Is arthroscopic surgery for stabilisation of chronic shoulder instability as effective as open surgery?

A SYSTEMATIC REVIEW AND META-ANALYSIS OF 62 STUDIES INCLUDING 3044 ARTHROSCOPIC OPERATIONS

A systematic search of the literature published between January 1985 and February 2006 identified 62 studies which reported the results of arthroscopic procedures for chronic anterior shoulder instability or comparisons between arthroscopic and open surgery. These studies were classified by surgical technique and research methodology, and when appropriate, were included in a meta-analysis. The failure rate of arthroscopic shoulder stabilisation using staples or transglenoid suture techniques appeared to be significantly higher than that of either open surgery or arthroscopic stabilisation using suture anchors or bio-absorbable tacks. Arthroscopic anterior stabilisation using the most effective techniques has a similar rate of failure to open stabilisation after two years.

Traumatic anteroinferior dislocation of the shoulder in young patients often results in recurrent instability. Open Bankart repair, in which the glenoid labrum and anterior glenohumeral ligament are reconstructed, is still considered by many to be the treatment of choice for stabilising the shoulder. However, open surgery may restrict external rotation and lead to secondary osteoarthritis. Arthroscopic techniques were developed in an attempt to avoid the wide dissection and scarring associated with open procedures. Their claimed advantages include reduced postoperative pain, earlier rehabilitation and less restriction of movement. The earliest arthroscopic technique relied upon capsulorrhaphy with metal staples. More recent techniques include the use of transglenoid sutures, bio-absorbable tacks and suture anchors.

Our aim was to assess from the published literature whether any particular method of arthroscopic shoulder stabilisation for chronic anterior instability is better than any other, and whether such surgery has a failure rate as low as that for open surgical stabilisation.

Literature search. We conducted a comprehensive search of various data sources including MEDLINE (Medical Literature Analysis and Retrieval System online, Bethesda, Maryland), EMBASE (Exerpta Medica Database, Amsterdam, The Netherlands), CINAHL (Cumulative Index to Nursing and Allied Health Literature Database Guide, Glendale, California) between January 1985 and February 2006 to identify appropriate studies which reported the outcome of arthroscopic procedures for recurrent anteroinferior instability of the shoulder. Our MEDLINE search used a combination of terms derived from its thesaurus including the exploded index terms ‘shoulder joint’, ‘instability’, and ‘arthroscopy’. We also scanned the reference lists of eligible studies for potentially relevant papers. We then reviewed the titles, abstracts and full text of apparently relevant articles in a three-stage process to determine their eligibility.

Eligibility criteria. We included comparative studies, analytical studies and case series if in English or French. We excluded studies with a mean follow-up of less than two years, abstract-only publications and chapters from books. Only patients undergoing stabilisation as a primary (first) surgical procedure were included. Patients without a history of recurrent dislocation or subluxation were excluded.

Extraction of data. At least two authors (two of DG, JH, MD, PB) independently extracted data from the eligible articles. Differences were resolved by discussion. Each study was also

Materials and Methods

We performed a meta-analysis of the available studies of open and arthroscopic surgery for chronic shoulder instability, following the Quality of Reporting of Meta-analysis (QUOROM) guidelines for synthesis of information from the existing literature.
reviewed for the quality of its methodology. Comparative studies were assessed using Detsky’s scoring system for randomised, controlled trials,\textsuperscript{16} while case series were assessed using a modification of the same scale which allowed assessment of observational studies and was specific for shoulder instability surgery (Table I). We used recurrence of instability as the outcome measure for failure. Recurrence was defined as the radiological documentation of further dislocation, recurrence of dislocation by re-injury requiring manual reduction, recurrence of symptoms of the shoulder ‘popping out’ or ‘slipping out’ in a position of abduction and external rotation suggestive of subluxation, or symptomatic subluxation or instability preventing the return to full activity or requiring further surgical stabilisation.

**Statistical analysis.** Risks for case series and risk ratios for failure for comparative studies were recalculated as were the confidence intervals (CI) for those risk estimates. All of the studies were tabulated to show, first, the incidence of failure from case-series studies of different arthroscopic techniques of stabilisation and, secondly, the relative risk of failure from trials comparing various arthroscopic techniques or arthroscopic techniques with open stabilisation.

