

The clinical effectiveness and cost-effectiveness of open mesh repairs in adults presenting with a clinically diagnosed primary unilateral inguinal hernia who are operated in an elective setting: systematic review and economic evaluation

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Scientific summary

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Scientific summary

Background

For people presenting with inguinal hernia, surgical repair (herniorrhaphy) is commonly undertaken to close the defect, alleviate symptoms of discomfort and prevent serious complications. With over 70,000 procedures carried out in 2012/13 in England alone and over 100,000 NHS bed-days of hospital resources utilised, inguinal hernia repair consumes the greatest resources and is the most common surgical intervention in the UK.

The tension-free technique, which involves the use of a 'mesh' (prosthetic or biological), is the most effective and recommended type of surgical procedure for the treatment for inguinal hernia. Compared with the traditional 'tissue-sutured' techniques, a reduction in the risk of recurrence between 50% and 75% has been demonstrated after mesh repair. Mesh repair methods can be performed by open procedures (e.g. Lichtenstein mesh repair or preperitoneal mesh repair) or laparoscopic procedures (e.g. totally extraperitoneal repair, transabdominal preperitoneal repair). Different open repairs with mesh, such as Lichtenstein repair and preperitoneal repair, have shown similar results and very low recurrence rates, ranging from 2% to 5%. The Lichtenstein mesh repair is the most commonly performed procedure for hernia repair in the UK (used by 96% of surgeons).

Chronic pain after Lichtenstein mesh repair is considered the main complication, with incidence rates ranging from 10% to 54% in the literature. The open preperitoneal approach has shown similar or even better outcomes compared with the laparoscopic approach. In general, open preperitoneal techniques with soft mesh have been reported to be safe and effective with a short learning curve. Laparoscopic mesh procedures are technically more complex and require longer operation time, special equipment, a high level of surgical experience and, at present, are not routinely performed in the UK. Given the low recurrence rates reported in the literature after surgical repair of inguinal hernia, the key outcomes on which to measure the clinical success of hernia recovery include chronic pain, complications, time to return to work or normal activities and quality of life (QoL). Recently published evidence assessing the effect of open preperitoneal mesh repair with Lichtenstein mesh repair, with regard to relevant clinical outcomes such as chronic pain and QoL, have produced inconsistent results.

The purpose of this assessment is to evaluate the current evidence for the clinical effectiveness and cost-effectiveness of open preperitoneal mesh repairs compared with standard Lichtenstein mesh repair, with particular attention to postoperative chronic pain.

The specific objectives of this assessment are the following:

- systematically review the relative clinical effectiveness of surgical open preperitoneal mesh repairs compared with standard Lichtenstein mesh repair for the treatment of adults presenting with a clinically diagnosed primary unilateral inguinal hernia who are operated in an elective setting
- systematically review existing economic evaluations on surgical open mesh techniques for the treatment of adults presenting with a clinically diagnosed primary unilateral inguinal hernia who are operated in an elective setting
- develop a de novo economic model to assess the cost-effectiveness of surgical open mesh repairs for the treatment of adults presenting with a clinically diagnosed primary unilateral inguinal hernia who are operated in an elective setting.

Methods

Comprehensive electronic searches were conducted to identify reports of trials, systematic reviews and other evidence-based reports evaluating the effect of open preperitoneal repair versus Lichtenstein repair. We searched major electronic databases including MEDLINE, MEDLINE In-Process & Other Non-Indexed Citations, EMBASE, Bioscience Information Service, Science Citation Index, Scopus Articles In Press, Cochrane Central Register of Controlled Trials, the Cochrane Database of Systematic Reviews, the Database of Abstracts of Review of Effects and the Health Technology Assessment database from inception to 31 October/1 November 2014. Members of our advisory group were contacted for details of additional reports. Evidence of unpublished studies was searched in World Health Organizations International Clinical Trials registry Platform and ClinicalTrials.gov. Final searches were carried out on 31 October 2014 and 1 November 2014 and were not restricted by year of publication or language.

