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## Research Paper

## Does Conservative Rehabilitation Program Lead to Long-Term Stiffness after Arthroscopic Rotator Cuff Repair?



## 關節鏡修復肩袖後，保守康復方案會導致長期僵硬嗎？

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## ABSTRACT

**Background:** Evidence on the ideal rehabilitation program for arthroscopic rotator cuff repair is lacking. Most data and results are conflicting with no consensus made. This study aims to compare between an early aggressive program with immediate postoperative range-of-motion (ROM) exercises and a more conservative program with early restriction of motion in Hong Kong Chinese population.

**Materials and methods:** We retrospectively evaluated 37 arthroscopic rotator cuff repair cases who underwent a standardized delayed rehabilitation protocol of immobilization for 4 weeks to 6 weeks before formal passive ROM exercises. Patients were evaluated at 3 months, 6 months, and 12 months after the surgery, for which they would be tested on passive forward flexion (FF). They were categorized as “stiff” if FF was less than 100°. Constant score, Disability of Arm, Shoulder and Hand (DASH) score, Visual Analog Scale (VAS) score, and isometric abduction power deficit percentage were parameters to assess the functional outcome, and they were obtained in all of the patients' last follow-up assessments.

**Results:** Two cases (5.4%) are considered “stiff” 6 months after the surgery. At 1 year, the stiffness in both cases resolved, resulting in 0% rate of stiffness. The mean FF at 1 year was  $153.33 \pm 20.15$ , which is comparable to the literature. Two cases (5.4%) of clinical retear occurred. Mean Constant score at the latest follow-up was  $62.4 \pm 13.2$ . Mean VAS score was  $1.1 \pm 1.8$  at rest and  $2.8 \pm 2.0$  on exertion. Mean DASH score was  $25.3 \pm 21.9$ . Mean isometric abduction power deficit was  $42.7\% \pm 0.2\%$ .

**Discussion:** Historically, due to concerns on long-term stiffness, an early aggressive postoperative rehabilitation protocol was used. We found that an early restriction of ROM with 4 weeks to 6 weeks of immobilization did not lead to long-term stiffness and functional disadvantage. This includes patients with stiffness even before the operations.

**Conclusions:** Immobilization for 4 weeks to 6 weeks after arthroscopic rotator cuff repair does not result in long-term stiffness and may even be beneficial to cuff tendon healing.

## 中文摘要

**背景:** 關於關節鏡修復肩袖的理想康復方案缺乏證據，大多數數據和結果是矛盾而沒有達成共識。本研究目的是以香港中國人，以積極方案即時術後可動範圍運動和較保守的早期運動限制方案作比較。

**材料與方法:** 我們回顧性評估了關節鏡修復肩袖37例，採用標準化的延遲康復方案，避免術後4至6周內的可動範圍被動活動。手術後3個月、6個月、12個月對患者進行評估，並測試向前屈曲，若向前屈曲少於100度，就被歸類為僵硬。評估能力結果的參數是Constant 評分、上臂肩手功能殘疾 (DASH) 評分、視覺模擬量表 (VAS) 和等距外展力量不足百分比，都在所有患者的最後隨訪中獲得。

**結果:** 手術6個月後，2例 (5.4%) 被認為“僵硬”。1年時，2例僵硬均可解決，僵硬的比率為0%。1年時，平均向前屈曲為  $153.33^\circ \pm 20.5^\circ$ ，與文獻類同。2例 (5.4%) 出現臨床再撕裂。最後隨訪中，平均Constant評分為  $62.4 \pm 13.2$ 。平均視覺模擬量表在休息時為  $1.1 \pm 1.8$ ，運動時為  $2.8 \pm 2.0$ 。平均上臂肩手功能殘疾 (DASH) 評分為  $25.3 \pm 21.9$ 。平均等距外展力量不足百分比是  $42.7\% \pm 0.2\%$ 。

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討論：從歷史上看，由於對長期僵硬的擔憂，使用了早期積極術後康復方案。我們發現在4至6周早期限制可動範圍運動並不會導致長期僵硬和功能缺陷。這包括了即使在手術前有僵硬的患者。