When appropriate, meta-analysis was performed to summarise risk estimates. This was based on a random-effects model using the method of DerSimonian and Laird\textsuperscript{17} with an estimate of heterogeneity taken from the Mantel and Haenszel\textsuperscript{18} model. We made a pre hoc decision not to perform meta-analysis if homogeneity was improbable (heterogeneity p < 0.2). For case series, risks were calculated for pooled data using the model, and confidence limits of those risks weighted for the size of the study. For comparative studies, risk ratios were calculated for the individual studies, and a random-effects model meta-analysis was performed to calculate a combined risk ratio and related CI. We used Stata programming software (Release 9.1 with Staff Technical Bulletin 43 and 44 installed; StataCorporation, College Station, Texas) for these analyses.

**Results**

The search strategy identified 244 potentially relevant articles (Fig. 1). Studies were excluded if they did not meet our inclusion criteria on reading the abstract or full text, or if they scored less than two points on the quality score and thus gave insufficient detail to allow proper extraction of data.\textsuperscript{19,20} We included 62 studies in the analysis, but subsequently excluded five\textsuperscript{21-24} which reported patients who had pre-operative pain on overhead activity, but no documented dislocation or subluxation. The results were then recalculated. One patient in the open Bankart repair group of the study by Geiger et al\textsuperscript{25} had a failed previous procedure and was excluded. Acute reconstructions were excluded from four studies and the failure rates recalculated.\textsuperscript{23,26-28} Four studies\textsuperscript{29-32} included a small number of acute reconstructions, but were retained since these patients could not be separated from most cases of reconstruction for chronic instability. Three studies of Suretac anchors\textsuperscript{21,33,34} included a number of open repairs because of a per-operative change in technique. The open repairs were excluded and failure rates recalculated. Finally, in five studies\textsuperscript{10,35-38} the definition of failure was not consistent with our study and therefore the results were recalculated according to our criteria. The quality scores, failure rates and results of meta-analysis for case series are shown in Figures 2 and 3.

**Staple capsulorrhaphy.** Six studies\textsuperscript{10,22,36,37,39,40} reported arthroscopic staple capsulorrhaphy in 233 shoulders. The failure rate for individual studies ranged between 16% and 33%. The overall failure rate was 23% (95% CI, 18 to 31). There was no significant statistical heterogeneity in the reported failure rates (p = 0.28).
Transglenoid suture. There were 27 studies which reported on 1267 shoulders using two principal techniques of transglenoid suture for arthroscopic anterior capsulorrhaphy. The failure rates in 1623,25,41-54 which described the Caspari technique55 ranged between 8% and 60% and in 1126,27,56-64 reporting on the Morgan technique11 between 5% and 75%. There was significant heterogeneity in the reported failure rates for each technique (p < 0.01).

Bio-absorbable tacks. The failure rates for 12 studies21,24,26,33-35,65-70 using bio-absorbable tacks to stabilise 514 shoulders ranged between 0% and 44%. There was significant heterogeneity in the reported failure rates (p < 0.01).

Suture anchors. The failure rates for 20 studies23,28-32,38,43,71-81 using suture anchors to stabilise 1030 shoulders ranged between 0% and 30%. Most showed a failure rate of 10% or less. One72 seemed to be a clear outlier with a failure rate of 30%. When all 20 studies were combined, there was a failure rate of 9.1%, but with significant statistical evidence of heterogeneity (p < 0.01). When this study was excluded, the remaining 19 showed no heterogeneity (p = 0.42) and the combined failure rate was 8.9% (95% CI, 7 to 11).

Comparative studies. There were 13 studies which compared two or more techniques and two which compared three techniques, resulting in 19 within-study comparisons. Only two were randomised, controlled trials69,74 Nine26,29,35,38,66,69,74,78,82 comparisons were of open techniques (Bankart repair with or without capsular shift) with arthroscopic stabilisation using suture anchors or bio-absorbable tacks. The risk ratios varied between 1.1 and 2.4 in favour of open surgery. There was no significant heterogeneity (p = 0.72) and meta-analysis provided a risk ratio estimate of 1.3 (95% CI, 0.8 to 2.1) which was not
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**Follow-up Estimate & 95% CI of risk**

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**Meta-analysis not performed**

*Fig. 2*

Quality scores, risk estimates and meta-analyses of case series of shoulder stabilisation, (*, outlier; 95% CI, 95% confidence interval).
statistically significantly different from 1 (p = 0.33). Six comparisons were of open techniques with arthroscopic stabilisation using transglenoid sutures. The risk ratios varied between 1 and 25 in favour of open surgery. There was no significant heterogeneity (p = 0.42) and meta-analysis provided a risk ratio estimate of 2.9 (95% CI, 1.6 to 5.2), which was statistically significant (p < 0.01).

