Rotator cuff repair protocols: a survey of current New Zealand practice

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ABSTRACT

Rehabilitation following surgical rotator cuff repair may enable return to pre-injury function. Optimal recovery is facilitated by the use of post-operative protocols that enhance communication between the surgeon and physiotherapist. The purpose of this study was to describe the rotator cuff repair rehabilitation protocols currently used in New Zealand. Orthopaedic surgeons practising in New Zealand were contacted to determine their current rehabilitation protocols. Length of immobilisation and exercise progression following surgical repair were analysed across weekly timeframes from the day of surgery until nine months post-operatively. The response rate was 55% with protocols received from 31 surgeons. Post-surgical rotator cuff protocols currently in use in New Zealand are predominantly determined by weekly time periods which vary from surgeon to surgeon. Immobilisation was most commonly recommended for four to six weeks, pendular exercises were started the week of surgery, active exercises commenced at six weeks, followed by resisted exercises at twelve weeks. Few protocols based the rehabilitation upon tissue quality and size of rotator cuff tear. Level of detail regarding sets and repetitions of exercises also differed between protocols. Variability across protocols was evident regarding the recommended activity level and time period from surgery. Consideration of tissue quality, size of the tear and strength of the repair is recommended to facilitate optimal results.

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Key words: Surgical repair, Tendon, Rehabilitation, Rotator cuff

INTRODUCTION

Rotator cuff tears are a frequent source of shoulder pain, with a prevalence of 25% in people over 60 years, rising to 50% in those over the age of 80 years (Tashjian, 2012; Yamamoto et al., 2010). A recent study in the United States of America (USA) reported that the incidence of rotator cuff repairs has increased by 238% since 1995 (Ensor, Kwon, DiBeneditto, Zuckerman, & Rokito, 2013). This increase may be due to improved imaging techniques, increased availability of surgery and an ageing population, which may lead to further demand for surgery (Ensor et al., 2013). In New Zealand, the total number of rotator cuff repairs in the 2015/2016 financial year was 3,205, with associated surgical and physiotherapy costs borne by the Accident Compensation Corporation (ACC) of $31,125,063 and $1,116,506, respectively (ACC, personal communication, September 7, 2016). In the USA, between 200,000 and 300,000 rotator cuff tears are surgically repaired each year (Colvin, Harrison, Flatow, Egorova, & Moskowitz, 2012), at a cost of between $US10,000 and $US17,000 per surgery (Vitale et al., 2007); total annual expenditure in the USA is estimated at between $US3-12 billion dollars (McElvany, McGoldrick, Gee, Neradilek, & Matsen, 2015). Additional post-surgical rehabilitation costs of approximately $US3,000 per person (Arshi et al., 2015) mean that the total expenditure is considerable.

Rehabilitation following surgical repair can involve significant periods of time, with some protocols providing guidance to therapists for 4 to 6 months, but this can be extended by complications such as tendon non-healing, which varies from 12% to 94% (Boileau et al., 2005; Galatz, Ball, Teefey, Middleton, & Yamaguchi, 2004; Kim et al., 2012; Thigpen et al., 2016). Tendon healing can be affected by various surgical, mechanical and patient specific factors following surgical repair (Mall, Tanaka, Choi, & Paletta, 2014). Patient specific factors associated with decreased healing include large sized tears (>3cm), an increased number of affected tendons (Boileau et al., 2005; Cho & Rhee, 2009; Gulotta et al., 2011; Le, Wu, Lam, & Murrell, 2014), fatty infiltration (Cho & Rhee, 2009; Chung, Kim, Kim, Kim, & Oh, 2013), the extent of tendon retraction (Charousset, Bellaïche, Kalra, & Petrover, 2010; Meyer, Wieser, Farshad, & Gerber, 2012) and the quality of bone stock (Chung, Oh, Gong, Kim, & Kim, 2011). Decreased tendon-to-bone healing has also been associated with increased patient age (Boileau et al., 2005; Cho & Rhee 2009; Gulotta et al., 2011). Excessive load on the tendon in the early post-operative phase has been shown to be detrimental to healing (Sonnabend, Howlett, & Young, 2010; Thomopoulos, Williams, & Soslowsky, 2003). However, non-healing may also result from complete lack of load, as a balance of load is required to promote optimal healing (Galatz et al., 2009). Optimally loading the tendon has been shown to increase fibroblast proliferation, and synthesis and organisation of collagen (Liu, Yang, Al-Shaikh, & Lane, 1995). Early loading of the tendon with passive range of motion (ROM) exercises may not be detrimental to healing in small to medium sized tears (< 3cm) (Keener, Galatz, Stobbs-Cucchi, Patton, & Yamaguchi, 2014; Kim et al., 2012). However, people

