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ORIGINAL PAPER

Manipulation under anaesthesia for frozen shoulder in patients with and without non-insulin dependent diabetes mellitus

Jung-Pan Wang · Tung-Fu Huang · Hsiao-Li Ma · Shih-Chieh Hung · Tain-Hsiung Chen · Chien-Lin Liu

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Abstract Manipulation under anaesthesia (MUA) has been used to speed up recovery. However, the outcome of frozen shoulder after MUA in patients with diabetes has not been well documented in the past. A higher prevalence of frozen shoulder has been reported in diabetes mellitus (DM) patients. In this study, we revealed the short- and long-term outcomes for treatment of frozen shoulders by MUA and compared these results in patients with and without non-insulin dependent DM by adjusted Constant score. The scores showed no significant differences between the two groups at both early and late follow-ups. Our results revealed that MUA for frozen shoulders is a simple and noninvasive procedure to improve symptoms and shoulder function within a short period of time. Even though DM is a predisposing factor to frozen shoulder, non-insulin dependent DM alone does not influence both the short- and long-term outcomes of frozen shoulder.

Introduction

A higher prevalence of frozen shoulder (20–29%) has been reported in diabetes mellitus (DM) patients [2, 14, 17]. However, the outcome of these patients has only been studied previously in Western countries [2, 15]. None have been documented in Asia. Adhesive capsulitis of the shoulder (frozen shoulder) is characterised by a gradual increase in stiffness and pain. This self-limiting disorder has three stages lasting up to one to three years [10, 22] and does not recur in the same shoulder [9]. The aetiology of frozen shoulder is yet to be discovered and excellent results of manipulation under anaesthesia (MUA) have been reported by many authors [7, 13, 15, 18, 24], but few have focussed on patients with DM [12, 15, 17]. Hence, in this study, we compared the objective improvement in range of motion and the subjective improvement in function after MUA in patients with and without non-insulin dependent DM. We revealed the short- and long-term results of frozen shoulder after MUA in patients with and without non-insulin dependent DM and further compared the short-term results in diabetic patients using different blood sugar control.

Each author certifies that he or she has no commercial associations (e.g. consultancies, stock ownership, equity interest, patent/licensing arrangements, etc.) that might pose a conflict of interest in connection with this article.

Level of Evidence: Level IV, prognostic study.

J.-P. Wang · T.-F. Huang (✉) · H.-L. Ma · S.-C. Hung · T.-H. Chen · C.-L. Liu
Department of Orthopaedics & Traumatology,
Taipei Veterans General Hospital and National Yang-Ming University,
Taipei, Taiwan, Republic of China
e-mail: huangtf@vghtpe.gov.tw

Materials and methods

Selection of patients

Between 1992 and 2005, a total of 306 patients with frozen shoulders were admitted for treatment in our hospital, one of the biggest medical centres in Northern Taiwan. We applied criteria by Shaffer et al. for the diagnosis of frozen shoulders [23], which included (1) at least a one-month history of pain and stiffness of the shoulder; (2) documented restriction of both passive and active gleno-humeral and scapulo-thoracic motion of equal to or less than 100 degree of elevation, and less than 50% of external rotation, as compared to the contra-lateral side; and (3) the intra-operative characteristic

feeling of tissue breakdown during manipulation. All patients were initially managed conservatively with medications and stretching techniques, with manipulation started after three months if pain and lost of motion were reported.

Patients were excluded from this study if they had (1) a history of cancer, or rheumatic disease, (2) surgery or suffered trauma, (3) severe neurological deficit of the involved upper extremity, (4) lost follow-ups or incomplete pre-operative data, or (5) regained a range of motion <80%. After selection, 58 cases with 63 frozen shoulders were obtained and evaluated retrospectively. These 63 frozen shoulders were further classified into diabetic and non-diabetic groups according to the system of Zuckerman et al. [25]. Forty-two shoulders were classified in the non-diabetic group. Twenty-one patients were classified in the diabetic group. Patients in the diabetic group had to meet the current WHO criteria [1], with diabetes diagnosed by having two hour plasma glucose ≧200 mg/dl during an 75 g-OGTT. In contrast with Caucasians, the incidence of insulin dependent diabetes mellitus (IDDM) is currently very low in Taiwan [4], which is similar to other Asian countries. Only two patients with type I diabetes were treated with manipulation under anaesthesia and were not included in our study. All 21 patients classified in the diabetic group were NIDDM (non-insulin dependent diabetes mellitus).