A further four comparisons were of arthroscopic stabilisation using transglenoid sutures with that using suture anchors. The risk ratios varied between 1.7 and 5.8 in favour of anchors. There was no significant heterogeneity (p = 0.64), and meta-analysis provided a risk ratio estimate of 2.4 (95% CI, 1.3 to 3.1) which was statistically significant (p < 0.01).

Discussion
Methodology. Meta-analysis is a statistical synthesis of the numerical results of several studies, all of which address the same question. A meta-analysis differs from a traditional, narrative literature review in several important ways. First, it uses pre-determined research protocols which specify the methods to be used and the types of report that will be eligible for review; secondly, it involves an extensive search for eligible reports in an attempt to assemble all the relevant literature; thirdly, an attempt is made to produce a quantitative summary of the eligible literature in contrast to the qualitative or narrative summary of a traditional literature review, the goal being to characterise the central tendencies of the eligible reports and to explore the variations among them.

Randomised, controlled trials provide the strongest evidence for meta-analysis. We found only one such study. The next best are comparative trials and population-based studies. We included 19 comparative trials in our study. We next expanded the usual meta-analytical approach to include data from case series. Although lacking a control group to allow a meaningful risk estimate, case-series reports represent most of the publications on arthroscopic stabilisation of the shoulder as well as providing the accumulated data of many expert surgeons on thousands of their patients. We felt that it was appropriate to include these studies, but to thoroughly question their potential for systematic and random error.
Systematic error. Many of the studies had methodological flaws even when allowances were made for the inherent weakness of observational studies to contribute to evidence of effectiveness. The extraction of data and analysis were impeded by the paucity of information provided by many authors and by the variable vigour with which they assessed outcome and presented their results. Many studies relied upon retrospective collection of data, and in some cases, review of the case notes. We considered the possibility that studies of poor quality were intrinsically more likely to be biased but we could find no evidence to show that quality scores were associated with outcome. We therefore included all studies with quality scores of 2 or more.

We considered the possibility of patient selection as an important source of bias since the inclusion criteria varied from study to study. Several patient factors are believed to influence the success of surgical stabilisation, including age and gender,28,37,41,43,48,71 the level of activity,23,33,41-43,47 participation in contact or collision sports,26,31 the type or severity of pre-operative instability,21,22,24,27,41 the number of pre-operative dislocations,32,33,43,56,62,72 severity and site of the capsular injury, the presence of a bone lesion and the competence of the glenohumeral ligaments.22,24,28,33,41-44,57,68 Since these variables were not adequately reported, we have been unable to adjust for them. Some authors seemed to have selected a low-risk group by excluding patients with bone loss, multiple dislocations or major labrocapsular disruptions. We suggest that variations in case-mix account for a considerable part of the variation in results and that the selection of a low-risk group may explain some of the studies with apparently very good results.

The interventions were generally well-defined, and yielded several clear groups. However, there were five studies of arthroscopic procedures which included a number of patients who had undergone thermal capsulorrhaphy. Four reported no benefit28,30,38,70 and one reported better results.50

The quality of reporting functional outcome and the method of reporting range of movement and complications varied markedly among the studies. This limited our review to clinical outcome with failure as the end-point, although it was not the only important outcome of stabilisation surgery. Even this was not without difficulty. Some studies reported only patients with recurrent dislocation as failures while others considered recurrent subluxation or shoulder pain during overhead activity or apprehension on provocative testing to constitute failure. We have tried to deal with this by defining failure clearly and by re-calculating the failure rates in each study. Even so, some studies did not specifically report provocative tests for instability and did not assess the ability of patients to return to all normal activities, including those likely to produce recurrent instability. Consequently, these are likely to have overestimated the effectiveness of reconstruction by our definition of failure. We do not believe that such overestimates apply to any particular surgical treatment.

