

Outcome of manipulation under anesthesia with or without intra-articular steroid injection for treating frozen shoulder

A retrospective cohort study

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Abstract

Manipulation under anesthesia (MUA) combined with intra-articular steroid injection (ISI) is preferred in management of the refractory frozen shoulder (FS). This study aimed to evaluate the effect of MUA with ISI or not on pain severity and function of the shoulder.

Data on 141 patients receiving MUA with primary FS refractory to conservative treatments for at least 1 month were retrospectively obtained from medical records. We performed propensity score matching analysis between patients receiving MUA only and those receiving MUA plus ISI, and then conducted logistic regression analysis to identify the risk factors for the need to other treatments during 6-month follow-up.

More improvement in terms of the SPADI pain scores and passive ROM at 2 weeks after first intervention remained in patients receiving MUA plus ISI after matching. The need to other treatments during 6-month follow-up occurred in 10.6% patients (n = 141). Logistic regression analysis revealed that a repeat MUA 1 week after first intervention was a protective factor (OR 0.042; 95% CI 0.011–0.162; *P* = .000) and duration of disease was the only one risk factor (OR 1.080; 95% CI 1.020–1.144; *P* = .008) for the need to other treatments during follow-up.

ISI immediately following MUA provided additional benefits in rapid relief of pain and disability for patients with refractory FS. Pain and disability of the shoulder may be rapidly alleviated by an earlier MUA from the onset of the symptoms and a repeat MUA 1 week after first intervention.

Abbreviations: CI = confidence intervals, FS = frozen shoulder, GIC = the patients' global impression of change, ISI = intra-articular steroid injection, MUA = manipulation under anesthesia, OR = odd ratios, ROM = range of motion, SPADI = the shoulder pain and disability index.

Keywords: frozen shoulder, intra-articular steroid injection, manipulation, outcome

1. Introduction

Frozen shoulder (FS), also known as adhesive capsulitis, is one common condition characterized by pain and reduction of the

range of motion (ROM), frequently accompanied by disability to work and disrupted sleep, with up to 5% of prevalence in the general population.^[1,2] This condition is often self-limited, but in some patients, it can persist for years with the outcome of never regaining full function of the shoulder.^[2,3] The pathogenesis of the primary FS remains elusive.^[1–4] Inflammation, fibrosis, and capsular contraction are linked to explain the symptoms of pain and stiffness of the shoulder.^[1,5,6]

Various therapeutic measures are available for treatment of the FS, including conservative treatments as physiotherapy, pain killers, acupuncture and intra-articular steroid injection (ISI), and non-conservative treatments as manipulation under anesthesia (MUA) and arthroscopic capsular release, of which the most effective treatment is still uncertain.^[1,2,7] MUA may be the most commonly used non-conservative treatment option for the refractory FS with good clinical outcome.^[8,9] Physiotherapy, analgesics, and ISI are the mainstay of the conservative treatment options before MUA. ISI is generally accepted as an effective treatment in the painful inflammatory stage for pain relief.^[7,10,11] The combination of ISI and MUA may be a preferred choice for some physicians in clinical management of the refractory FS. However, the potential benefit of the addition of ISI to MUA is unclear. Thus, we performed a retrospective cohort study with propensity score-matched analysis to evaluate the effect of MUA with ISI or not on pain severity and function of the shoulder in patients with FS.

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2. Materials and methods

2.1. Study design

This retrospective cohort study was approved by the Ethics Committee of Jining No.1 people's hospital on May 14, 2019 (#2019-009). The informed written consent was waived due to the retrospective nature of the study design. We retrospectively reviewed medical records of 203 consecutive patients with FS who received MUA between January 2015 and December 2018. Of these patients, 11 patients with bilateral involvement were excluded, 23 patients with incomplete preoperative and/or follow-up data were excluded, and 28 patients were excluded due to secondary FS, such as osteoarthritis, calcific tendinopathy, rotator cuff rupture, or rheumatic diseases. The remaining 141 patients with the diagnosis of primary FS were allocated into MUA only (group M, 60 cases) and MUA plus ISI (group MS, 81 cases). Patients who had a fasting blood glucose level ≥ 8.0 mmol/L or was unwilling to steroid administration received MUA only. Forty-four patients in each group were included through a propensity score matching analysis for an unbiased comparison (Fig. 1).