with larger sized tears (> 3cm) may be prone to an increased re-tear rate with early passive ROM (Lee, Cho, & Rhee, 2012).

Rehabilitation following rotator cuff repair is guided by post-surgical protocols which may recommend a period of immobilisation followed by progressive loading of the tendon through passive, active and resisted exercise (Littlewood et al., 2015). Currently, there are a lack of detailed published guidelines for rehabilitation following rotator cuff repair in New Zealand (Accident Compensation Corporation, 2003). The aim of this study was to describe rotator cuff repair rehabilitation protocols currently used in New Zealand. It was hypothesised that, although there would be variation amongst protocols, they would contain information regarding restrictions on immobilisation, passive and active ROM, and resisted exercises.

METHODS

In order to establish the current protocols available to New Zealand physiotherapists, orthopaedic surgeons with a special interest in shoulder surgery were identified via the New Zealand Orthopaedic Association and contacted for their post-surgical rotator cuff protocols, between May and December 2014. Ethical approval was not required as this study was considered a clinical audit because it did not involve human participants and the protocols received from surgeons were de-identified. In addition, some protocols were publicly available documents. A protocol was defined as any pre-printed formal protocol, website protocol, or a protocol received via email describing the implementation of various treatment modalities at specific times in order to maximise tissue healing and minimise joint stiffness (van der Meijden et al., 2012).

Data from the protocols were extracted individually by two researchers (BH and MO) into a standardised data form, including the length of immobilisation, and the time at which passive, active and resisted exercises were commenced, as well as the duration of these exercises (van der Meijden et al., 2012). Consensus was reached in a single meeting by the researchers if disagreement existed over the protocols.

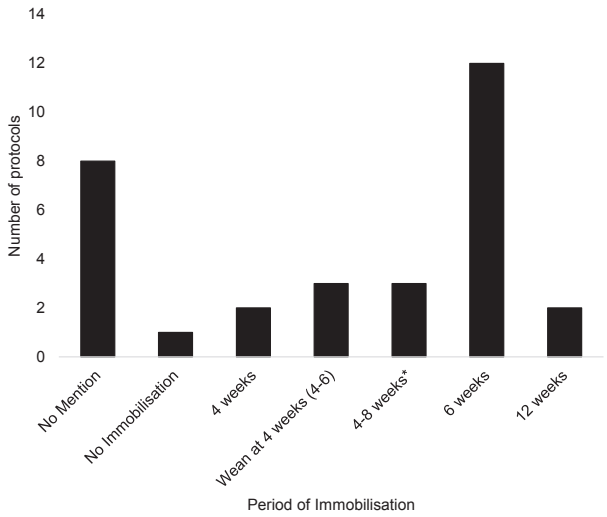
Pendular exercises and self-assisted shoulder flexion are common passive exercises that have been previously reported in a rehabilitation protocol (Millett, Wilcox, O'Holleran, & Warner, 2006) and were chosen to represent the passive phase of rehabilitation. As electromyographic (EMG) activity is low with these exercises, they were considered representative of passive exercise (Dockery, Wright, & LaStayo, 1998; Long et al., 2010; McCann, Wootten, Kadaba, & Bigliani, 1993). Active exercise was defined as "patient-generated movement" whereas resisted exercise was defined as movement undertaken with load applied (Petty, 2014). In instances where return to work/sport, and/or alternative therapies such as aquatherapy or cryotherapy were described in a protocol, these data were also extracted as such forms of therapy have been shown to enhance patient outcomes (Brady, Redfern, Macdougal, & Williams, 2008; Osbahr, Cawley, & Speer, 2002). Data from protocols which reported variation according to the size of the rotator cuff tear, the quality of tissue, or other variables such as the level of pain, were also documented.