Evidence for clinical effectiveness was considered from published and unpublished randomised controlled trials (RCTs) comparing open preperitoneal mesh repair with the standard Lichtenstein mesh repair. The relative effectiveness of any open preperitoneal techniques including Kugel™ patch repair (Davol, Warwick, RI, USA), Read–Rives repair, transinguinal preperitoneal (TIPP) repair, Nyhus repair or Stoppa repair compared with the standard Lichtenstein approach was assessed. The population considered was adults with a clinically diagnosed primary unilateral inguinal hernia who were operated in any appropriate elective setting. Two reviewers independently selected studies for inclusion. One reviewer completed data extraction and assessed risk of bias for included studies, and two reviewers independently crosschecked the details extracted by the first reviewer. Where appropriate, outcome data (pain, numbness, mortality, recurrence, complications and time to return to normal activities) were pooled to produce a summary estimate of effect. The primary analyses for binary outcomes were based on either a random-effects model, using the Mantel–Haenszel approach, or the Peto approach (when events were rare) to calculate pooled estimates of effect. For continuous outcomes, mean differences were pooled using the inverse variance approach. The Cochrane risk-of-bias tool was used to assess the risks of bias of the included RCTs.

Cost-effectiveness

We performed a comprehensive review of economic evaluations comparing open preperitoneal mesh repair with Lichtenstein mesh repair. Economic evaluations (conducted alongside RCTs) and decision-analysis models were included. Studies were assessed for relevant data and appraised, where appropriate, against the *British Medical Journal* guidelines for reviewers of economic evaluations and against the National Institute for Health and Care Excellence reference case. Narrative summaries of results were provided.

Owing to the lack of long-term UK-specific cost-effectiveness evidence from the review of economic evaluations, a de novo economic evaluation was conducted. A probabilistic Markov cohort model was developed to estimate the expected costs, quality-adjusted life-years (QALYs) and cost-effectiveness for the open preperitoneal approach and the Lichtenstein approach. The model incorporated data from the systematic review of clinical evidence and compared postoperative occurrences of chronic pain, chronic numbness, complications and recurrences. The model was based on an average male patient with primary inguinal hernia, aged 58 years, progressing through health states based on 3-monthly cycles over a total time horizon of 25 years. Costs were estimated from the UK NHS health services perspective and presented in 2013/2014 UK pound sterling. QALYs were calculated using utility data based on the European Quality of Life-5 Dimensions-3 Levels reported in the literature. Costs and QALYs were discounted at a rate of 3.5% per annum. The impact of results on NHS budgets and costs to patients and society were considered separately.

Results

Clinical effectiveness

A total of 12 RCTs (11 RCTs published in 13 full-text papers and one ongoing RCT) with 1568 participants (797 participants randomised to Lichtenstein mesh repair and 771 to open preperitoneal mesh repair) were included in the clinical effectiveness review. Eleven trials, with a total of 1523 participants, provided suitable data for the statistical analyses.

In general, trials were of small sample size (mean 130.7 participants, range 45–302 participants) and at unclear or high risk of bias. Only two trials were judged to be at low risk of bias with adequate sequence generation, allocation concealment, blinding of participants and blinding of outcome assessor. In the majority of trials, length of follow-up was relatively short (mean 17 months).

Participants who underwent open preperitoneal mesh repair returned to work or usual activities statistically significantly earlier than those who underwent Lichtenstein mesh repair [mean difference -1.49 days, 95% confidence interval (CI) -2.78 to -0.20 days]. Mean days of hospital stay ranged from 0.34 to 4.6 days after open preperitoneal mesh repair and from 0.37 to 4.65 days after Lichtenstein mesh repair. Although we did not find any statistically significant differences at the conventional 5% level between the open preperitoneal approach and the Lichtenstein approach with regard to incidence of chronic pain [risk ratio (RR) 0.50, 95% CI 0.20 to 1.27], chronic numbness (RR 0.48, 95% CI 0.15 to 1.56), acute pain (mean difference -0.49 , 95% CI -1.06 to 0.09), recurrences (Peto odds ratio 0.76, 95% CI 0.38 to 1.52) and various complications, fewer events were generally reported after open preperitoneal mesh repair. None of the included trials reported acute numbness.

Only three deaths were reported after each surgical approach. None of the included trials specifically assessed QoL.

Cost-effectiveness

The review of economic evidence did not identify any decision-analysis models answering the research question. We identified one study that reported a cost minimisation alongside a RCT comparing TIPP mesh repair with Lichtenstein mesh repair, over a 1-year follow-up period. The study did not find any difference in QoL, and reported average, although not statistically significant, cost savings from a NHS health services perspective for the TIPP approach. The TIPP approach was, however, significantly cost saving when patient and societal benefits of earlier return to work for non-retirees were included.