2.2. Inclusion and exclusion criteria

The inclusion criteria were

1. at least a 1-month history of unilateral shoulder pain and stiffness with normal imaging studies,
2. the passive shoulder movement with a reduction of $>30^\circ$ in at least two planes (flexion, abduction, and external rotation) when compared with the opposite side, and
3. refractory to at least a 1-month conservative treatments, such as medications, stretching techniques, acupuncture, and/or steroid injection.

The imaging studies of plain radiography, ultrasonography, and/or magnetic resonance imaging were applied to detect secondary causes for painful stiffness of the shoulder. The exclusion criteria included secondary FS, age <40 or older than 70 years, infection at the site of injection, oral corticosteroid, severe cardiac or pulmonary dysfunction, and gastrointestinal ulcers.

2.3. Treatment protocol

MUA is to stretch and tear the adhesive capsule of the shoulder. In our pain center, the manipulating procedure for treatment of the FS is simple, only manual abduction of the affected-side upper limb on the anatomic plane to the extent as the contralateral done. Briefly, face to face with the patient who was placed in a supine position with the affected side at the side close to bed edge, the therapeutic physician gripped and pushed cephalad the distal humerus of the patient using one hand, and meanwhile pressured on the outer aspect of the proximal humerus of the patient using the other hand to prevent the complication of dislocation. Before manipulation, cervical nerve root block was performed first with the patient placed in a supine position, identifying the transverse of the sixth cervical vertebra (C6) by palpating or under the guidance of ultrasound and injecting 1% lidocaine 10 mL around the C6 nerve root. Manipulation was started 10 min after NRB. A typical cracking sound or characteristic feeling of adhesive tissue breakdown in the shoulder during manipulation was frequently reported, and as a sign to confirm the diagnosis of FS. Patients in group MS also received an ISI immediately following MUA. ISI was performed using a 21G yellow needle with triamcinolone acetonide 20 mg in 0.5% lidocaine 10 mL, through a lateral approach by palpating and marking anatomic landmarks, under aseptic conditions with the patient in a sitting position. Passive stretching exercises were commenced immediately following MUA and active self-exercises such as wall climbing movements maintained daily for the next week. If insufficient control of painful stiffness were reported on the visiting at 1 week after first intervention, a repeat MUA was provided. Insufficient control was defined as a score of the patients' global impression of change (GIC) ≤ 3 . All patients were discharged home 30 min after intervention without events. All patients were allowed to use pain killers on need during the next week after intervention.

2.4. Data collection

Baseline demographic and clinical patient data were collected and analyzed from the medical records. At inclusion (baseline) and each subsequent visiting on 1, 2, and 4 weeks after first intervention, pain intensity and shoulder function were evaluated by the shoulder pain and disability index (SPADI); and passive ROM was measured upon flexion (the arm at the side lifted in the sagittal plane), abduction (the arm at the side lifted in the coronal plane), external rotation (the arm at the side with the elbow in 90° flexion rotated externally in the axial plane) and internal rotation (the highest spinous process touched by the tip of the thumb: 1 = the level no higher than the coccyx [S5], 2 = the level no higher than the middle of the sacrum [S3], 3 = S1, 4 = L1, 5 = L2, 6 = L3, 7 = L4, 8 = L5, 9 = T12 and 10 = the level no lower than T11). Clinical improvement was assessed using a 4-point Likert scale of the GIC (1 = much improved; 2 = slightly improved; 3 = no improved; 4 = worse), at each subsequent visiting on 1, 2, and 4 weeks after first intervention, and on 3- and 6-month follow-up by phone. Furthermore, other parameters were also recorded, including a repeat MUA 1 week after first intervention, treatment-related adverse events, and other treatments applied during 6-month follow-up, such as acupuncture, stretching techniques, and/or arthroscopic capsular release.