RESULTS

Of the 56 surgeons who were contacted for post-surgical protocols, 31 (55%) responded, with protocols received from a wide geographical area throughout New Zealand. Eleven were in printed form, while 18 were written directly to the researchers in an email. One protocol referred to published literature (Millet et al., 2006) and one referred to an independent website (Moon Shoulder Group, 2008).

Immobilisation

Length of immobilisation varied from no immobilisation to twelve weeks. Twelve (39%) protocols recommended immobilisation for 6 weeks (Figure 1), and three (10%) specifically addressed the severity of the tear by requiring immobilisation for 4 weeks in cases of a small tear, and 6 or 8 weeks for a large tear.



* Period of immobilisation between 4 to 8 weeks dependent on tear size

Figure 1: Period of immobilisation recommended following rotator cuff repair (n=31 protocols)

Passive exercise

Pendular exercises were included in 22 (71%) protocols. Eighteen of these (58%) recommended pendular exercises in the first week following surgery (week 0) (Figure 2). One protocol introduced pendular exercises from week 1, another started these at week 2, while two delayed commencement of these exercises until week 4. Only five (16%) indicated the number of repetitions, which varied from two to four times per day. A third of the protocols (29%) did not contain any information on pendular exercises.

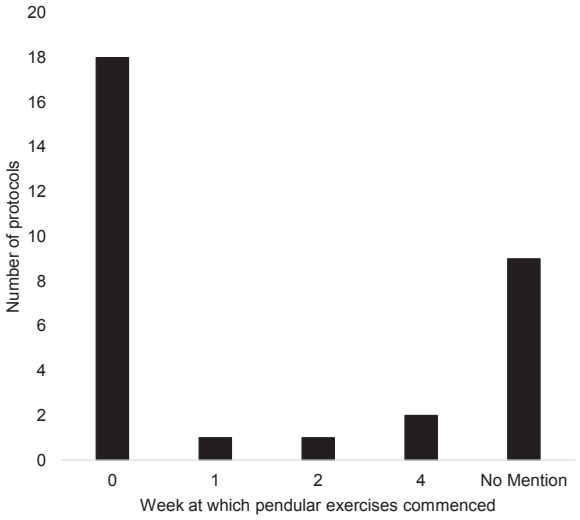


Figure 2: Time of commencement of pendular exercises (n=31 protocols)

Self-assisted shoulder flexion was recommended by 26 (84%) protocols. Two (6%) of these recommended an alternative exercise of table slides instead of supine self-assisted shoulder flexion. Eleven (35%) protocols commenced self-assisted shoulder flexion the week of surgery (week 0) (Figure 3). Seven (23%) restricted the range of shoulder flexion to 90° for a stipulated period of time, varying between 4 to 12 weeks. One protocol limited flexion to 45° until week 3, after which flexion could be increased to 90° until week 6. Four (13%) protocols accounted for tissue quality and size of the tear, by varying the commencement of self-assisted flexion from week 2 to 4 (two protocols) or from week 4 to 6 (two protocols). The two protocols (6%) that recommended table slides commenced this exercise at either week 0, or week 4. Five (16%) protocols made no mention of any passive flexion exercises.

