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Do patients benefit from physiotherapy for shoulder dysfunction following neck dissection? A systematic review

A S Harris

Head and Neck Unit, Oxford University Hospitals, UK

Review Article

Mr A S Harris takes responsibility for the integrity of the content of the paper

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Author for correspondence:
Mr Andrew S Harris, Blenheim Head and Neck Unit, The Churchill Hospital, Oxford, UK
E-mail: drewharris@doctors.org.uk

Abstract

Objective. Accessory nerve palsy affects a proportion of patients following neck dissection, and results in shoulder dysfunction and regional pain. This project aimed to establish the evidence supporting post-operative physiotherapy for the shoulder following neck dissection.
Method. A systematic review was conducted of prospective trials investigating the efficacy of rehabilitation for shoulder or upper limb dysfunction and pain following any type of neck dissection.
Results. A total of 820 papers were identified; through a staged review process, 7 trials were found that fulfilled the inclusion criteria. These included three randomised, controlled trials and four non-randomised studies. Five out of the seven trials demonstrated a statistically significant benefit of physiotherapy.
Conclusion. Current evidence shows a benefit from physiotherapy in patients with shoulder dysfunction following neck dissection. Some evidence suggests progressive resistance is superior to other types of physiotherapy. Long-term benefit and cost efficacy have not been studied.

Introduction

Neck dissection remains a common and integral part of the management of patients with head and neck cancer. Radical or modified radical neck dissection comprises either excision of the spinal accessory nerve, or extensive dissection and mobilisation of the nerve. In contrast, more conservative, even selective neck dissection, may involve mobilisation and retraction of the accessory nerve. Inevitably, many of these patients suffer a degree of temporary or permanent accessory nerve palsy.

The direct result of accessory nerve palsy is ipsilateral weakness, and loss of tone of the sternocleidomastoid muscle and, more importantly, the trapezius muscle.[1] Impairment of the trapezius muscle causes depression, abduction and medial rotation of the scapula at rest, and impacts on the abduction, flexion and stability of the shoulder, leading to dysfunction of the upper limb and regional pain.[1,2] The prevalence of shoulder dysfunction is difficult to define given the heterogeneity of this group; however, up to 77 per cent is described after radical neck dissection, and a range of 29 to 39 per cent after selective neck dissection.[3,4] This, coupled with the substantial effect of any synchronous procedures and adjuvant radiotherapy, amounts to significant morbidity.[5,6] Reduced upper limb function may lead to additional care needs, a longer stay in hospital, mobility issues and increased cost to healthcare providers. Upper limb dysfunction may also mean patients are unable to return to work, or pursue their hobbies and interests.

As mortality from head and neck malignancy continues to improve, emphasis shifts to reducing morbidity in this enlarging group of surviving patients. This is particularly pertinent with the increasing incidence of human papilloma virus related oropharyngeal cancer, and the resulting change in demographics; patients are presenting younger and healthier. The more favourable prognosis in this group means patients may have to bear any disability far longer. Methods that reduce accessory nerve damage during surgery should be sought, such as identifying when level 2b can be spared. Evidence-based rehabilitation to maximise function post-operatively should also be part of modern practice.[7] A recently published survey, of nine regional centres across the UK, revealed that the provision of post-operative physiotherapy is not standardised; it is provided in the majority of centres only when significant dysfunction is found, and was not available at all in 11 per cent of centres.[8]

Hypothesis

This study aimed to establish the evidence behind the rehabilitation of shoulder function following neck dissection. The experimental hypothesis was that physiotherapy improves shoulder function following neck dissection.

Materials and methods

Inclusion criteria

We identified prospective studies on human subjects, published in the English language that investigated, as a primary or secondary outcome, the efficacy of physiotherapy for shoulder or upper limb dysfunction and pain, following any type of neck dissection.