2.5. Statistical analysis

All statistical testing was performed using SPSS (version 19.0; SPSS Inc). Data normality was evaluated using the

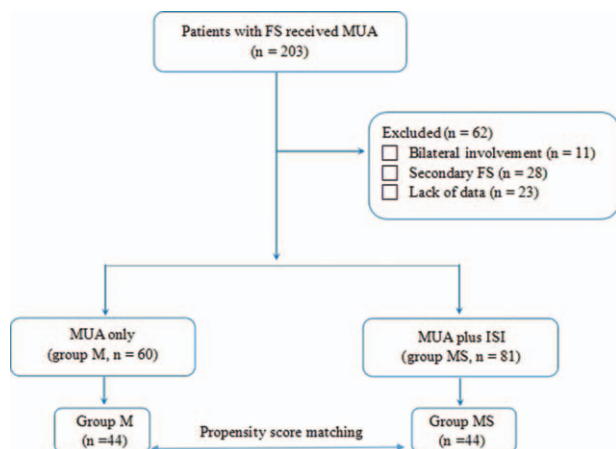


Figure 1. Flowchart of patient enrollment. FS=frozen shoulder, ISI=intra-articular steroid injection, MUA=manipulation under anesthesia.

Kolmogorov–Smirnov test. Data were expressed as means \pm standard deviation (SD) for quantitative variables (age, duration of disease, etc), number (%) for categorical variables (gender, the side of the affected shoulder, etc), or median (interquartile range, IQR) for ordinal variables (the ROM upon internal rotation and the GIC). Propensity score matching analysis was used to allow an unbiased comparison. Propensity score was calculated by logistic regression analysis using age, gender, duration of disease, diabetes mellitus, and the SPADI total score at inclusion as independent variables. A 1:1 match was achieved using the nearest neighbor-matching algorithm with a caliper definition of 0.02. The unpaired Student's *t* test, Mann–Whitney *U* test, and Chi-square test or Fisher's exact test was performed for statistical analysis when appropriate. In addition, a logistic regression analysis was conducted to identify risk factors for the need to the other treatments during 6-month follow-up. Odd ratios (OR) and 95% confidence intervals (CI) were calculated as estimates of relative risk. $P < .05$ was considered statistically significant.

3. Results

3.1. Demographic and intervention characteristics

Despite remarked difference was observed in age and pre-existing diabetes before propensity score matching, the difference was eliminated after matching. A repeat MUA was performed in a minority of patients with an overall incidence of 18.6%. Dislocation of the shoulder during MUA occurred in only one patient, who received immediately a manual reposition and recovered without negative results. No fracture or nerve injury occurred in any patient (Table 1).

3.2. Pain, disability, and ROM of the shoulder

There were no significant differences in the SPADI scores (including pain, disability, and total scores) and passive ROM degrees upon flexion, abduction, and external and internal rotation at inclusion (baseline) between the two groups, whether propensity score matching or not. Compared to baselines, all these parameters were improved in both groups following intervention. Before matching, less improvement was observed in group M in terms of the SPADI pain scores at 1 and 2 weeks after first intervention, the SPADI disability scores at 2 weeks after first intervention, the SPADI total scores at 1 and 2 weeks after first

intervention, and passive ROM degrees upon abduction at 1, 2, and 4 weeks after first intervention, upon external rotation at 2 and 4 weeks after treatment and upon internal rotation at 2 weeks after first intervention. After matching, more improvement remained in group MS regarding the SPADI pain scores at 2 weeks after first intervention, and passive ROM degrees upon abduction at 2 weeks after first intervention and upon external rotation at 2 and 4 weeks after first intervention (Tables 2 and 3).

3.3. Clinical improvement and application of other treatments during follow-up

Although there was significant difference in the GIC score at 2 weeks after first intervention before matching, no difference was observed after matching. The GIC scores were comparable at 4 weeks after first intervention, and 3- and 6-month follow-ups between groups, whether propensity score matching or not. During follow-up, mainly within 3-month follow-up, some patients in each group still received other treatments such as acupuncture and/or stretching techniques, but none received arthroscopic capsular release. The number of patients who received other treatments during follow-up was comparable between groups, with an overall incidence of 10.6% (Table 4).

On logistic regression analysis for the entire cohort, duration of disease was the only one risk factor for the need to other treatments during follow-up (OR 1.080; 95% CI 1.020–1.144; $P = .008$), and a repeat MUA was associated with a decreased likelihood for the need to other treatments during follow-up (OR 0.042; 95% CI 0.011–0.162; $P = .000$).