Clinical assessment

X-rays were taken in the anteroposterior plane for internal rotation and abduction, and in the axillary plane and supraspinatous-tunnel views to exclude other shoulder disorders. Ultrasound was also performed for all patients. The subjective symptoms and objective findings were graded according to the adjusted Constant score (Constant score after excluding the 25 points for assessment of muscle strength) [6]. The maximum score for pain was 15, with 15 points representing no pain and 0 points being severe, constant pain. A maximum of 20 points were assigned for the ability to carry out daily activities. Flexion, abduction, external rotation, and internal rotation were each given a maximum of 10 points (total maximum score for motion was 40 points). The maximum total score attainable was therefore 75 points.

Technique

All patients received general anaesthesia with intravenous barbiturate given by anaesthetists for the procedure. The technique used for manipulation started with the gradual forward elevation in the sagittal plane to the maximum possible extent while the scapula was fixed. Passive external rotation was then performed in 0° of abduction, followed by external rotation in 90° of abduction. Lastly, internal rotation in 90° of abduction and cross-body adduction were performed. Care was taken not to fracture the humerus during manipulation. Forces for external rotation were applied very carefully by two thumbs. A full range of motion was always achieved. The shoulder joint was injected with 3 ml of bupivacaine and 1 ml of steroid. Five cases (5/68, 7.3%) with refractory frozen shoulder (regained <80% of the range of motion) had subsequent arthroscopic release to avoid intraoperative complication and were not included in our series.

Postoperative treatment

All patients received continuous passive exercise in the ward immediately after the procedure. After discharge, exercise training with a physiotherapist in our outpatient clinic was continued until the range of motion was satisfactory.

After the operation, each case was reviewed at three weeks, three months, six months, and one year and then a final review. Additional visits were arranged if indicated. Each patient had a special chart with detailed records of their personal data, mechanism and associated condition of the injury, classification of the type of frozen shoulder, course of management (including time of treatment, operation course, presence of early and late complications, and management of complications), and course of functional recovery. Measurement of shoulder function was obtained at each follow-up visit with all evaluations and recording done by senior staff. The earliest follow-up was on average three weeks after shoulder manipulation while the longest period was 95 months (range 18–153 months).

Glycosylated haemoglobin (HbA_{1c}) was recorded at three weeks after manipulation at the endocrine outpatient department for each patient. The level of glycosylated haemoglobin (HbA_{1c}) is a useful and reliable marker for glucose metabolism over two to three months. It indicated that we could therefore evaluate the relationship between blood sugar level and the total score before and three weeks after manipulation.

Statistical analysis

The details of patients in both groups were compared between patients with and without diabetes. Unpaired Student's *t*-tests were used for continuous variables including age, duration, BMI, and gender. A p value of less than 0.05 was considered statistically significant. All analyses were performed with the use of SPSS for Windows software (version 13.0).

Results

The average age of the patients at the time of presentation was 55.8 years (range 41–79 years). The group was composed of 23 male and 40 female patients. The average duration from the onset of the disease to manipulation was 7.39 months, with a range from three to 18 months. The minimum follow-up period was 18 months. There were 43 right sided and 20 left sided. Five patients had both shoulders involved, but on different occasions.

Shoulder stiffness noted during anaesthesia and the typical rasping noise occurring during manipulation confirmed the clinical diagnosis of frozen shoulders. All patients had complete functional assessments. These results are summarised in Table 1. The adjusted average Constant score at pre-manipulation was 22.8±4.9 (range 10–31) points. The average follow-up period was 95 months (range 18–189 months). The adjusted Constant score from early follow-up was 23.79±3.46 (range 16–34), and 52.6±9.2 (range 31–67) points on average with 13 shoulders scoring less than 50 points. Adjusted Constant score from late follow-up was on average 72.3±4.26 (58-75) points, with 25 shoulders scoring the maximum of 75 points. However, the results are influenced by the natural course of the disorder if the follow-up period is longer than 12 months. There was no complication after manipulation. Significant improvement was seen three weeks after manipulation and we found a very good early response to manipulation with a rise in adjusted Constant score from the pre-operative median of 30.4% to a post-manipulation of 70.2%.