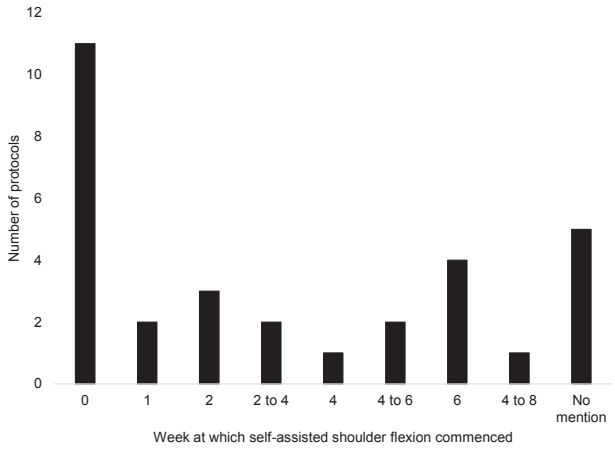
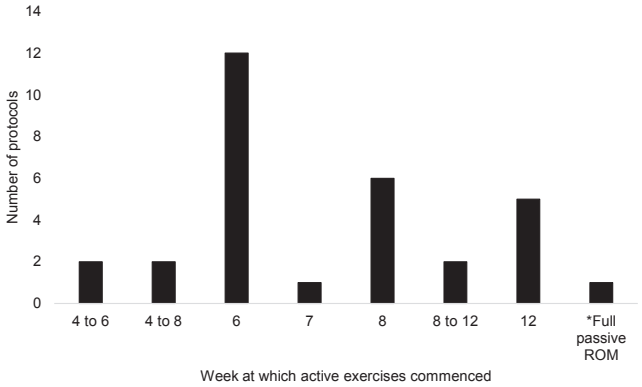


Figure 3: Time of commencement of self-assisted shoulder flexion (n=31 protocols)

Active exercise

All 31 protocols recommended the use of active exercise (Figure 4), commencing with exercises such as active shoulder flexion and light weight waist level activities. Active exercise commenced at week 6 in twelve (39%) protocols, at week 8 in six (19%), and at week 12 in five (16%) protocols. Six (19%) recommended adjusting the commencement of active exercise dependent upon other variables (e.g. size of tear and quality of tissue) at 4 to 6 weeks, 4 to 8 weeks, or 8 to 12 weeks. Active ROM was restricted until full passive ROM was achieved in one protocol.

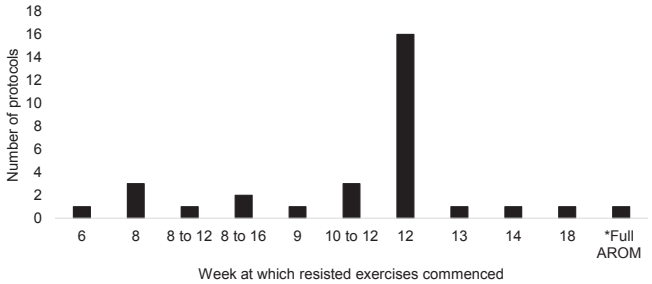


* Active movement commenced when full passive ROM was gained

Figure 4: Time of commencement of active exercises (n=31 protocols)

Resisted exercise

All 31 (100%) protocols recommended resisted exercise during rehabilitation (Figure 5). Sixteen (52%) protocols recommended commencement of resisted exercise at 12 weeks following surgery. Some protocols advised the physiotherapist to delay the commencement of resisted exercises depending on tear size and tissue quality. One (3%) protocol advised commencement from 8 to 12 weeks, two (6%) advised from 8 to 16 weeks and three (10%) advised from 10 to 12 weeks. Five (16%) protocols recommended starting resisted exercises with isometric exercises. Only two (6%) protocols indicated the number of sets and repetitions for strengthening. One recommended resisted dumb-bell exercises three times per week with three to four sets of 10 repetitions. The other recommended three sets of 10 repetitions of Thera-Band® (The Hygenic Corporation, Akron, Ohio) exercises, three times per day.