結論：關節鏡修復肩袖後4至6周的不動不會導致長期僵硬，甚或有利於肩袖筋腱癒合。

## Introduction

Arthroscopic rotator cuff repair has become the preferred method of treatment of rotator cuff pathology due to its rapid advancement over the past decade. Other than good surgical techniques, the postoperative rehabilitation program plays a major role in the success of the surgical treatment for rotator cuff injury. However, a rehabilitation program that best allows tendon-to-bone healing while preventing shoulder stiffness has not been established. Historically, concerns about postoperative stiffness have led surgeons to choose a more aggressive rehabilitation protocol that allows earlier passive motion. However, recent studies in animal models have shown that a period of immobilization could result in better microscopic tendon structure and better mechanical properties.<sup>1</sup> Immediate postoperative motion could actually cause more postoperative stiffness due to gapping in the repair site with scar formation and adhesion in the

subacromial space.<sup>2</sup> Furthermore, multiple studies have demonstrated a significant rate of retear in arthroscopically treated rotator cuff tears.<sup>3</sup> Therefore, the idea of a more conservative rehabilitation protocol has been proposed to reduce the stress at the repair site. Our study investigated on the functional outcome and long-term stiffness of a conservative protocol that included 4 weeks to 6 weeks of immobilization in Hong Kong Chinese population.

## Materials and methods

This is a retrospective study conducted in a Hong Kong regional hospital. We identified 36 patients who underwent arthroscopic rotator cuff repair operations between July 2012 and March 2014. One of the patients underwent bilateral rotator cuffs repair, resulting in a total of 37 cases. One case of rotator cuff repair revision was excluded from this study. The minimal follow-up period was 6 months and the average follow-up period was 15 months (range, 6–26 months). All operations were performed by a single surgeon.

The demographic and clinical data of the patients are presented in Table 1. The mean age was 58 years with a female-to-male ratio of 1.8; 22% of patients were smokers and 57% of tears were injury related. The average duration of symptoms before surgery was 11 months. As much as 51% of cases were single tendon tears and 14% had three or more tendons torn. We performed double-row repairs in 73% of cases. Additional procedures include acromioplasty (76%), biceps tenodesis (38%), and biceps release (3%).

All patients were enrolled into our standardized rehabilitation protocol involving 4 weeks to 6 weeks of immobilization after surgery. During this period, patients were encouraged to have elbow and wrist active mobilization exercises and pendulum exercises of shoulder three times/day. Five cases were assigned to undergo 4 weeks of immobilization period, whereas 32 cases were assigned a period of 6 weeks, which was followed by 4 weeks of passive range-of-motion (ROM) exercises. At 10 weeks, active ROM exercises would be started. Resisted strengthening exercises would be started at 3 months to 4 months.

The surgeon evaluated the shoulders' ROM at 3 months, 6 months, and 12 months. Stiffness was defined as passive forward flexion (FF) less than 100 degrees. At the latest follow-up, therapists would assess the Visual Analog Scale (VAS) score, Constant score, Disability of Arm, Shoulder and Hand (DASH) score, and the isometric abduction power deficit percentage.