There were no statistically significant differences preoperatively or postoperatively in age, gender, or duration of symptom of the patients (Table 1). There was no difference in the baseline preoperative scores between the non-insulin dependent diabetic and non-diabetic groups (Table 1). The mean pain score in the non-insulin dependent diabetic group was 12.38±3, and 14.52±1.5 at the early and late follow-ups, respectively, which was not significantly different to the non-diabetic group (Table 2). The mean activity in the non-insulin dependent diabetic group was 14.38±1.49, and 18.85± 1.49 at the early and late follow-ups, respectively, which was not significantly different to the non-diabetic group ($p>0.05$, Student's t-test) (Table 2). The mean ROM score in the non-insulin dependent diabetic group was 29.14± 3.4, and 38.76±1.94 at the early and late follow-ups, respectively, which was also not significantly different from the non-diabetic group ($p>0.05$, Student's t-test) (Table 2). Finally, the total adjusted Constant score at the early and late follow-ups was not significantly different between the non-insulin dependent diabetic and non-diabetic groups ($p>0.05$, Student's t-test) (Table 2). The level of blood sugar around the manipulation may not influence the short-term outcome of frozen shoulders (Table 3). One patient from the non-diabetic group did not show much improvement in range of motion at three weeks follow-up. One shoulder took more than one year before reaching satisfactory outcome, i.e. a spontaneous recovery.

In this series, there were no complications including iatrogenic neurological injury, fracture or dislocation noted. After an average eight-year follow-up, no recurrence was found in non-insulin dependent diabetic and non-diabetic patients.

Table 1 Patient characteristics

Description	Non DM *N* (%) mean ± SD	DM *N* (%) mean ± SD	Statistical significance *p* value
Number	42	21	
Male/female	16 (38.09%) /26 (61.9%)	7 (33.33%) /14 (66.66%)	0.7113
Right/left side	29/13	14/7	0.8482
Mean age (years)	56.24±9.17	55.19±8.41	0.3312
Duration of disease (months)	7.64±3.8	6.9±3.41	0.2281
Body mass index (BMI)	24.06±3.67	24.79±2.58	0.2115
Before-surgery score			
Pain	4.28±2.6	4.04±2.55	0.366
Activity	7.19±1.77	7.23±1.48	0.4579
ROM	12.19±1.38	12.76±1.84	0.0862
Total	23.66±3.36	24.04±3.7	0.3419

DM diabetes mellitus, *ROM* range of motion

*$p\leq0.05$, statistically significant

Statistical method used was the Student's t-test

Table 2 Results after surgery in the two groups

Evaluation	Measurement	Groups		Statistical significance
		Non DM	DM	*p* value
Post-surgery 3 weeks	Pain	12.14±2.5	12.38±3	0.309
	Activity	14.14±1.55	14.38±1.49	0.2821
	ROM	29.61±1.93	29.14±2.72	0.2133
	Total	55.78±3.46	55.9±5.29	0.4574
Post-surgery 95 months	Pain	14.4±1.63	14.52±1.5	0.3905
	Activity	19±1.48	18.85±1.49	0.36
	ROM	38.97±2.19	38.76±1.94	0.3529
	Total	72.38±4.28	72.14±4.3	0.4181

DM diabetes mellitus, *ROM* range of motion

*$p \leq 0.05$, statistically significant

Statistical method used was the Student's *t*-test

Discussion

Untreated frozen shoulders usually resolve naturally within one to three years. The condition of frozen shoulder can lead to severe pain requiring several months of medications and even some restrictions in motion, which implies that the condition itself does not always have a successful long-term outcome [23]. Nevertheless, it has been reported by many authors that this period of disability can be minimised by manipulation under anaesthesia [18].

This study illustrates our experience of the short- and long-term outcomes of treating 63 cases of frozen shoulders with and without diabetes by manipulation under anaesthesia over a mean follow-up period of 95 months. There was no recurrence in the same shoulder in our long-term follow ups. Five out of 58 patients (8.6%) had both shoulders involved at different times. We found that after an average of eight years follow-up, no recurrence was noted in patients with or without diabetes, nor were there severe residual complications of frozen shoulders.

Excellent early response to manipulation was found in short-term follow-ups [24]. Such an improvement has never occurred in untreated frozen shoulders over such a short period of time. In a series reported by Othman and Taylor, the adjusted Constant score at the early follow-up was on average 54.9 points (range 28–75) [18], which was close to our average of 52.6 points (range 31–67). As for our long-term follow-up, the scores were even better than those at early follow-up, therefore representing spontaneous recovery (Table 2).