The potential for bias when the operating surgeon collects outcome data is well recognised, and yet less than half of the studies used independent reviewers. We also know that persistent symptoms are more accurately reported when using self-administered questionnaires than when data collecting via a face-to-face28 or telephone interview.58 However, such questionnaires were rare. This was likely to have led to over-estimation of benefit, but probably applied to all of the surgical treatments.

Losses to follow-up were seldom explained adequately, even though patients that are lost to follow-up in orthopaedic outcome studies have been shown to have worse results than those who remain in the study.74,86,87 We also know that the incidence of redislocation after shoulder stabilisation surgery increases with time.41,63 The heterogeneity of rates of failure between shoulder series was probably partly due to differences in the length and completeness of the follow-up. We minimised this by setting a minimum mean follow-up period for inclusion of two years, by which time most failures should have occurred.

There were methodological weaknesses in many of the comparative studies. Five studies were retrospective23,25,43,58,78 and only two69,74 were randomised. In two studies,35,62 the allocation of treatment appeared to have been biased with those patients with a worse prognosis undergoing an open repair. In some studies,25,58,66,82 the patient chose their preference of procedure. Two studies compared two consecutive series,23,78 one study assigned treatment by hospital,59 while the other gave no details of allocation.45 Seven specified that they had used an independent observer,25,35,39,62,66,78,82 but only two described blinding of the observer.15,59 All of these issues may have introduced important bias. The selection of patients with a poor prognosis for open surgery and the longer follow-up in the reports on open surgery tended to underestimate the rate of failure of arthroscopic techniques when compared with open repair.

Random error. None of the studies acknowledged that estimates from small samples were subject to sampling error. We calculated the CIs for each risk estimate to give an indication of the range within which the true risk could be expected to lie.88 The imprecision of estimates from small samples was illustrated by the width of the CIs in many of the studies. In many cases those for individual studies were so wide that the risk estimates became meaningless. All but one43 of the comparative studies were small and lacked the statistical power to identify clinically important differences in outcome. We have sought to combine as many studies as possible to generate risk estimates which were precise enough to be of clinical use.

Pooling. The combining of data from multiple studies assumes that the differences between studies are primarily a product of chance. This is particularly problematic when combining case series, which are likely to differ in criteria for their patient selection, outcome measures, follow-up, and in the detail of the operative technique and peri-
operative care. Statistical testing for heterogeneity examines the extent to which differences in studies are a product of chance rather than a product of systematic differences - in other words, the extent to which the studies demonstrate a common effect. We have used this to examine groups of trials and to provide objective support when determining whether or not to combine case series. There was no significant heterogeneity in the reported results of case series of staple capsulorrhaphy and therefore these were combined. We found significant heterogeneity in the reported results for transglenoid suture and bio-absorbable tacks, so we did not combine any of these. We decided to exclude one outlying study from the 20 studies of suture anchors; the rest showed no significant heterogeneity and removal of that one study did not affect the point estimate of the combined rate of failure. There was no significant heterogeneity in the comparative studies in relative risks of the different techniques.

We chose to pool the data for comparative trials of suture anchors and bio-absorbable tacks in order to maximise the statistical power of our review, particularly when comparing the best arthroscopic techniques with open surgery. We accept that this may not have been ideal. However, data from the case series suggested that the rates of failure of suture anchors and bio-absorbable tacks were similar. Also, there was no significant heterogeneity between the rates of failure for the two techniques reported in the comparative studies, suggesting that pooling of the data was appropriate. This provided a meta-analysis for arthroscopic anchors or tacks compared with open stabilisation which included 365 patients. Despite this number, we found no evidence of a difference in the techniques. A single, randomised, controlled trial including 365 patients would have approximately only 18% of power to detect our best estimate of the relative risk of failure of 1.3. In order to achieve a more acceptable power of 80% to detect a relative risk of 1.3 with p < 0.05, a trial would need to include more than 2000 patients. It is difficult to imagine the performance of such a trial and we are therefore inclined to suggest that our results are as representative as possible of the clinical comparison.

