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REVIEW

Conservative treatment or surgery for shoulder impingement: systematic review and meta-analysis

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Abstract

Objective: To investigate the evidence on effectiveness of surgery for shoulder impingement compared with conservative treatment. *Data sources*: Cochrane Controlled Trials Register, MEDLINE, EMBASE, CINAHL and Science Citation Index databases were searched in March 2013 unrestricted by date or language. *Study selection*: Controlled randomized (RCT) or quasi-randomized clinical trials comparing surgery and conservative treatment of shoulder impingement were included. *Data extraction*: The methodological quality of each included trial was assessed according to the Cochrane Collaboration's domain-based evaluation framework. *Data synthesis*: Of seven included RCTs, risk of systematic bias was considered to be low for two, high for four, and unclear for one RCT. The random-effect meta-analysis was conducted on four RCTs involving 347 subjects (173 surgically treated cases and 174 controls). There was no significant difference in changes in pain intensity between surgically and conservatively treated subjects (Hedges's $g = 0.01$ in favor of conservative treatment, 95% CI −0.27 to 0.30). *Conclusion*: Based on the review of seven RCTs, the evidence on effectiveness of surgical or conservative treatment of shoulder impingement was found to be limited. There was, however, moderate evidence that surgical treatment is not more effective than active exercises on reducing pain intensity caused by shoulder impingement.

➤ Implications for Rehabilitation

- Based on the review of seven RCTs, the evidence on effectiveness of surgical or conservative treatment of shoulder impingement was found to be limited.
- There was moderate evidence that surgical treatment is not more effective than active exercises on reducing pain intensity caused by shoulder impingement.
- Because of surgery's higher costs and susceptibility for complications compared with costs and risks of conservative treatment, conservative treatment can be recommended as a first choice of treatment of shoulder impingement in first or second grade.

Keywords

Acromioplasty, effectiveness, exercise, pain, rehabilitation shoulder impingement, rotator cuff, shoulder pain, surgery, treatment

History

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Introduction

Shoulder pain has been suggested to be the most common non-traumatic complaint arising from an arm, neck and shoulder region. The 1-year prevalence of shoulder pain among the general population has been estimated to vary between 7% and 30%, while life-time prevalence up to 70% [1,2]. Shoulder, or subacromial, impingement syndrome, understood as a complex of clinical symptoms and radiological findings related to compression of rotator cuff's muscles and tendons, has been proposed as the most common source of shoulder pain [3]. The importance of this condition is emphasized by the fact that it often affects people of working age increasing the negative economic impact of this disorder.

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There are several options for the treatment of shoulder impingement. They include different types of open and arthroscopic surgical decompression techniques of the subacromial space, and numerous conservative methods, such as heat, cold, education, exercises, shockwave therapy, and acupuncture among others. For many physicians, choosing between operative and conservative treatment of a patient with shoulder pain is a frequent challenge. Surgery is presumably more expensive and prone to risk of complications compared to conservative methods. Thus, taking steps towards surgery should be supported by evidence on its superiority over other treatment methods. So far, the evidence of effectiveness of any type of treatment of shoulder impingement, as well as the evidence of superiority of a particular treatment over others, is limited. Several studies have suggested the arthroscopic technique to be more effective and to have lower risk of complications compared to open surgery [4–6]. There are also some studies and reviews comparing different conservative approaches [6–13]. The important issue of superiority of surgical over non-surgical methods is less studied. So far, only a few

randomized controlled studies (RCTs) on this topic have been conducted, ending up with controversial conclusions [4,14]. Previous systematic reviews have not found evidence to support the use of surgery over conservative treatment of shoulder impingement. Previous reviews on the topic of interest have included two to four relevant RCTs conducted without meta-analysis on any outcome [4,14].

The objective of this review was (1) to identify controlled randomized and non-randomized studies comparing the effectiveness of surgical and non-surgical treatment of shoulder impingement, (2) to assess the methodological quality of the evidence, (3) and to conduct a meta-analysis on any outcome variable available.

Methods

Criteria for considering studies for this review

Criteria for considering studies for this review were based on the PICO (Population, Intervention, Comparison, and Outcome) framework [15] as follows.

Population

Adults (≥18 years) with shoulder impingement confirmed by physical or radiological examination. Other diseases of shoulder region such as tumors, adhesive capsulitis, shoulder instability, joint replacement or fractures were excluded.