Some authors state that patients with diabetes tend to perform worse initially after manipulation but with similar long term outcome when compared to the non-diabetes patients [17]. In our series, our outcome for both diabetic and non-diabetic groups was similar for short- and long-term follow-up (Table 2, $p<0.05$). Frozen shoulder in patients with IDDM were reported to be difficult to treat [8]. However, when mobilisation was made possible by manipulation, the outcome was similar between patients with IDDM and NIDDM [15]. Despite the similar incidence of IDDM in Taiwan compared to other Asian countries, it is still much lower than Caucasians [20]. Patients with IDDM were excluded from our study since 98% of our DM patients with frozen shoulders were NIDDM. Higher incidence of triopathy, retinopahty, and nephropathy was reported to be related to poor blood sugar control and longer duration of diabetes.

Table 3 HbA1C results before and after surgery in the DM group

Evaluation	Measurement	HbA_{1c} (<9%)*n* = 10	HbA_{1c} (>9%)*n* = 11	Statistical significance *p* value
Before-surgery	Pain	4.28±2.6	4.04±2.55	0.366
	Activity	7.19±1.77	7.23±1.48	0.4579
	ROM	12.19±1.38	12.76±1.84	0.0862
	Total	23.66±3.36	24.04±3.7	0.3419
Post-surgery 3 weeks	Pain	12.14±2.5	12.38±3	0.3703
	Activity	14.14±1.55	14.38±1.49	0.2821
	ROM	29.61±1.93	29.14±2.72	0.2133
	Total	55.9±3.62	55.9±5.83	0.5

HbA_{1c} glycosylated haemoglobin, *DM* diabetes mellitus, *ROM* range of motion

*$p \leq 0.05$, statistically significant

Statistical method used was the chi-square test

After an average eight-year follow-up, recurrence and severe residual complications did not occur in DM patients with frozen shoulders. In our opinion, diabetes is only a precipitating factor with no direct relationship to poor prognosis in long-term follow-up. Patients with poor blood sugar control around manipulation showed no significant difference in outcome when compared to those with good sugar control after short-term follow-up (Table 3).

Complications after manipulation, such as shoulder dislocation, rotator cuff tear or brachial plexus palsy have been reported [3]. To avoid intra-operative complications, five cases (7.3%) with refractory frozen shoulders that underwent open or arthroscopic release were excluded from our series. We did not see any intra-operative or postoperative complications following manipulation. The adjusted Constant score was used for its advantage in assessing shoulder function. However, assessment of muscle strength prior to manipulation was still seen to be almost impossible by some authors for the fear of false scores, since most patients cannot abduct their shoulders to 90 degrees [5, 18, 19].

Manipulation alone should be sufficient for the majority of patients [16–18, 24], as suggested by some authors, while arthroscopy should be reserved for combined rotator cuff tear, sub-acromial decompression, and refractory shoulder stiffness [11, 19, 21]. In our series, five cases of refractory frozen shoulders (7.3%) ended up having arthroscopic release (four non-diabetic and one diabetic) in the past 13 years. Treatment with manipulation alone was sufficient for 92.6% of frozen shoulders with and without diabetes in our series. It was difficult to assess the outcome of arthroscopic release compared to manipulation since the number of cases that underwent arthroscopic release following manipulation were minimal. Some suggested that patients with diabetes should consider arthroscopic release [17]; nevertheless, most of our patients performed well after manipulation alone (Table 2). Until now, frozen shoulder within diabetes has been less well documented in other Asian countries; hence, we should keep in mind the possible different outcomes between races.

This study has several limitations. The sample size which was solely based on our own hospital was not insufficient. Larger population size involving other medical centres would be required for more reliable results. Our study only involved DM patients treated with manipulation. Those who received treatment other than manipulation following frozen shoulders, including patients who were unable to have anaesthesia due to poor blood sugar control, were not studied.

We conclude that manipulation under anaesthesia when initial conservative management failed speeds up the recovery of frozen shoulders and improves shoulder function and symptoms within a short period of time. Diabetes is found to be only a precipitating factor. Satisfactory outcome was achieved in patients with and without non-insulin dependent diabetes mellitus after short- and long-term follow-up study. Most frozen shoulders in patients with non-insulin dependent diabetes can be treated with manipulation under anaesthesia.

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