*Resisted exercises were commenced when full AROM was gained

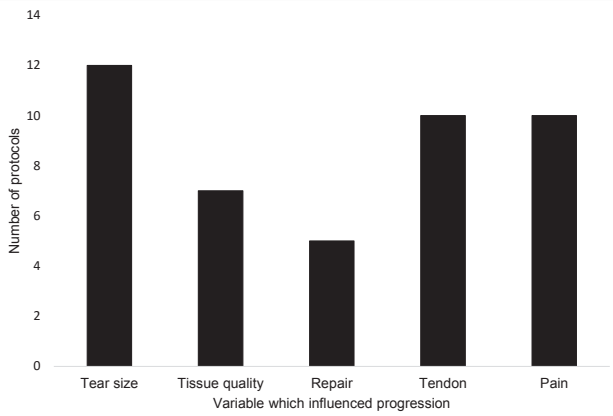
Figure 5: Time of commencement of resisted exercises (n=31 protocols)

Return to work or sport

Time frames for return to work were recommended by three (10%) protocols. Two (6%) suggested return to light work at 3 to 4 months, and heavy work at 6 to 9 months after surgery. One (3%) recommended return to work at 6 months. Return to sport was recommended in four (13%) protocols at various time frames, from 4 to 9 months post-operatively.

Other variables related to rehabilitation

Rehabilitation was altered depending on variables including the size of the tear, quality of the tissue, quality of surgical fixation, presence of pain and whether aquatherapy or cryotherapy was added. The size of the rotator cuff tear was considered in twelve (39%) protocols with progression delayed for large sized tears (Figure 6). Delayed progression of rehabilitation was recommended in seven (23%) protocols when the tissue was of poor quality and in five (16%) when tendon fixation was considered poor. Ten (32%) altered the rehabilitation according to the particular tendon involved, and treatment was varied in 10 (32%) if pain was present. Seven recommended slowing progression to reduce pain, while one advised caution with rapid progression if the patient had minimal pain. Two (6%) documented that ROM exercises be undertaken to the point of pain. Aquatic therapy was proposed as an adjunct in three (10%) protocols, while seven (23%) incorporated cryotherapy into the rehabilitation programme.



* Some protocols included more than one variable

Figure 6: Other variables considered to influence rehabilitation of rotator cuff repairs (n=31 protocols)

DISCUSSION

This study established that a wide variety of rotator cuff post-operative protocols are currently in use throughout New Zealand and highlights the need for further discussion regarding the optimal management following rotator cuff repair. The majority of protocols divided the gradation of rehabilitation into phases, including immobilisation, passive, active and resisted exercises; however, considerable variation was evident in the commencement and definition of these phases. Few protocols considered individual factors such as size of the tear, tissue quality or strength of the fixation.

Immobilisation

Immobilisation following a rotator cuff repair has been shown to increase viscoelastic properties and collagen organisation of the repaired tendon (Parsons et al., 2010; Thomopoulos et al., 2003). In the current study, the length of immobilisation varied across the protocols from no immobilisation to 12 weeks. The majority of protocols recommended immobilisation for 4 to 6 weeks, which is similar to current practice in the United Kingdom (Littlewood & Bateman, 2015). A review of randomised controlled trials, which compared the effect of early versus delayed rehabilitation on outcomes and re-tear rates, showed no adverse effect on outcomes or re-tear rates with early rehabilitation (Littlewood et al., 2015). Some of these studies may have been underpowered however, potentially leading to a Type II error or a false negative result (Littlewood et al., 2015). An optimal balance may be required between some immobilisation to protect the repair and some load to promote healing within the tendon (Galatz et al., 2009). The consensus statement from the American Society of Shoulder and Elbow Therapists (ASSET) on rehabilitation following arthroscopic rotator cuff repair recommends immobilisation for a period of four to six weeks (Thigpen at al., 2016). Both the ASSET consensus statement (Thigpen et al., 2016) and a recent sytematic review (Thomson, Jukes & Lewis, 2016) suggest consideration of tear size and tissue quality to be important, with the latter also advocating a period of immobilisation for four to six weeks for a large tear.