Intervention

Any type of open or arthroscopic surgical techniques targeting release of shoulder impingement.

Comparison

Any type of conservative treatment including physical training, education, and passive physiotherapy, or comparable treatment.

Outcome

All outcomes reported in the trials. Intensity or frequency of pain (measured as a single covariate or as a part of other score, such as among others Constant, Neer, American Shoulder and Elbow Surgeons Shoulder) was considered as a main outcome. Other outcomes than pain were considered as secondary outcomes and included such measures as quality of life, range of motion, return to work, and satisfaction with treatment among others.

Search methods for identification of studies

Cochrane Controlled Trials Register (CENTRAL), MEDLINE, EMBASE, CINAHL and Science Citation Index databases were searched in March 2013 unrestricted by date or language. The search clauses are presented in Table 1. In order to avoid missing relevant studies, use of limits was restricted and further selection was conducted manually. The references of identified articles and reviews were also checked.

Study selection and methodological quality assessment

The relevant studies were selected by one reviewer (M.S.) and methodological quality assessment conducted by two independent reviewer teams (M.S. and V.Ä. + K.L.). Disagreements were resolved by consensus with the fourth review author (P.V.). Data were extracted from the included trials using a standardized form based on recommendations by the Cochrane Handbook for Systematic Reviews of Interventions Version 5.1.0 [16]. The methodological quality was assessed according to the Cochrane Collaboration's domain-based evaluation framework [16].

Table 1. Search strategy.

Database	Search conditions	Result *N*
CENTRAL	#1 shoulder:ti or rotator cuff:ti (Word variations have been searched) #2 surg* or acromioplast* or debride* or repair*:ti (Word variations have been searched) #1 and #2 in Trials (Word variations have been searched)	219
MEDLINE	((shoulder [TITLE]) OR (rotator cuff [TITLE])) AND ((surg* [TITLE]) OR (acromioplast* [TITLE]) OR (debride* [TITLE]) OR (repair* [TITLE])) AND ((Controlled Clinical Trial[ptyp] OR Randomized Controlled Trial[ptyp]) AND hasabstract[text])	168
EMBASE	#1 shoulder:ti #2 'rotator cuff':ti #3 surg*:ti #4 acromioplasty:ti #5 debride*:ti #6 repair*:ti #7 = #1 OR #2 #8 = #3 OR #4 OR #5 OR #6 #9 = #7 AND #8 #9 AND ('controlled clinical trial'/de OR 'randomized controlled trial'/de)	189
CINAHL	(TI shoulder OR TI rotator cuff) AND (TI surg* OR TI acromioplast* OR TI debride* OR TI repair*) Limiters – Abstract Available; Publication Type: Clinical Trial, Randomized Controlled Trial	32
Science Citation Index	((TI = (shoulder) OR TI = (rotator cuff)) AND TI = (impingement)) AND (TI = (surg*) OR TI = (acromioplast*) OR TI = (debride*) OR TI = (repair*)) Timespan = All years. Databases = SCI-EXPANDED.	35

Main domains were assessed in the following sequence: (1) selection bias (randomized sequence generation and allocation concealment); (2) performance bias (blinding of participants and personnel); (3) detection bias (blinding of outcome assessment); (4) attrition bias (incomplete outcome data e.g. due to dropouts); (5) reporting bias (selective reporting); (6) other sources of bias. The scores for each bias domain and the final score of risk of systematic bias were graded as low, high, or unclear risk.

Methods used in the meta-analysis

The heterogeneity of results of the included studies was assessed and reported as I^2 and its 95% confidence intervals (CI). We used a random effects meta-analysis to quantify the pooled size of the effect found in included studies on reducing pain level of the participants. Three studies were excluded from the meta-analysis. One of them did not report any statistics on sample variance [17]. Two studies were excluded as they utilized samples already employed in other studies conducted by the same research teams but with different periods of follow-up [18,19]. If pain intensity level was reported in more than one form, only pain at performance was included. Because of using different pain scales, the comparison between raw means of differences between groups was not possible. First, effect sizes for each study were calculated as Hedges's g, and second, obtained estimates were jointed into a weighted pooled effect size reported as Hedges's g along with 95% CI and *p*-values. The potential publication bias was evaluated by Egger's test for asymmetry of the funnel plot

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Table 2. The descriptive characteristics of included studies.