Interpretation. Transglenoid suture appeared to be associated with a high rate of failure, but the studies were so heterogeneous as to make quantitative combination inappropriate. Pooled data from the comparative trials indicated that the arthroscopic transglenoid suture techniques had a significantly higher rate of failure than arthroscopic techniques using suture anchors or bio-absorbable tacks and open repair. Staple capsulorrhaphy probably had a higher rate of failure than that using anchors, and, although we could not formally assess this, our impression was that re-operation for post-operative shoulder pain, staple impingement or loosening was relatively frequent. We could not distinguish between the results of arthroscopic surgery with tacks or suture anchors. Both techniques were associated with specific complications, such as chondrolysis with metal anchors and synovitis with absorbable implants.33,66,90

By our definition of failure, the pooled rate of failure for open repair was 8.7%. This initially looked poor compared with the figure of 3.5% (95% CI, 1.1 to 7.9) reported by Rowe et al,4 but their definition of failure was narrower since their patients experienced a significant loss of external rotation with only one-third returning to their pre-injury sport. Procedures which tighten the capsule sufficiently to restrict movement tend to have a low rate of failure, but may compromise function and risk osteoarthritis in the long term.4,7 Our pooled rate of failure of 8.7% was similar to those of the 8% to 12% reported in other recent large series using open techniques91-93 and we therefore remain confident that the studies included in our review were not biased against open surgery. Our best estimate from pooled comparative studies was that arthroscopic stabilisation with tacks or anchors had a slightly higher rate of failure than open surgery (RR 1.3), although equality was entirely credible. We suggest that the overall balance between these techniques may well rest on the risk of complications, including their effect on the range of movement, and the potential benefits of less invasive surgery as much as or more than the risk of failure.

There have been two previous systematic reviews which have compared arthroscopic and open surgery for instability of the shoulder.94,95 These included only studies which directly compared techniques and thus claimed to avoid the bias inherent in non-comparative studies. This limited the number of studies available to 11 and six, compared with our 62. While we support the use of randomised, controlled trials, we believe that when there are so few, and so few robust observational studies such as prospective series without selection bias, case series can be critically interpreted and analysed so that they can make a significant contribution to the available evidence. For example, one review94 performed a sub-group analysis and found no significant difference in the rate of recurrent dislocation between arthroscopic transglenoid sutures and bio-absorbable tacks. However, with only 77 and 90 patients respectively in each group, the analysis was likely to be subject to type-II (false-negative) error and could not exclude a significant clinical difference. By contrast, 1267 patients treated by transglenoid sutures and 514 treated by tacks were included in our review and demonstrated that there was wide variation in outcome with both techniques, and provided a graphical representation of the published experience suggesting that transglenoid sutures were less effective.

Both previous reviews pooled the results of all arthroscopic techniques in their analyses. Their calculated risks of recurrent dislocation after arthroscopic and open surgery (OR 2.095 and RR 3.794) were similar in magnitude and significance to those of our meta-analysis of transglenoid sutures versus open technique (RR 2.9). Our finding of a small and statistically insignificant difference (RR 1.3) between suture anchors or bio-absorbable tacks compared
with open surgery was a result of the transglenoid suture studies being excluded and including the two most recent comparative studies in which there was no difference in rate of recurrence.\textsuperscript{29,74} This improvement in results may represent the continued evolution of arthroscopic skills and technique.

The rate of failure of arthroscopic stabilisation of the shoulder using staples or transglenoid suture techniques appears to be significantly higher than that seen after open surgery or arthroscopic stabilisation using suture anchors or bio-absorbable tacks. Arthroscopic anterior stabilisation with suture anchors or bio-absorbable tacks has a similar rate of failure after two years as that after open stabilisation. On the basis of this meta-analysis, it appears that arthroscopic stabilisation with suture anchors or bio-absorbable tacks may be as effective as open surgery whereas transglenoid sutures should be avoided.

### Supplementary Material

An appendix of the search strategy results on April 1, 2006 is available with the electronic version of this article on our website at www.jbjs.org.uk

We wish to acknowledge the contribution of Mr D. Demany FRCS (Trauma & Orth) who helped to prepare an early version of this study which was presented to the British Orthopaedic Association Annual Congress in 2004.

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

### References