Passive exercise

The current study found that in general pendular exercises were initiated up to 4 weeks post-operatively. Small pendular exercises (20cm in diameter) performed in a position of trunk flexion generate less than 10% maximal voluntary contraction (MVC) of supraspinatus, whereas large, incorrectly performed pendular exercises can generate more than 15% of MVC of supraspinatus (Long et al., 2010). The ASSET consensus statement recommends protected passive ROM during the first 6 weeks after rotator cuff repair of small to medium sized tears (< 4cm), with EMG activity of 15% (Thigpen et al., 2016). Previous studies have defined passive exercise as below 20% MVC (Ellsworth, Mullaney, Nicholas, McHugh, & Tyler, 2004; Smith et al., 2006), below 10% MVC (Uhl, Muir, & Lawson, 2010), or below 5% MVC (Dockery et al., 1998).

The use of self-assisted shoulder flexion was initiated between 0-8 weeks post-operatively. As demonstrated in EMG studies, self-assisted shoulder flexion involves less supraspinatus activity than reciprocal pulleys; however, it has a higher level of muscle activity than pendular exercises (Dockery et al., 1998; Gurney et al., 2016; Murphy, McDermott, Petersen, Johnson, & Baxter, 2013). Many protocols did not identify the specific passive exercises to be used in rehabilitation yet therapists should be aware of the variability in EMG activity across passive exercises for individual muscles (Gurney et al., 2016).

Active exercise

Some of the protocols (39%) reported commencement of active exercise at 6 weeks following rotator cuff repair, but this is slightly later than current practice in the United Kingdom where active exercises commence between 4 to 6 weeks (Littlewood & Bateman, 2015). The strength of the repaired tendon is likely to only be up to 30% of normal at 6 weeks post-operatively and therefore unlikely to be able to withstand large loads or repetitive loading (Gerber, Schneeberger, Perren, & Nyffeler,

1999; Thigpen et al., 2016). Removal of an immobilisation sling necessitates active movement (Gurney et al., 2016). Few protocols provided examples of specific active exercises. The ASSET consensus statement recommends light muscle activities at chest level or below (Thigpen et al., 2016).

Resisted exercise

Over 50% (16/31) of protocols implemented resisted exercises at 12 weeks post-operatively. This is in agreement with a study on primates which found an increased number of Sharpey fibres connecting tendon to bone at 12 weeks following rotator cuff repair (Sonnabend et al., 2010). In animal studies, the strength of the repair is between 29% and 50% at 12 weeks (Gerber et al., 1999; Thigpen et al., 2016). The consensus statement by ASSET recommends progressing to strengthening from 12 weeks and to start with light strengthening when pain is well controlled (<2/10 on a numeric pain rating scale) and sufficient passive ROM has been achieved (Thigpen et al., 2016). Some protocols started a resistance programme with isometric exercises; however, care is needed as maximal isometric exercise may load the tendon more than isotonic exercise (Thigpen et al., 2016). Pain free exercise at low levels of MVC can provide a mechanical stimulus for mechanotransduction (Khan & Scott, 2009) and the progressive loading of tissue results in collagen deposition and increased tensile strength of the tendon (Lin, Cardenas, & Soslowsky, 2004). While few protocols indicated the number of sets and repetitions for strengthening, the two protocols that did provide specific guidelines varied from performing resisted exercises three times per week, to three times per day. As improvement in strength is dependent on the type of exercise intensity and frequency prescribed (Kraemer & Ratamess, 2004), further detail regarding the volume of resisted exercises may enhance patient outcome. Additionally, the volume of load should be individualised dependent on patient goals, and other variables such as the quality of tissue.

Cryotherapy and aquatic therapy

Seven (23%) protocols recommended the use of cryotherapy. The benefit of pain relief from cryotherapy has been demonstrated post-operatively following shoulder surgery (Osbahr et al., 2002; Singh, Osbahr, Holovacs, Cawley, & Speer, 2001; Speer, Warren, & Horowitz, 1996). However no difference in pain relief has been found between a commercial compressive cryotherapy device compared to a standard ice wrap (Kraeutler, Reynolds, Long, & McCarty, 2015). Only three (10%) protocols included aquatic therapy, which has been shown to increase ROM following rotator cuff repair (Brady et al., 2008). Aquatic therapy also produces less muscle activity with shoulder elevation when performed slowly compared to dry land exercise (Kelly, Roskin, Kirkendall, & Speer, 2000). Slow speed aquatherapy for ROM is recommended from 3 to 6 weeks by ASSET and cryotherapy is recommended for pain relief from the first day post-operatively (Thigpen et al., 2016).