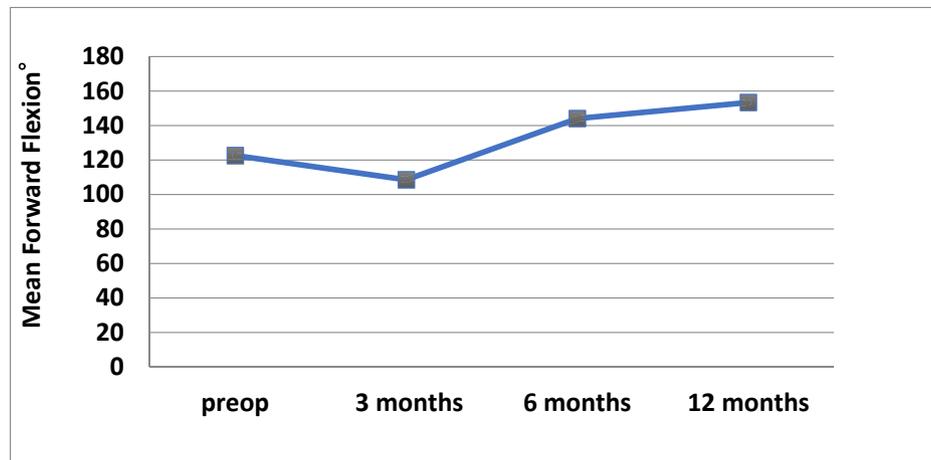
## Results

Figure 1 shows the mean passive FF at preoperative, 3 months, 6 months, and 12 months evaluations. It shows that although there is a significant drop in the FF at 3 months [ $122.57 \pm 36.77$  (preoperative) vs.  $108.51 \pm 32.89$  (3 months)] after surgery, the FF values at 6 months ( $144.06 \pm 18.92$ ) and 12 months ( $153.33 \pm 20.15$ ) show a significant improvement in FF when compared with the preoperative stage ( $p < 0.05$ ). The FF at 12 months also shows a significant improvement compared with that at 6 months ( $p < 0.05$ ).

Nine patients (24.3%) met the criteria for being stiff before the surgery (Figure 2). At 3 months after the surgery, 14 (37.8%) were

**Table 1**  
Demographic and clinical data

Variables	Data
Age, yr	58.08 (37–80)
Sex	13 males, 24 females
Side of involvement, n (%)	
Dominant	22 (59.5)
Nondominant	15 (40.5)
Occupation, n (%)	
Nil	14 (37.8)
Sedentary	5 (13.5)
Light duty	13 (35.1)
Heavy duty	5 (13.5)
Smoker/Ex-smoker, n (%)	
Yes	8 (21.6)
No	29 (78.4)
History of injury, n (%)	
Yes	21 (56.8)
No	16 (43.2)
Tear size, n (%)	
Partial	7 (18.9)
One tendon	19 (51.4)
Two tendons	6 (16.2)
Three or more tendons	5 (13.5)
Repair technique, n (%)	
Single row	10 (27.0)
Double row	27 (73.0)
Repair completeness, n (%)	
Complete	35 (94.6)
Partial	2 (5.4)
Acromioplasty, n (%)	
Yes	28 (75.7)
No	9 (24.3)
Biceps procedure, n (%)	
Nil	17 (46.0)
Tenodesis	14 (37.8)
Ruptured	5 (13.5)
Released	1 (2.7)
Immobilization period, n (%)	
6 wk	32 (86.5)
4 wk	5 (13.5)
Orthosis, n (%)	
Sling	31 (83.8)
Abduction brace	6 (16.2)
Symptom duration, mo	10.6 $\pm$ 25.3



	Preop	3 mo	6 mo	12 mo
Forward flexion	122.57 ± 36.77	108.51 ± 32.89*	144.06 ± 18.92†	153.33 ± 20.15‡

\* Significant drop versus preoperative value ( $p < 0.05$ ).

† Significant improvement versus preoperative value and 3 months' value ( $p < 0.05$ ).

‡ Significant improvement versus preoperative value and 6 months' value ( $p < 0.05$ ).

**Figure 1.** Mean passive forward flexion at pre-operative, 3 months, 6 months and 12 months.

found to be stiff. The number of patients with stiff shoulder significantly reduced at 6 months' evaluation ( $p < 0.05$ ), with only two patients (5.4%) having stiff shoulder (arrows in Figure 2). These two patients were the ones who had stiff shoulder preoperatively. Moreover, these two patients' stiffness also resolved at 12 months' evaluation. Therefore, no patients were labelled as *stiff* 12 months after surgery.

When we further divide the cases into stiff (9 cases) and nonstiff groups (28 cases), according to their preoperative FF (Figure 3), the average FF of the stiff group progressively increases from 76.22 degrees to 144.17 degrees at 12 months, whereas the nonstiff group suffers a drop from 140.36 degrees to 110.71 degrees at 3 months and then gradually regains the range to 166.94 degrees at 12 months.