Search strategy

The review was conducted and reported with reference to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses ('PRISMA') statement.[9]

A search of PubMed, Ovid (including the Allied and Complementary Medicine Database, the Cumulative Index of Nursing and Allied Health Literature, Embase, and Medline) and Cochrane databases was carried out. Bibliographies of review articles were examined. The search was conducted with the following search terms: 'neck' (title or abstract) or 'cervical' (title or abstract), together with 'accessory' (title or abstract), '11th' (title or abstract), 'eleventh' (title or abstract) or 'shoulder' (title or abstract), and 'exercise' (title or abstract), 'exercises' (title or abstract), 'physiotherapy' (title or abstract), 'rehabilitation' (title or abstract) or 'therapy' (title or abstract).

The search terms were designed to capture all papers and therefore were intentionally broad. Following the initial search, the results were screened by title, then abstract, to identify papers meeting the inclusion criteria and to eliminate duplicates. Full papers were then examined to ensure they met the inclusion criteria and were of sufficient quality to merit discussion.

Results

The initial search revealed 820 unique papers. After a review of titles, 42 remained and their abstracts were examined. This left 18 papers to be reviewed as full texts, following which 7 trials were found that fulfilled the inclusion criteria (Figure 1). These were published from 2004 to 2018, and included three randomised, controlled trials and four trials of less robust design. Table 1 gives characteristics of the different papers.[10–16]

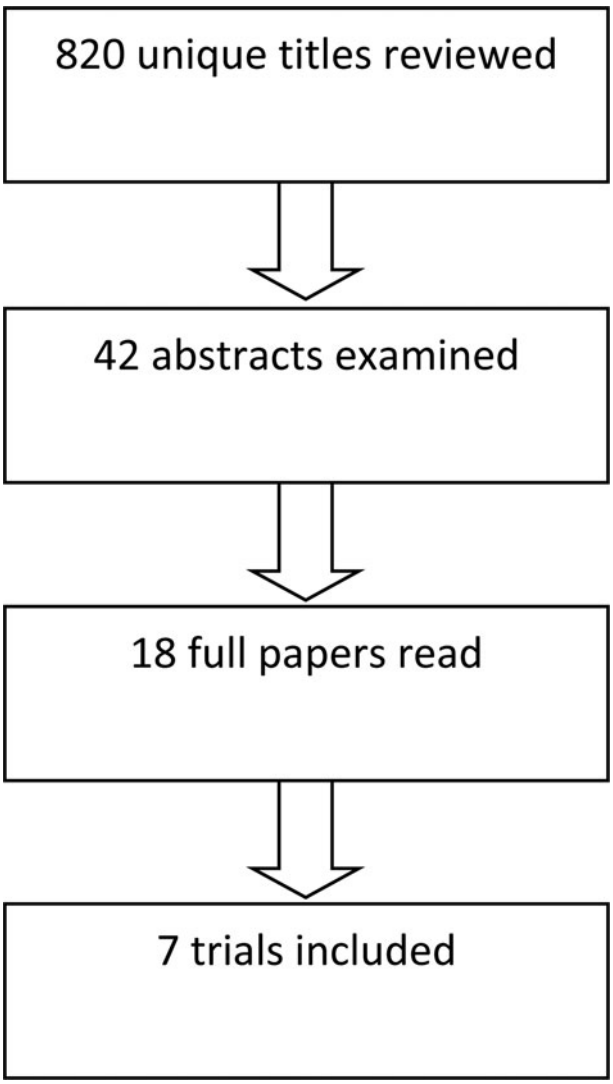

Fig. 1. Flow chart of search strategy.

Discussion

McNeely et al. (2004)[10]

This randomised, controlled trial was conducted in Canada. Twenty patients were randomised to receive either progressive resistance training or standard care. The intervention arm consisted of physiotherapy with progressing sets, repetitions and weights. The control arm was physiotherapy with range of movement and stretching exercises, with light, non-progressive resistance training. Both groups received therapy three times a week for 12 weeks. Outcomes were measured at baseline, week 6 and week 12. Eighty-five per cent of patients completed the trial. Statistically significant improvements were shown in the intervention arm, in terms of active shoulder external rotation ($p = 0.001$), shoulder pain ($p = 0.038$), and the overall score for shoulder pain and disability ($p = 0.045$).