Study	Brox	Peters	Rahme	Brox	Haahr	Haahr	Ketola
Year	1993	1997	1998	1999	2005	2006	2009
Country	Norway	Germany	Sweden	Norway	Denmark	Denmark	Finland
Settings	Public hospital	n/s	Public hospital	Public hospital	Public hospital	Public hospital	Public hospital
Risk of bias	Low	High	High	Unclear	High	High	Low
Enrollment	n/s[a]	n/s	1986–1988	n/s	1996–2001	1996–2000[b]	2001–2004
Follow-up (rate %)	0.5 year (95%)	4 years (67%)	0.5 years[h] (93%)	2.5 years (88%)	1 year (91%)	4 to 8 years (88%)[c]	2 years (96%)
Cases, *N* (women %)	45 (64)	32 (56%)	21 (n/s)[e]	39 (64)	41 (29%)	39 (29%)[d]	68 (41%)
Controls, *N* (women %)	50 (44)	40 (70%)	18 (n/s)[e]	45 (44)	43 (33%)	40 (33%)[d]	66 (33%)
Age (years)	48/47	56/59	42[e]	48/47	44/45	44[f]	46/48
Case treatment	Arthroscopic bursectomy and acromioplasty	Open ($n = 17$) acromioplasty according to Neer or arthroscopic ($n = 15$) subacromial decompression according to Ellman	Open anterior acromioplasty according to Neer	Arthroscopic bursectomy and acromioplasty.	Arthroscopic subacromial decompression (bursectomy with acromioplasty resection of coracoacromial ligament)	Arthroscopic subacromial decompression (bursectomy with acromioplasty resection of coracoacromial ligament)	Arthroscopic acromioplasty with or without coracoacromial ligament release
Postoperative treatment	Training programme supervised by physiotherapist; intensity and duration n/s	Training program supervised by physiotherapist, intensity and duration n/s	Similar to controls	Training programme supervised by physiotherapist; intensity and duration n/s	Physiotherapy, intensity and duration n/s	Physiotherapy, intensity and duration n/s	Similar to controls
Control treatment	Information and training probably supervised by a physiotherapist 2/w[g] for 3–6 months.	Two-week hospital stay: intensive physiotherapy supported with NSAIDs and 1–3 corticosteroid injections	Information and training probably supervised by a physiotherapist. The intensity of training is not clearly defined	Information and training probably supervised by a physiotherapist. 2/w, 3–6 months	Heat and cold, physiotherapy 60 min (19 sessions) 3/w for 2 w, 2/w for 3 w and 1/w for 7 w	Heat and cold, physiotherapy 60 min (19 sessions) 3/w for 2 w, 2/w for 3 w and 1/w for 7 w	Information and training supervised by a physiotherapist. 4/w; individually planned home exercise program

[a]Non-specified; [b]Inconsistency with 2005 study; [c]Mean not reported, 11 patients (24%) moved from control to case group; [d]Gender distribution not specified, probably the same as in previous study; [e]The mean age and gender are reported for the entire sample as 42 years (45% men); [f]The mean age for the entire sample as 44 years; [g]Week(s); [h]12 month-follow-up was excluded from the review due to a high rate of crossover from conservative to surgery group after 6 months ($n = 12$).

(test for the Y intercept = 0 from a linear regression of normalized effect estimate against precision). The trim and fill method was used to impute studies into funnel plot to correct asymmetry.

All calculations for the meta-analysis were made using MIX 2.0. Version 2.0.1.4. BiostatXL, 2011, available from http://www.meta-analysis-made-easy.com

Results

Description of studies

Seven RCTs were considered to fulfill the inclusion criteria of a systematic review [17–23]. Their descriptive characteristics are introduced in Table 2. Follow-ups varied from 6 months to 8 years. Sample sizes varied from 39 (21 cases and 18 controls) to 134 (68 cases and 66 controls) participants. Six of the seven studies were conducted in public hospitals. Participants' age ranged mostly between 40 and 50 years, except for one study where older patients were involved [17]. Open surgery techniques were used in two studies [17,23], and arthroscopic methods in six studies (in one study cases were operated using open as well as the arthroscopic methods [17]). The inclusion and exclusion criteria for the RCTs included in this review are summarized in Table 3. The inclusion criteria of all RCTs were similar requiring shoulder impingement confirmed clinically by using conventional provocation tests and response to anesthetic infiltration. Other than shoulder impingement conditions were excluded. Conservative treatment included usually active training under supervision by physiotherapist combined with physiotherapy and pain medication. Methods, intensity, and duration of conservative treatment varied widely.