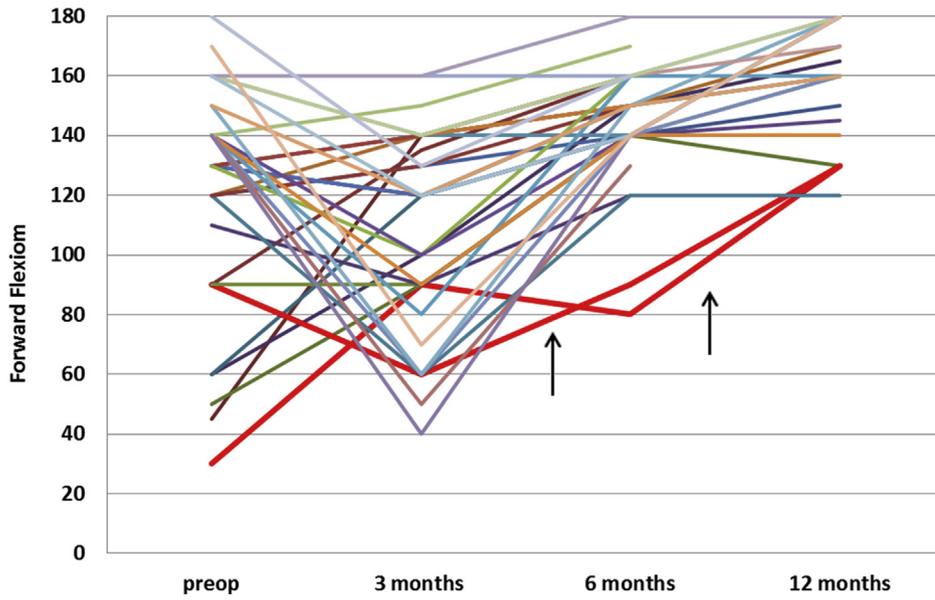
The mean Constant score at the latest follow-up was  $62.4 \pm 13.2$ . Mean VAS score was  $1.1 \pm 1.8$  at rest and  $2.8 \pm 2.0$  on exertion. Mean DASH score was  $25.3 \pm 21.9$ . Mean isometric abduction power deficit was  $42.7\% \pm 0.2\%$ .

One patient (female) had transient stiffness at 3 months with 40 degrees of FF. She received intra-articular steroid injection and the FF improved to 140 degrees at 6 months. Two patients required postoperative intensive care unit airway support due to neck swelling but both were discharged uneventfully. One patient suffered from deep infection at the anterior portal wound 2 months after operation. This was treated with debridement and anchor removal. There were two cases of clinical re-tear and both had massive rotator cuff tear.

## Discussion

An aggressive rehabilitation protocol following arthroscopic rotator cuff repair has been the preferred option by most surgeons aiming to reduce joint stiffness and improve muscle strength. From the experience of hand tendon repair, immediate mobilization reduces joint stiffness and improves tendon healing. However, a recent animal study actually shows a detrimental effect on shoulder range after immediate postoperative passive motion. Cathryn D. Peltz<sup>2</sup> suggested several significant differences between flexor tendons and rotator cuff tendons. The differences affect adhesion formation that determines the joint mechanics as well as how immobilization modulates this effect. Given that the weak link in fixation of rotator cuff is the suture tendon interface, early aggressive rehabilitation can lead to structural failure of a repair.<sup>4</sup> Therefore, multiple studies comparing early versus late rehabilitation were performed, with the aim to identify an optimal rehabilitation protocol. However, the results are conflicting with regard to the effect of immobilization on cuff tendon healing and joint stiffness. Ross et al<sup>5</sup> reviewed seven studies comparing early and late rehabilitation after arthroscopic cuff repair. Five studies showed significantly poorer range in the late rehabilitation group and the others did not. In these five studies, the differences at 12 months' follow-up were all less than 10 degrees only. Therefore, the clinical significance of early rehabilitation is doubtful. In our study, the FF range is  $153.3 \pm 20.2$  degrees, which is functionally satisfactory and is comparable to literatures.