4. Discussion

This retrospective study compared the outcome of MUA plus ISI with MUA alone in pain relief and functional improvement in patients with FS. Both the entire cohort and the propensity score-matched cohort analysis showed that MUA plus ISI was more rapid to reduce pain and to increase the ROM than MUA alone. However, the GIC scores indicated an equivalent clinical improvement between the two regimens after matching.

FS remains a poorly understood condition. Although described as inflammatory adhesion or contraction of the articular capsule,^[1,5,6] the exact mechanism underlying the FS is still elusive. It is regarded traditionally as a self-limiting and benign disease, but can last with pain and disability for months or

Table 1
Demographics and intervention characteristics.

Variable	Before matching			After matching		
	Group M (n=60)	Group MS (n=81)	<i>P</i>	Group M (n=44)	Group MS (n=44)	<i>P</i>
Age, years	53.0 \pm 5.5	55.1 \pm 6.4	.043	52.5 \pm 5.3	53.4 \pm 5.9	.449
Male, n (%)	26 (43.3)	33 (40.7)	.758	18 (40.9)	18 (40.9)	1.000
Right shoulder affected, n (%)	24 (40.0)	28 (34.6)	.509	18 (40.9)	10 (22.7)	.067
Duration of disease, weeks	17.7 \pm 9.2	18.9 \pm 9.8	.489	17.2 \pm 8.7	17.8 \pm 9.8	.747
Comorbidities						
Diabetes mellitus, n (%)	21 (35.0)	16 (19.8)	.042	10 (22.7)	10 (22.7)	1.000
Hypothyroidism, n (%)	0 (0)	1 (1.2)	1.000	0 (0)	0 (0)	1.000
Repeat MUA, n (%)	14 (23.3)	16 (19.8)	.608	6 (13.6)	8 (18.2)	.560
Adverse events						
Dislocation, n (%)	0 (0)	1 (1.2)	1.000	0 (0)	1 (2.3)	1.000

Data are present as mean \pm standard deviation or number (%). Group M, MUA only; Group MS, MUA plus ISI. ISI=intra-articular steroid injection, MUA=manipulation under anesthesia.

Table 2
SPDI of the affected shoulder between two groups.

Variable	Time points	Before matching			After matching		
		Group M (n=60)	Group MS (n=81)	P	Group M (n=44)	Group MS (n=44)	P
Pain	At inclusion	60.4 ± 11.6	58.3 ± 14.8	.357	58.2 ± 10.6	60.6 ± 14.2	.360
	1 week after first intervention	39.9 ± 12.0	32.5 ± 11.2	.001	36.4 ± 9.2	31.4 ± 10.3	.018
	2 weeks after first intervention	33.5 ± 10.9	29.6 ± 10.3	.034	30.7 ± 9.4	29.3 ± 9.5	.493
	4 weeks after first intervention	23.3 ± 10.1	20.5 ± 10.1	.104	21.3 ± 9.0	20.7 ± 8.7	.746
Disability	At inclusion	66.5 ± 12.2	65.4 ± 11.0	.590	66.2 ± 11.9	67.0 ± 10.7	.725
	1 week after first intervention	40.1 ± 13.6	37.1 ± 12.0	.164	37.7 ± 12.3	37.5 ± 12.4	.940
	2 weeks after first intervention	35.7 ± 13.5	30.0 ± 11.7	.009	32.6 ± 11.5	29.9 ± 11.4	.261
	4 weeks after first intervention	29.1 ± 12.7	25.6 ± 12.6	.104	26.6 ± 11.2	25.8 ± 10.9	.746
Total	At inclusion	64.1 ± 7.9	62.7 ± 8.5	.307	63.1 ± 7.7	64.5 ± 8.2	.389
	1 week after first intervention	39.7 ± 10.9	35.3 ± 9.7	.014	37.2 ± 8.9	35.1 ± 10.3	.321
	2 weeks after first intervention	34.8 ± 10.7	29.9 ± 9.2	.004	31.9 ± 8.3	29.7 ± 9.3	.238
	4 weeks after first intervention	26.9 ± 11.7	23.6 ± 11.7	.104	24.6 ± 10.3	23.9 ± 10.1	.746

Data are present as mean ± standard deviation. Group M, MUA only; Group MS, MUA plus ISI.