Risk of bias in included studies

Systematic risk of bias was considered to be high in two studies, low in four, and unclear in one (Table 4). The most frequent source of potential bias was performance bias relating to blinding of participants and personnel, which was expected in studies involving a surgical procedure.

Effects of interventions

Outcome measures used in the included studies varied widely (Table 5). The only outcome shared across all studies was pain intensity assessed, however, with different scales. Surgery was found to be superior to conservative treatment in four studies [17,18,20,23]. Of them, the risk of bias was considered high in two studies [17,23], low in one [20], and unclear in one study [18]. Three studies, all of low risk of bias, reported no differences between groups [19,21,22]. Treatment costs were analyzed in two studies finding surgery almost twice as expensive as no-surgery [20,22]. Four of the studies found improvements in both groups [18,20,22,23]. Two studies, conducted on the same study sample, reported that both surgery and conservative treatment were superior to no-treatment [18,20].

Meta-analysis

The heterogeneity assessment resulted in I^2 of 41% (95% CI 0–80%) which was considered moderate. The results of the meta-analysis of effects of included studies on reducing pain intensity are presented in Figure 1. In the forest plot the studies are represented by symbols whose areas are proportional to the study's weight in the analysis. No statistically significant effect size was observed in any of the studies. The random-effect

Table 3. Inclusion and exclusion criteria of included studies.

Study	Brox (1993, 1999)	Peters (1997)	Rahme (1998)	Haahr (2005, 2006)	Ketola (2009)
	Positive clinical impingement tests, positive result of a subacromial anesthetic infiltration AND:				
Inclusion	Age 18–66, shoulder pain ≥3 months		Working age, isolated shoulder disease, pain ≥1 year		Shoulder pain ≥3 months
Exclusion	Arthritis, cervical syndrome, rotator cuff rupture, glenohumeral instability, bilateral muscular pain with tenderness and severely decreased ability to relax the shoulder, neck, and temporomandibular joints, reluctancy to treatment	Full thickness tear	Osteoarthritis, requirement for a resection of lateral end of clavicle	Osteoarthritis, cervical syndrome, impaired rotation, history of acute trauma, previous surgery or previous fracture in the affected shoulder, calcifications >2 cm, cuff tear	Osteoarthritis, cervical syndrome, gleno-humeral instability, previous surgery to the affected shoulder, a full thickness tear, adhesive capsulitis, neuropathy.

Table 4. Risk of bias summary.

Study	Random sequence generation (selection bias)	Allocation concealment (selection bias)	Blinding of participants and personnel (performance bias)	Blinding of outcome measurement (detection bias)	Incomplete outcome data (attrition bias)	Selective reporting (reporting bias)	Overall risk of systematic bias
Brox (1993)	☺	☹	😐	☺	☺	☺	☺
Peters (1997)	☹	☹	☹	☹	☹	☺	☺
Rahme (1998)	☹	☹	☹	☹	☹	☺	☺
Brox (1999)	☺	☹	😐	☹	☺	☺	☺
Haahr (2005)	☺	☺	☹	☹	☺	☺	☺
Haahr (2006)	☺	☺	☹	☹	☺	☺	☺
Ketola (2009)	☺	☺	😐	☺	😐	☺	☺

☺ Low risk of bias; ☹ High risk of bias; 😐 Unclear risk of bias.

Table 5. The outcome measures and main results of included studies.

