diabetes from this study group has already been published.⁵ There was significant improvement in ROM and OSS ($p < 0.001$) following MUA of diabetic shoulders. However during the 10 years of the study, 36% required a repeat MUA versus 15% for nondiabetic shoulders. Following the revision MUA, 85% of the shoulders were successfully treated.

Symptom severity and duration before MUA has been reported to modify the efficacy of MUA.²⁸ However, we observed no difference in the efficacy of MUA with an extended symptom length prior to MUA. Adapting our raw OSS into a four-tier OSS grading system (satisfactory 40 to 48; mild 30 to 39; moderate 20 to 29; severe 0 to 19) suggests that, pre-operatively, the majority of our patients fall into the moderate category, which is not dissimilar from their cohort, and end up with a normal OSS postoperatively. This same study group has analyzed the effect of the timing of MUA on outcome further and has shown that the benefit of MUA is independent of the duration of symptoms, such that prolonging conservative management is not detrimental to the final outcome.⁴

Given that we had quite a broad age range (25 years to 81 years), we were surprised that age did not make a significant difference to outcome over the short- or long-term, albeit that the younger age group tended to include the diabetic patients. This has not been analyzed further.

Complications such as fracture of the humeral neck, dislocations and neurological injuries have been reported previously,²⁸ whereas no adverse effects or complications were observed in this cohort. Although the lack of complications may represent the cohort characteristics or the severity of adhesive capsulitis prior to MUA, we do not consider that this is the case as a result of the broad patient mix observed. We consider the most likely explanation for the lack of complications is surgical experience, particularly care in performing the procedure in the elderly or osteoporotic patient.

The strengths of the present study include the large number of sequential patients, allowing a meaningful statistical comparison and the uniformity of technique as it was a single surgeon series. There was a very low loss to follow-up or loss of data over the short-term.

Manipulation under anaesthesia of adhesive capsulitis is our chosen technique because it is the simplest, safest and cheapest method of obtaining capsular release, as demonstrated by our zero complication rate. The local anaesthetic and steroid injection into the joint ensured that the procedure was well tolerated by the patients.

We recognize that the present study has a number of limitations, including admission as a day case and administration of a general or regional anaesthetic. MUA was performed by a single surgeon; therefore, the results may not be reproducible by other surgeons. However, a single surgeon, single institution eliminates inter-observer error and helps reduce the intra-observer error. ROM was measured pre- and post-manipulation perioperatively. The length of symptoms may be an inaccurate value because it is dependent on accurate patient recollection. Some patients recollect the point at which the shoulder became painful, whereas others remember the point when their shoulder function was significantly impaired (pain and stiffness). We assumed that all patients were in at least stage 2 of the disease, although some with longer pre-operative symptoms may have been in stage 3.

The ROM was not recorded at follow-up, although we consider that the functional questions from the OSS give a good indication of the restriction of movement. The lack of imaging postoperatively to check for iatrogenic rotator cuff injury may be considered as a drawback but it was not clinically warranted for any of our patients.

Long-term data collection differed from the short-term data (i.e. telephone versus face-to-face respectively) and patients may have felt it easier to give a more honest opinion in the former. Although this may account for a small attenuation in the efficacy of OSS seen between short- and long-term assessment, we consider it unlikely to explain all of the reduction in OSS observed. We were only able to collect 80% of the long-term follow-up data at 3.5 years, despite the attempts made by letter and telephone, probably as a result of a transient population. We consider that 20% loss to follow-up is comparable and better than many studies of a similar size and duration. No control group was used, although this is justified because the present study investigated the factors affecting the outcome of MUA rather than comprising a comparison of MUA with other methods of treatment.

Conclusions

MUA is a safe and effective treatment for all groups of patients presenting with adhesive capsulitis. Although

there may be some gender differences in outcome, and a trend for primary adhesive capsulitis to do better than secondary adhesive capsulitis, all groups do well, and this improvement is maintained over the long-term. Diabetics have a higher rate of revisions than nondiabetics, yet they still receive short- and long-term benefits from MUA. Therefore, we would recommend that MUA be performed on any patient with adhesive capsulitis provided that they are fit for a general anaesthetic because an improvement in their subjective and objective shoulder function can be anticipated over the short-term (within 1 month) and maintained over the long-term.

Conflicts of interest

None declared

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