Other variables

Less than 40% of the protocols considered other factors such as tear size, tissue quality, strength of the fixation or the tendon involved and yet rehabilitation based on these variables has been advocated (Killian & Cavanaugh, 2014; Pabian, Rothschild, & Schwartzberg, 2011; van der Meijden et al., 2012; Thigpen et al., 2016; Thomson et al., 2016). A recent meta-analysis reported that increased re-tear rates were associated with larger tear size, advanced age, and more fatty infiltration (McElvany et al., 2015). Few of the protocols left the progression of rehabilitation to the discretion of the therapist, and none reported informing the therapist of the tear size, type of repair, or degree of fatty infiltration. Given that these variables are significantly associated with re-tear rates following rotator cuff repair, communication regarding these variables may allow therapists to optimise individual progression to achieve better outcomes.

Ten (32%) protocols considered pain during rehabilitation with most of these suggesting adjustment (slowing down) in cases of excessive pain. Only one protocol suggested that minimal pain may be detrimental, with the temptation for the patient to progress too quickly and risk re-tear. Patients who have a rapid early improvement in clinical outcome and/or are less compliant with their rehabilitation are at greater risk of re-tear (Ahmad, Haber, & Bokor, 2015). Further research into individualised rehabilitation programmes, based upon such factors as size of tear, location, quality of fixation, tissue quality, and general health is warranted (Boileau et al., 2005; Killian & Cavanaugh, 2014; Murphy et al., 2013; Thigpen et al., 2016; Thomson et al., 2016; van der Meijden et al., 2012).

Study limitations

A limitation of this study was the 55% response rate from the surgeons who were approached to participate. While this study replicated the information currently available to New Zealand therapists by extracting data from each protocol, the use of a standardised questionnaire completed by participating surgeons may have provided more detail regarding surgical protocols (e.g. sets and repetitions of exercises). In addition, collecting data from different modes such as email, printed protocols and website information may have resulted in a variation in the level of detail provided. Future research could also investigate therapist adherence to protocol implementation or therapist interpretation of the information contained in protocols.

CONCLUSION

Variability is evident amongst the protocols currently in use in New Zealand, but some similarities across protocols alongside comparisons with international studies can be used to guide therapeutic rehabilitation following rotator cuff repair. The majority of protocols recommend immobilisation of the shoulder following a repair for 4 to 6 weeks. Passive exercises (or exercises that produce low-levels of muscle activity as determined with EMG) commence between 0-8 weeks and most protocols progress to active exercises between 6 and 8 weeks. The majority of protocols recommend starting resisted exercises at 12 weeks which is when the tendon may be sufficiently healed to start exercise against resistance. Communication from the surgeon to the therapist regarding tear size, tissue quality and strength of fixation may reduce the risk of re-tear following surgery. Further investigation into the optimisation of rehabilitation based upon individual patient factors may result in more timely return to full function, following a rotator cuff repair.

KEY POINTS

1. This study adds to current knowledge about rotator cuff repair protocols by identifying the variability across protocols currently in use in New Zealand.
2. Most protocols recommended immobilisation for four to six weeks, followed by passive and active exercises, with commencement of resisted strengthening at twelve weeks.
3. Identification and communication of variables which impact on rehabilitation following surgical repair, such as tear size, degree of fatty infiltration, and type of repair, could enhance outcomes for individuals following rotator cuff repair.
4. Future research could investigate the benefit of an individually tailored rehabilitation programme.

DISCLOSURES

No conflicts of interest have been identified for this research.

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