	Outcome	Main results	Authors' conclusions
Brox (1993)	Main: Neer shoulder score Secondary: Pain on activity, at rest, and at night during the previous week on 9-point scale; Hopkins symptom check list (emotional distress); treatment coasts	Neer score improved 4 points in cases and 2 points in controls. Reduction of pain was equal. Significant improvement in both groups compared with placebo. Treatment costs were higher in cases (£720 v £390)[a]	''. . . results were better after surgery, but the difference between the two treatments was neither significant nor clinically important''
Peters (1997)	Subjective shoulder rating scale (SSRS), modified Constant score, pain, restriction of movement, activity, feeling of instability, ability to work overhead	Pain intensity, range on motion, activity, and ability to work overhead improved more in cases[b]	''. . . both forms of treatment led to an improvement of the subacromial impingement . . .'' Surgery was more beneficial regarding treatment of pain
Rahme (1998)	Pain intensity at rest and during performance. Change was dichotomized by relative ratio of pain score at baseline and follow-up	At 6 months ''success'' in 57% cases and in 33% controls[c]	''. . . surgical treatment is more effective than a standardized physiotherapy . . .''
Brox (1999)	Main: Neer shoulder score Secondary: Pain on activity, at rest, and at night during the previous week on 9-point scale; Hopkins symptom check list (emotional distress)	Neer score improved in cases >1.5 (OR) times compared to controls. In surgery group better Neer score improvement in those who were not on sick leave and who did not use pain medication. Improvement regarding pain intensity in both groups compared with placebo	Surgery was superior to conservative treatment; both were superior to no-treatment
Haahr (2005)	Constant score, Prim score	No group differences in mean pain and dysfunction score improvement	No group differences
Haahr (2006)	Sick leave and disability pension, employment status, work ability, PRIM score	No group differences except for higher rate of sick leaves in cases	No group differences
Ketola (2009)	Main: Pain intensity overall Secondary: Disability level, pain at rest, work ability, shoulder questionnaire score, rate of painful days, proportion of pain-free patients, costs of treatment	Improvement in both group without differences between them; mean total cost in cases €2961, €1864 in controls	No group differences, higher costs in cases

[a]Study sample was divided in three groups: surgery, physiotherapy, and placebo (comparison with placebo group was excluded from the meta-analysis).
[b]No statistical analysis of significance was conducted.
[c]12 month-follow-up was excluded due to a large crossover from conservative to surgery group.

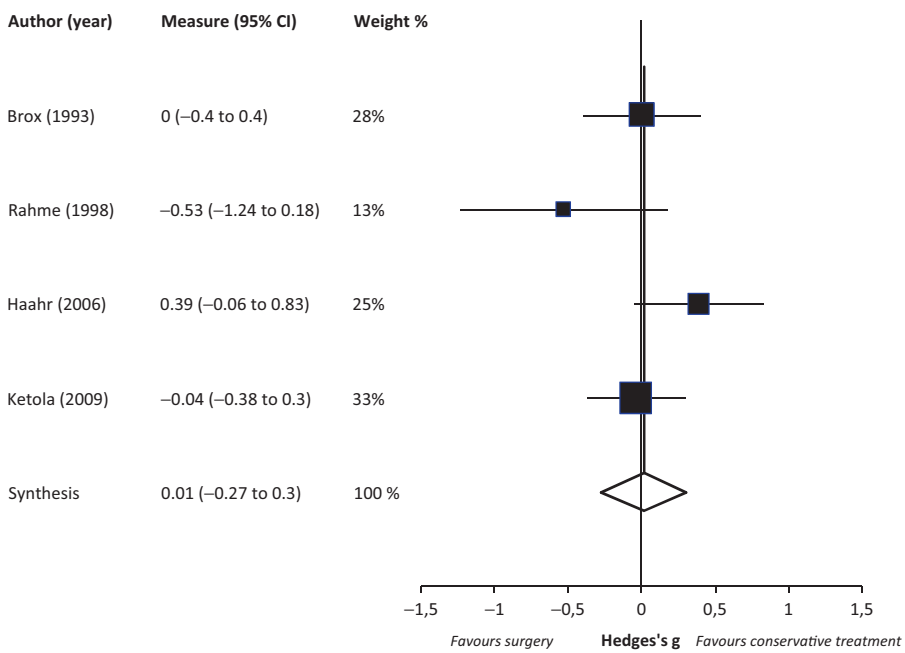


Figure 1. Forest plot demonstrating effects sizes of each study and weighted pooled effect size.

meta-analysis was conducted on four RCTs involving 347 subjects (173 surgically treated cases and 174 controls). The pooled effect size of four included studies, calculated as Hedges's g, was 0.014 (95% CI −0.27 to 0.30, $p = 0.923$) in favor of conservative treatment. This effect size was considered as weak. We also conducted a sensitivity analysis of the results by running synthesis four times excluding each time one of the included studies (Figure 2). In this sensitivity test, the synthesis estimate

Figure 2. Exclusion sensitivity plot.