This was a well-designed and well-written study, which led to a larger trial, described below. Despite being designed as a pilot study, with the main aim of proving feasibility, they did show significant results. However, there was no long-term follow up and the small numbers meant that different variables could not be allowed for statistically.

Shimada et al. (2007)[11]

This Japanese study included 29 patients with complete accessory nerve palsy following radical neck dissection. The intervention was a multifaceted programme of therapy, including relaxation techniques and occupational therapy, in addition to physiotherapy. Physiotherapy encompassed massage, passive and active stretching, and non-loaded exercises; there was no resistance training. The period of time before starting therapy varied considerably (range, 11–263 days). The control group consisted of nine patients who did not receive therapy (assessed at a range of 70–2466 days). The outcomes included a visual analogue scale pain score, and analysis of shoulder flexion and abduction (Mann–Whitney tests), and of shoulder elevation and pain (Wilcoxon tests). They found a limited effect on pain, but a statistically significant improvement in passive and active range of movement.

This study is well-written and describes positive results from a holistic programme of rehabilitation. However, given the multifaceted therapy, it is impossible to define how much each individual therapy contributed to the overall improvement. It is unclear how useful the control group is; it appears to represent an untreated baseline rather than a true control. The numbers are also small, and the range of time after treatment is wide.

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Table 1. Characteristics of included trials

Trial	Location	Intervention	Control	Numbers of cases that completed trial (intervention: control)	Cases lost from initial sample (%)	Randomised?	Blinded?	Significant difference (at 5% level)?
McNeely *et al.* (2004)[10]	Canada	Progressive resistance physiotherapy	Non-progressive physiotherapy	8:9	15	Yes	Outcome testing blinded	Yes
Shimada *et al.* (2007)[11]	Japan	Multifaceted rehabilitation programme including physiotherapy	No rehabilitation	29:9	0	No	No	Yes
McNeely *et al.* (2008)[12]	Canada	Progressive resistance physiotherapy	Non-progressive physiotherapy	27:25	12	Yes	Outcome testing blinded	Yes
Nibu *et al.* (2010)[13]	Japan	Unspecified physiotherapy	No therapy, data from previous study	224:74	0	No	No	Yes
Lauchlan *et al.* (2011)[14]	Scotland	Tailored physiotherapy	No physiotherapy	11:13	25	Yes	Outcome testing blinded	No
Wu *et al.* (2018)[15]	China	Upper limb physiotherapy	No physiotherapy	29:36	14	No	No	No
Do *et al.* (2018)[16]	South Korea	Supervised physiotherapy	Unsupervised physiotherapy	20:20	15	No	No	Yes

McNeely et al. (2008)[12]

This was a Canadian randomised, controlled trial that was preceded by the pilot study described above. It is included as a different study, as both were published as separate studies and include different patients. As in the pilot, this trial compared progressive resistance training to standard non-progressive physiotherapy; both groups had a minimum of two supervised sessions a week for 12 weeks. Patients were eligible if they had confirmed signs of shoulder dysfunction, having undergone any type of neck dissection. Randomisation was stratified to allow for primary site and extent of neck dissection. Outcome assessors were blinded.

Fifty-two patients were randomised to treatment groups, with 27 in the intervention arm. Ninety-two per cent of patients completed follow up; 95 per cent and 87 per cent completed the intervention and control arms respectively. The intervention arm showed statistically significant improvements in terms of: shoulder pain and disability (patient-rated score of 29.6; 95 per cent confidence interval (CI) = 216.4–24.5; $p = 0.001$), upper extremity strength (110.8 kg; 95 per cent CI = 5.4–16.2 kg; $p < 0.001$), and upper extremity endurance (194 repetitions at 3 kg; 95 per cent CI = 10–378; $p = 0.039$).

Although the assessors were blinded, the physiotherapist (the first author) was the same for both groups, which is a potential source of bias. Two other concerns are the wide range of time from surgery to beginning therapy (over 18 months in 44 per cent of cases), and the limited follow-up time. Outcomes were measured at the end of the three-month programme, leaving no evidence that the gains made are sustained long-term.