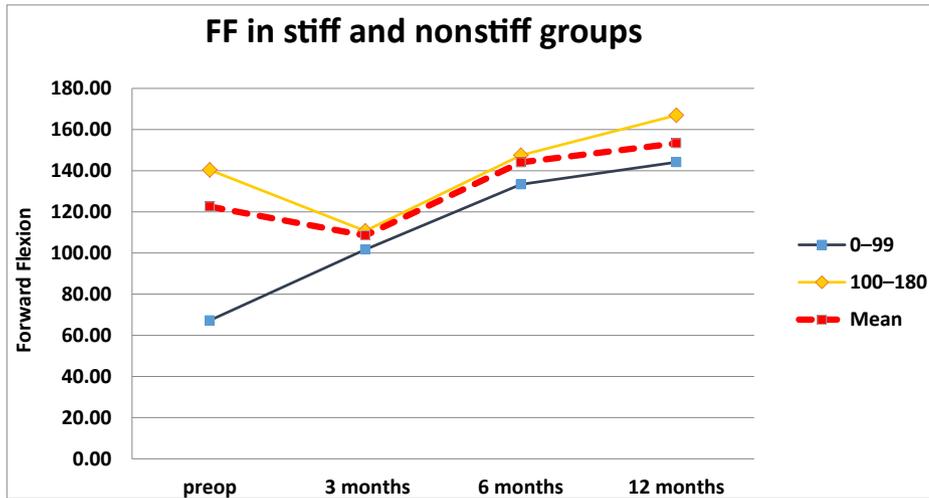
### FF in individual patients



	Preoperative	3 mo	6 mo	12 mo
Stiff patients	9	14	2	0
Rate of stiffness (%)	24.3	37.8	5.41	0

Figure 2. Individual passive forward flexion at pre-operative, 3 months, 6 months and 12 months. FF = forward flexion.

### FF in stiff and nonstiff groups



FF	No. of Patients	Preop	3 mo	6 mo	12 mo
<100	9	76.22	101.67	133.33	144.17
100–180	28	140.36	110.71	147.50	166.94

Figure 3. Mean forward flexion in stiff and non-stiff group at pre-operative, 3 months, 6 months and 12 months. FF = forward flexion.

**Table 2**  
Change in forward flexion at different periods of evaluation

Forward flexion	Preop	3 mo	6 mo
<100	76.22	101.67 *	133.33 †

\* Significant versus preoperative value.

† Significant versus preoperative value and 3 months' value.

A systemic review done by Denard et al<sup>6</sup> showed that the incidence of transient stiffness after arthroscopic repair was 10% and resistant stiffness that required operation was 3.3%. In our study, the rate of stiffness at 6 months is 5.41% and 0% at 12 months.

One of the very encouraging findings in our study was the favourable response of those patients with stiff shoulder before operation. Instead of being more stiff after immobilization, their range actually improve significantly from 76.22 degrees to 101.67 degrees ( $p < 0.05$ ) at 3 months and 133.33 degrees ( $p < 0.05$ ) at 6 months (Table 2), respectively. We conclude that conservative rehabilitation is also suitable for those patients who present with stiff shoulders.

The functional outcome measures, including the Constant score ( $62.4 \pm 13.2$ ), DASH score ( $25.3 \pm 21.9$ ), and the VAS score ( $1.1 \pm 1.8$  at rest,  $2.8 \pm 2.0$  on exertion), are also similar to some large-scale studies.<sup>5</sup> Therefore, we believe that a more conservative rehabilitation protocol with 4 weeks to 6 weeks of immobilization after the surgery followed by passive ROM exercise is a reasonable option, which gives satisfactory functional outcome and ROM.

There are several limitations in this study. First, it is a retrospective study and has the intrinsic problem in data collection as in all other retrospective studies. Second, there is no case–control to compare against and we have to compare the results with the literature instead. Third, the assessment of range is by a single surgeon and is prone to bias. Fourth, stiffness in other planes, which also have functional implication, is not assessed.

## Conclusion

Our study shows that conservative rehabilitation after arthroscopic rotator cuff repairs has a lower rate of stiffness as well as a reasonable pain relief and functional outcome. In particular, it was beneficial to patients with preoperative stiffness. We believe that the stress on both patients and therapists when they are trying to mobilize painful shoulders in the early postoperative period is avoidable; 4 weeks to 6 weeks of immobilization does not lead to long-term stiffness nor does it cause a detrimental effect on the functional outcome. It also shows that an early stiffness at around 3 months after cuff repair does not indicate long-term stiffness and does not require any operative treatment. Most of the early stiffness cases will resolve after further physiotherapy. Further prospective studies are warranted to investigate on the optimal duration of immobilization that balances between the risk of stiffness and the risk of retear after rotator cuff surgeries.

## Conflicts of interest

None declared.

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