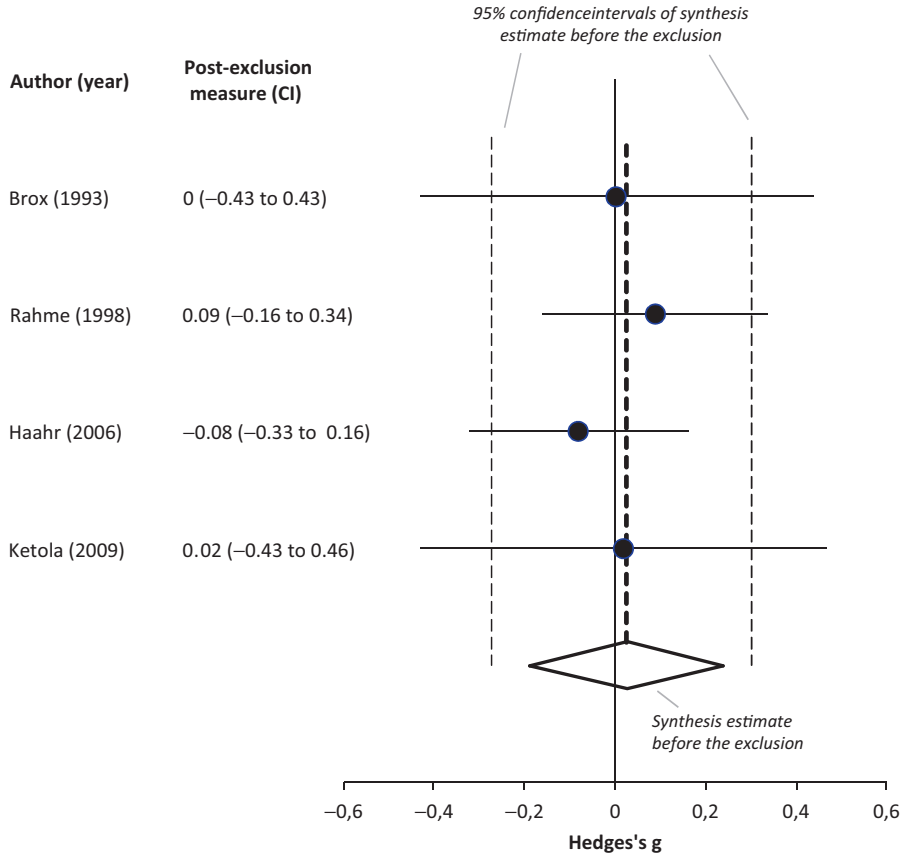
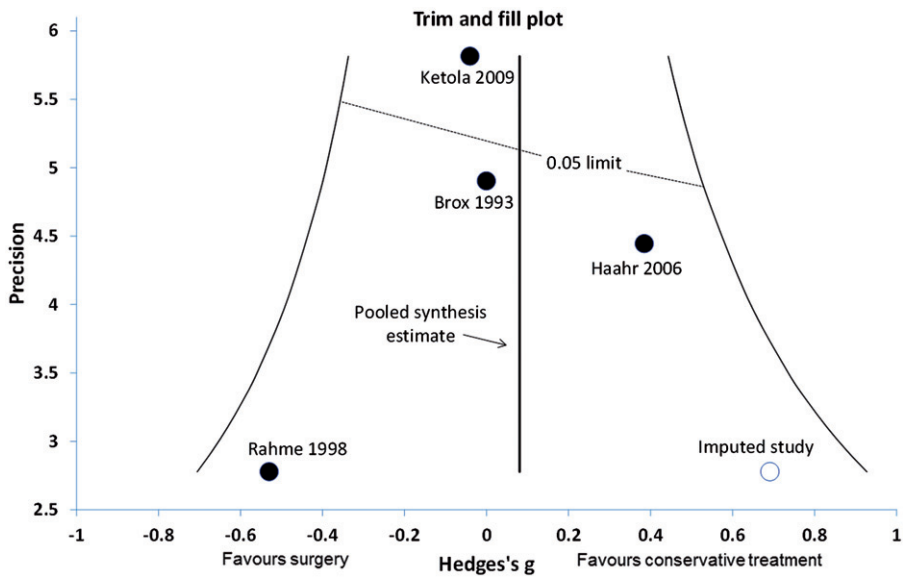


Figure 3. Funnel plot of standard error by Hedges's g after trim-and-fill applied.



(Hedges's g) varied between −0.08 (95% CI −0.33 to 0.16) and 0.09 (95% CI −0.16 to 0.34) showing no statistical significance. A mild asymmetry of funnel plot was observed in the analysis for possible publication bias (Figure 3). As suggested by trim-and-fill method, a single imputed study would favor conservative treatment.