Nibu et al. (2010)[13]

This Japanese study was a non-randomised trial that included a control group from a previous study. The patients had undergone neck dissection for head and neck cancer at a single centre. Exclusion criteria included previous neck or shoulder conditions. There were 224 patients in the intervention group and 74 patients in the control group. The outcome measurements were a questionnaire and assessment of the ability to abduct the upper limb to 180 degrees. At 12 months, the arm abduction test results were significantly better in the intervention group compared to the control group in those patients who had undergone accessory nerve sacrifice ($p = 0.03$); a statistically significant improvement was not seen in patients with an intact accessory nerve.

This is a large study that shows some significant improvement in function with physiotherapy. However, the study primarily looks at the level of disability in different types of neck dissection and the patients included are therefore heterogeneous. Adjuvant radiotherapy is not commented on, which, as described above, is thought to have a significant impact. Most disappointingly, there is very little description of the type of shoulder rehabilitation the patients were given, other than that the programme was 'designed for neck dissection'; no detail is given on when it was introduced, the level of support, monitoring or training, or the type of therapy given.

Lauchlan et al. (2011)[14]

This was a randomised, controlled trial including patients who underwent neck dissection at a single hospital in Scotland. Thirty-four patients were approached, 32 patients enrolled in the trial, and the findings for 24 patients were finally available for interpretation (11 in the intervention group). The type of therapy administered was tailored by the physiotherapist for each patient; therapy included active and passive range of motion exercises, and resistance training. Outcomes were the Constant–Murley score, and the American Shoulder and Elbow Surgeons Shoulder Assessment score. The final

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assessment was single-blinded. There was no statistical difference between the groups at one year of follow up.

The authors acknowledge disappointment in the low numbers enrolled and included in the final study. From the previous year's throughput, they were expecting 60 patients in total. This was a well-designed and written study that unfortunately did not recruit and retain enough participants to be adequately powered.

Wu et al. (2018)[15]

This was a prospective, non-randomised, controlled trial conducted in China. It included 76 patients who underwent total laryngectomy with neck dissection. Salvage cases were excluded. The control group received standard care with no formal shoulder rehabilitation. The intervention group received early shoulder physiotherapy lasting 12 weeks; this began from day 2 with light range of motion exercises, and built up with progressive resistance training. Outcome measurements were recorded at baseline, and at two and six months, and consisted of the Constant–Murley score. Forty patients were recruited to the intervention group, with data for 29 remaining for analysis, and 36 patients were recruited to the control group. There was no statistically significant difference found between the groups. The authors concluded that physiotherapy has no significant effect.

In analysing this trial, there are some deficiencies that make it difficult to agree with the authors' acceptance of the null hypothesis. The trial included no blinding and no randomisation. In terms of design, it was an observational study that compared one unit which provided active physiotherapy to another unit that did not. This inevitably introduces elements of bias, as there may be differences between the two hospitals at each step of the patients' pathway, including different surgical teams. Much of the physiotherapy programme was unsupervised. The researchers admit that general upper limb exercises were used, and hypothesise that more focused trapezius muscle exercise may have been more beneficial.

Furthermore, there are no power calculations, and it seems likely that this sample was too small to show an effect. In contrast to the other studies, the intervention was preventative, with all patients receiving rehabilitation. The intervention arm finally included 29 patients; it is unclear how many had an accessory nerve palsy, and therefore the proportion of those patients who could have obtained any benefit from the intervention is unknown.

Do et al. (2018)[16]

This prospective trial was conducted in South Korea. Forty patients were included; all had shoulder dysfunction following neck dissection, with accessory nerve palsy confirmed by electromyography. Forty-seven patients were enrolled and seven dropped out. Twenty patients received 40 minutes of supervised physiotherapy, three times every week. Twenty patients were assigned to home-based physiotherapy following an initial training session and receipt of instruction leaflets. Both programmes included range of motion, massage, stretching and resistance exercises. Outcomes were assessed in terms of a quality of life score, active range of movement measurements, a neck and shoulder disability index, and a pain score. Sixty per cent of the hospital group and 75 per cent of patients in the home group received radiotherapy. Statistically significant differences were shown in favour of the hospital-based group in terms of: the neck and shoulder disability index ($p = 0.006$), neck extension ($p = 0.007$), neck rotation ($p = 0.001$), and pain scores ($p = 0.001$).