ISI=intra-articular steroid injection, MUA=manipulation under anesthesia, SPADI=the shoulder pain and disability index.

years.^[2,3] Early recovery from the FS is essential to improve the patients' quality of life. MUA is generally considered as an option when conservative treatments fail.^[12] Excellent outcomes were found following MUA in short- and long-term follow-ups.^[13,14] MUA is time-efficient and relatively easy, by stretching and tearing capsular adhesion, thus resulting in rapid improvements of pain and the ROM.^[14,15] Our results demonstrated a rapid pain relief at 1 week after first intervention, similar with that in two previous studies,^[8,16] even one of which reported that pain was relieved at 1 h and 1 day following manipulation, but the rapid relief may be associated with the rotator interval block using bupivacaine and triamcinolone.^[16] A rapid increase of the ROM following MUA was also demonstrated in the present study. A remarked improvement was reported overall in 66% patients (n=141) at 1 week after first intervention, 72.3% at 2 weeks after first intervention and 89.4% at 4 weeks after first intervention. Additionally, our results demonstrated a relatively constant efficacy between 1 and 3 months after MUA. This constant efficacy and the early improvement of ROM following MUA also been demonstrated by Tsvieli et al.^[17]

ISI has long been used to treat FS with satisfactory short-term results.^[10,11,18] It is useful to reduce pain and disability, mainly in the painful freezing stage.^[7,10,11] It attributes to the anti-inflammatory action of steroids by activating glucocorticoid receptors and inhibiting the function of inflammatory mediators,^[19] thereby decreasing synovitis and peri-articular fibrosis. MUA involves passive tearing of the capsular adhesion, which causes traumatic inflammation and reactive pain aggravation. Theoretically, an ISI is helpful to alleviate the pain aggravation and to inhibit the return of the capsular adhesion following MUA. The combination of ISI and MUA may be preferred in clinical practice, as showed in multiple previous studies,^[8,9,13,14,16,17,20] which rarely explored the additional benefits of ISI on the outcome following MUA. In this study, patients receiving MUA plus ISI had less pain at 1 and 2 weeks after first intervention, less disability at 2 weeks after first intervention, and more increase of the ROM upon abduction at each subsequent visiting, external rotation at 2 and 4 weeks after first intervention, and internal rotation at 2 weeks after first intervention. Notably, to some extent, the benefits of ISI were still observed for pain and

Table 3
ROM of the affected shoulder between two groups.

Variable	Time points	Before matching			After matching		
		Group M (n=60)	Group MS (n=81)	P	Group M (n=44)	Group MS (n=44)	P
Flexion, °	At inclusion	107.1 ± 11.4	105.9 ± 11.8	.568	108.5 ± 11.2	105.5 ± 11.0	.215
	1 week after first intervention	134.6 ± 15.4	135.0 ± 14.1	.850	137.8 ± 13.7	135.0 ± 13.6	.333
	2 weeks after first intervention	147.6 ± 14.3	150.7 ± 12.2	.165	150.4 ± 12.8	150.3 ± 11.1	.986
	4 weeks after first intervention	153.1 ± 12.2	156.1 ± 10.8	.126	156.3 ± 10.0	157.2 ± 9.6	.657
Abduction, °	At inclusion	67.1 ± 14.0	66.8 ± 12.4	.915	68.0 ± 13.7	65.2 ± 11.5	.307
	1 week after first intervention	112.1 ± 15.8	121.6 ± 12.6	.000	115.4 ± 14.4	120.5 ± 12.5	.080
	2 weeks after first intervention	116.2 ± 16.2	127.9 ± 12.8	.000	119.4 ± 14.2	126.8 ± 11.7	.009
	4 weeks after first intervention	132.7 ± 16.1	138.9 ± 12.2	.014	136.3 ± 14.1	137.3 ± 10.5	.707
External rotation, °	At inclusion	30.6 ± 11.3	30.7 ± 10.9	.939	31.1 ± 10.9	29.9 ± 10.5	.619
	1 week after first intervention	41.9 ± 12.2	45.4 ± 11.7	.092	44.7 ± 10.6	45.3 ± 11.3	.800
	2 weeks after first intervention	51.4 ± 7.5	58.4 ± 7.6	.000	53.5 ± 6.6	58.1 ± 7.3	.002
	4 weeks after first intervention	61.4 ± 7.2	69.4 ± 8.5	.000	63.8 ± 5.8	69.2 ± 7.9	.000
Internal rotation	At inclusion	2 (2–2)	2 (2–2)	.084	2 (2–2)	2 (2–2)	.845
	1 week after first intervention	6 (4–8)	7 (5–8)	.101	7 (5–8)	6.5 (5–8)	.688
	2 weeks after first intervention	7 (7–8)	8 (7–9)	.005	8 (7–8)	7 (8–10)	.184
	4 weeks after first intervention	9.5 (8–10)	10 (9–10)	.159	10 (9–10)	10 (9–10)	.880