Discussion

This first meta-analysis associated with shoulder impingement syndrome found moderate evidence that surgery and conservative methods have similar effect on the reduction of pain intensity. The meta-analysis estimating the reduction of pain intensity showed small and statistically insignificant pooled effect size in favor of conservative treatment. Patients included in the meta-analysis had mostly shoulder impingement in stage two. In the systematic review of seven RCTs, no evidence was obtained to support the superiority of surgery over conservative treatment or vice versa among patients with shoulder impingement. The studies included in the review have found surgery to be more expensive than conservative treatment.

There are many limitations to the strength of the conclusions that can be drawn from the results of the meta-analysis. Some of the included studies were prone to risk of systematic bias, were

conducted on relatively small samples, and often assessed outcomes by using different evaluation scales. Conservative treatment used pre- and postoperatively in the surgery group, as well as treatment used in the control group, varied widely and were described insufficiently in most of the trials. Of all outcome measures used in the included RCTs, only the change in pain intensity was reported by all research teams, and reported figures were considered precise enough to perform a meta-analysis. This leaves many potentially important effects unrevealed. For instance, speed of recovery, return to work, use of pain medication, and utilization of health services were either reported by a few trials or not reported at all. Cost-effectiveness of operative versus conservative treatment or placebo as well as diverse effects of operations were also reported only in a few studies. The follow-ups of included studies were too short to confirm previously suggested protective effect of surgery on the risk of rotator cuff tears in the long run. There is no consensus on causes and diagnostic criteria of shoulder impingement syndrome which makes it a commonly used diagnosis for patients with non-specific shoulder pain. This fact was reflected by inconsistency and impreciseness of inclusion criteria observed in the studies under review. Therefore, there might be numerous confounding factors and differences between the studied samples. All four studies included in the meta-analysis evaluated a second stage shoulder impingement as defined by Neer classification [24]. While not clearly defined, it is probable that the study by Brox et al. [20] also involved patients with impingement in stage three. The clinical decision between surgical and non-surgical line of treatment may apparently depend on the stage of impingement. This must be taken into account when interpreting the results of clinical studies on the topic of interest.

Our conclusions were in line with reports of previous systematic reviews [4,14] which found no firm evidence on the superiority of surgery over conservative treatment of shoulder impingement. As far as we know, only one previous systematic review focused mainly on comparison between surgery and conservative treatment of shoulder impingement [14]. Some previous reviews primarily focused on the comparison between different surgical techniques [4–6] or conservative treatment methods [8–13]. There are also reviews on the entire set of problems related to the shoulder region [4–6,11], while we focused on only one particular condition – shoulder impingement. When compared to previous reviews, our review includes more studies on the topic of interest [4,14]. This fact made it possible to conduct the first meta-analysis on the subject. Contemplation on an aforementioned wide-ranged diversity of outcome scales suggests that at least one important issue may be missed from all of the included RCTs. Outcome measures used in the studies assess mostly changes in severity of the participants' physical or psychological symptoms. The impact of these symptoms and their changes on a person's everyday life (as well as, in reverse direction, impact of everyday life on the severity of symptoms) remained unrevealed. Especially, the role of environmental factors (e.g. support by employer, family, physical demands to shoulder functions during recreation activities or sport) has not been reported so far. Comprehensive assessment of functioning, activity and participation, introduced by the World Health Organisation through the International Classification of Functioning, Disability and Health (ICF), undoubtedly should be included in studies on the topic of interest [25,26].

Implications for further research

Further randomized control trials on the topic of interest are needed. Such studies should be conducted on large samples with long periods of follow-up. Further research may focus on comparison between different methods of treating patients with impingement of different severities, duration of symptoms, and morphological types. Comprehensive assessment of patients' functioning, activity and participation should be used in further research with the ICF as a first choice of such outcome measures.

Implications for practice

There is no evidence of surgery being more effective than conservative methods in the treatment of shoulder impingement. There is moderate evidence that surgery and conservative methods have similar effect on reduction of pain intensity amongst patients with shoulder impingent in stage two. Because of surgery's higher costs and susceptibility for complications compared with costs and risks of conservative treatment, surgical release of shoulder impingement cannot be recommended as a first choice of treatment until its use is justified by more firm evidence. As some of the included studies suggested conservative treatment may be more effective than placebo, rehabilitation could be favored over waiting for spontaneous improvement.

Declaration of interest

The authors declare no conflicts of interests. The authors alone are responsible for the content and writing of this article.

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