This was a well reported study that described the power calculation and statistics used in detail. However, there was no randomisation; the participants chose the group they would enrol in, which introduces a large risk of bias. It seems possible that more proactive, less unwell patients may choose to attend hospital three times a week and fully engage in therapy. The difference in radiotherapy between groups is also a concern, although otherwise the groups appear balanced.

Summary and comparison

This systematic review has identified seven prospective studies that are relevant to the research question. However, all have flaws in design or do not directly test the hypothesis.

There were three randomised, controlled trials identified. McNeely and colleagues' two papers were both well designed randomised, controlled trials.[10,12] However, the physiotherapist (and lead author), was unable to be blinded and that may have introduced bias. Both trials described statistically significant differences in favour of progressive resistance physiotherapy; however, they compared one type of physiotherapy to another and therefore did not specifically test the hypothesis. The results of progressive resistance physiotherapy are convincing, but the follow up is limited; it is regrettable that the larger trial did not include outcomes after 12 weeks. Lauchlan and colleagues' study was well designed and reported, with a year of follow up, and aimed to test the hypothesis.[14] However, they failed to recruit sufficient patients and therefore the results did not reach significance.

The remaining studies all had large deficiencies, although they did yield some useful findings. Nibu and colleagues' study was the largest; it showed a statistically significant improvement in abduction, but failed to describe what the physiotherapy entailed, which severely limits its usefulness and application.[13] Shimada and colleagues' study did not include a true control arm; however, it described significant improvements following a holistic rehabilitation programme that included physiotherapy.[11] Do *et al.* demonstrated that supervised physiotherapy was superior to unsupervised outpatient physiotherapy, although the lack of randomisation is a significant source of bias.[16] These three studies add some weight to the conclusion that physiotherapy is beneficial for shoulder dysfunction following neck dissection. However, given the weaknesses in their design, it is not possible to quantify the scale of the benefit; a properly orchestrated control group, matched or statistically allowing for variables, would be needed for this.

Wu and colleagues' study was the only one to conclude that physiotherapy has no benefit. However, given that it was underpowered, without randomisation and with a high risk of bias, it was not felt to provide strong enough evidence to prove equipoise.[15]

Importantly, none of the papers described any adverse effects of therapy. Furthermore, the majority of patients enrolled completed the studies. This is in line with other research showing a positive patient response to rehabilitation programmes, and a reasonable uptake amongst head and neck patients specifically.[17]

All the studies identified relied on subjective outcomes; shoulder dysfunction is measured using questionnaires, patient responses, or by measuring strength or range of movement.

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Objective measures are possible; for example, by measuring trapezius muscle mass or via electro-physiological tests. However, such measures have inherent difficulties, and may be less relevant to the clinical problem and to the individual patient.[1]

As with all systematic reviews, publication bias is a valid concern. All full papers identified with the search strategy were accessed, and as such this review is felt to represent a thorough summary of the current published evidence. The heterogeneity in design, outcome measures and demographics precludes a meta-analysis. A large, randomised, double-blinded, multicentre, controlled trial would be desirable; however, the funding and level of interest across the professional community make this unlikely to be feasible.

Conclusion

The available evidence shows that physiotherapy can benefit shoulder function following neck dissection. The strongest evidence is in favour of progressive resistance physiotherapy, and it is likely that regular supervised therapy is superior to patient-led regimes. The studies with significant results included the highest risk groups (such as after radical neck dissection) or patients with proven shoulder dysfunction; no high-quality studies investigating the clinical or cost effectiveness of providing physiotherapy for all patients after neck dissection were found. Further research, including cost-effectiveness analysis and long-term follow up, would be valuable in allowing healthcare providers to decide if physiotherapy should become part of standard care, following this common procedure.

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