Data are present as mean ± standard deviation or median (interquartile range). Group M, MUA only; Group MS, MUA plus ISI.

ISI=intra-articular steroid injection, MUA=manipulation under anesthesia, ROM=range of motion.

Table 4
Clinical improvement following treatment and application of other treatments during 6 months follow-up.

Variable	Time points	Before matching			After matching		
		Group M (n=60)	Group MS (n=81)	P	Group M (n=44)	Group MS (n=44)	P
GIC	1 week after first intervention	1 (1-2)	1 (1-2)	.242	1 (1-2)	1 (1-1)	.398
	2 weeks after first intervention	1 (1-2)	1 (1-1)	.036	1 (1-2)	1 (1-1)	.456
	4 weeks after first intervention	1 (1-1)	1 (1-1)	.359	1 (1-1)	1 (1-1)	.977
	3-month follow-up	1 (1-1)	1 (1-1)	.331	1 (1-1)	1 (1-1)	.670
	6-month follow-up	1 (1-1)	1 (1-1)	.099	1 (1-1)	1 (1-1)	.317
	GIC sore=1, n (%)	1 week after first intervention	37 (61.7)	56 (69.1)	.355	32 (72.7)	35 (79.5)
GIC sore=1, n (%)	2 weeks after first intervention	38 (63.3)	64 (79.0)	.040	32 (72.7)	35 (79.5)	.453
	4 weeks after first intervention	52 (86.7)	74 (91.4)	.372	41 (93.2)	41 (93.2)	.672
	3-month follow-up	52 (86.7)	74 (91.4)	.372	42 (95.5)	41 (93.2)	1.000
	6-month follow-up	58 (96.7)	81 (100)	.098	43 (97.7)	44 (100)	1.000
Other treatment during follow-up, n (%)		8 (13.3)	7 (8.6)	.372	2 (4.5)	3 (6.8)	1.000

Data are present as median (interquartile range) or number (%). Group M, MUA only; Group MS, MUA plus ISI.

GIC, the patients' global impression of change, ISI=intra-articular steroid injection, MUA=manipulation under anesthesia.

the ROM after matching. The additional benefits of steroid injection were also demonstrated by McKean et al,^[16] who evaluated the outcome following MUA under the rotator interval block using bupivacaine and triamcinolone for treatment of the FS. Even a previous study showed that an ISI just before an arthroscopic capsular release improved the ROM upon flexion and pain at 3-month follow-up in non-diabetic patients with refractory FS.^[21] Nevertheless, an earlier previous study with a randomized design denied the benefit of the additional ISI, but which only reported the ROM at 1 day and 4 months after MUA with a small sample (about 10 cases in each group).^[22] Additionally, as mentioned in previous studies,^[10,23,24] there are side effects and potential complications associated with the ISI. However, the data of minor transitory side effects such as facial flushing, rash, after-pain, nausea and dizziness was lack in our medical records, and all patients recovered without the complication of infection.

It is unknown about the indications for MUA. The best time for MUA had been suggested to be between 6 and 9 months from the onset of the symptom when conservative management failed.^[25] The failure of conservative management is not clearly defined. The minimal duration of symptoms required in the literature was different, varying from 1 to 6 months.^[26] Early recovery from pain and disability is expected by patients. In our pain center, MUA was performed 1 month later if conservative management failed, and repeated on the next week visiting if a poor response following the initial treatment. In this study, no significant difference was observed in patients receiving repeat MUA between groups, and the overall incidence of repeat MUA was 21.3% (n=141), similar with the results from two previous studies.^[20,27] Woods et al^[20] reported an incidence of 17.8% for a repeat MUA at 3 weeks after the initial intervention. Jenkins et al^[27] described that a repeat MUA was performed at an average of 3 weeks (range, 2–10 weeks) after the initial intervention for 14 of 39 shoulders in diabetic patients and 42 of 274 shoulders in non-diabetic patients (an overall incidence of 17.9%) with a successful rate of 85%. Interestingly, we found that a repeat MUA was a protective factor for the need to other treatments during 6-month follow-up due to insufficient control. This also demonstrated the potential benefits of a repeat MUA when patients were dissatisfied with improvement of pain or the ROM following the initial intervention.

As our results showed, 10.6% patients (n=141) still received other treatments during 6-month follow-up due to insufficient control. Our analysis showed that duration of disease was associated with an increased risk for the need to other treatments during follow-up. Previous studies also found that duration of disease modified the efficacy of MUA.^[28,29] Rizvi et al^[30] reported that more improvement upon internal rotation was made following arthroscopic capsular release in patients with a duration of symptoms <10 months than those with a longer duration of symptoms and suggested that there was no reason to delay surgery. An earlier previous study also demonstrated that patients with a duration of symptoms <9 months had a better functional score following MUA at final follow-up.^[29] Diabetes is identified as a precipitating factor for resistance to conservative treatments or MUA and the need to multiple surgical interventions.^[31–33] In our opinion, diabetes may be a risk factor for the need to other treatments due to poor outcome following MUA. However, its association with the need to other treatments during follow-up was not demonstrated on our logistic regression analysis. Similar results were reported in a previous study,^[14] which found no significant difference in the short- (post-surgery 3 weeks) and long-term (post-surgery 95 months) outcomes between diabetic and non-diabetic patients. Secondary FS is also identified as a potential risk factor for poor outcome following MUA,^[30] but only patients with primary FS were included in this study.

The present study had several limitations. First, this was a single-center retrospective study. The small sample maybe reduce the power to detect clinical differences due to confounding factors, despite a propensity score matching analysis was made. In our practice, diabetic patients with poor blood sugar control were susceptible to obtain MUA only. A subgroup analysis involved diabetic patients with poor blood sugar control was not feasible due to a lack of detailed data about blood sugar levels in this study. A previous study found no significant difference in the short-term (post-surgery 3 weeks) outcome following MUA between patients with poor blood sugar control and those with good blood sugar control around manipulation.^[14] Secondly, the manipulating procedure varies in different institutes as described in a review study.^[26] In this study, the manipulating technique was simple, only abducting manually the shoulder to the extent as the opposite side done. Thirdly, manipulation can be performed under general anesthesia, brachial plexus block, or cervical root nerve block as described in a previous review.^[26] Nerve block

provides not only pain relief during manipulation, but also prolonged analgesia for passive and/or active exercise that immediately commenced following intervention. Fourthly, self-exercise or physiotherapy is commonly included as a part in daily management of the FS. It could also play an important role in maintenance and improvement of the ROM achieved during the manipulation with a potential preventive effect on the rapid relapse of the capsular adhesion. In addition, MUA is not generally accepted in management of the FS. Some clinicians have an idea of waiting for the FS to open spontaneously without treatment because of its self-limiting nature. The natural history of the FS is relatively long, and it can take one to two years to get full resolution of symptoms in most patients.^[2,3] Rapid improvement in pain and disability with treatment is expected by patients with FS. Therefore, further prospective randomized trials with large samples are warranted to investigate the potential benefits of the addition of ISI to MUA in patients with refractory FS.

5. Conclusion

ISI immediately following MUA provided additional benefits in rapid relief of pain and disability for patients with FS. However, the addition of ISI to MUA did not change clinical outcomes at 3- and 6-month follow-ups. Earlier improvement in pain and function may be achieved by an earlier MUA from the onset of the symptoms and a repeat MUA 1 week after first intervention. The benefit of the addition of ISI to MUA deserves to explore in further clinical controlled trials.

Author contributions

Conceptualization: Chengwen Li.

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