Based on the results of the de novo economic model, open preperitoneal mesh repair was found to improve patient QoL by 0.041 QALYs compared with Lichtenstein repair. Improved QoL was achievable owing to fewer incidences of chronic pain, chronic numbness, early complications and recurrences following surgery. Both open preperitoneal mesh repair and Lichtenstein mesh repair were assumed to have equal costs of surgery because of similar equipment, materials, staff requirements, theatre time and time to discharge. Cost savings were achievable to the NHS through fewer postoperative health problems. Cost savings, from a health services perspective over the duration of the model, were estimated as £256 per additional case treated with the open preperitoneal approach. The open preperitoneal approach was therefore the dominant treatment strategy in the model with a high probability ($> 98\%$) of cost-effectiveness to the UK NHS. If implemented as routine practice, the open preperitoneal approach has the potential to deliver substantial cost savings to the NHS, dependent on the rate of uptake of the new technique. Furthermore, from a societal perspective, earlier return to work and normal activities will have financial benefits to patients and to employers owing to a reduction in productivity losses for non-retirees.

Sensitivity analyses

Across the majority of the performed sensitivity analyses, the probability of cost-effectiveness remained in excess of 95% at a willingness-to-pay threshold of £20,000 per QALY. The results of the base-case analysis were most sensitive to assumptions surrounding the equal cost of surgery for both techniques and the cost of treatment for chronic pain. Although such analyses were found to have a substantial impact on incremental cost savings, and thus impact on NHS budgets, they did not alter the overall conclusions regarding cost-effectiveness. Results were also sensitive to a worst-case scenario analysis for open preperitoneal mesh repair, where the upper limits of the CIs for the RRs of chronic pain and recurrence were combined into a single sensitivity analysis.

Limitations

Available data were of limited quantity. Most of the included trials were at high or unclear risk of bias. Meta-analyses results demonstrated significant statistical heterogeneity for most of the assessed outcomes. Potential sources of clinical heterogeneity include the definition and measurements of pain, the definition of 'work/usual activities', time of follow-up measurements, overall length of follow-up, characteristics of the hernia defect, type of mesh and surgeon's expertise.

Meta-analyses results were based on trials conducted outside the UK and there is still some uncertainty on whether or not they can be applied to UK NHS practice reliably.

Cost-effectiveness

There were insufficient data to model different techniques of open preperitoneal repair and, as such, the estimates of cost-effectiveness generated by the model represent an average of all approaches. The model may, however, over- or under-estimate the cost-effectiveness of individual open preperitoneal approaches.

The nature of the data available to populate the economic model generated uncertainty, particularly the lack of consensus on the appropriate treatment approach for chronic pain after hernia repair. This was further confounded by the heterogeneity between baseline data in the way pain was reported, by the lack of adequate data to stratify chronic pain according to severity within the model, and by the lack of a direct link between treatment strategies and resolution of chronic pain. In consultation with our clinical experts, we have adopted conservative assumptions and conducted sensitivity analyses to explore plausible alternatives, which led to similar cost-effectiveness conclusions.

A number of structural assumptions were imposed on the model, in particular, regarding recurrence. We assumed that following a recurrence, participants were either well or would die of natural causes. Participants had a maximum of two recurrences before they were assumed to be well. The model results were not sensitive to changes to this structural assumption.

Conclusions

Current evidence indicates, although with some uncertainty, that the open preperitoneal approach may be a safe and efficacious alternative to the standard Lichtenstein approach for the treatment of inguinal hernia with similar recurrence and complication rates, potentially lower incidence of postoperative pain, and a significant earlier return to work and to usual daily activities. According to our base-case model analysis, the open preperitoneal mesh repair improves patient QoL through a reduction in chronic pain, chronic numbness, early complications and recurrences. If implemented in clinical practice it could have the potential to save NHS resources and to impact positively on NHS budgets.

Earlier return to work or to normal activities would also be regarded as a preferable outcome from a patient and societal perspective.

Recommendations for future research

1. A large, well-designed clinical trial comparing the long-term effects of open preperitoneal mesh repair versus standard Lichtenstein mesh repair with regard to chronic pain, complications and recurrences in people with primary unilateral inguinal hernia is required. Ideally, such a trial would include relevant outcomes measures (e.g. chronic pain, persistent numbness, postoperative complications and QoL measures) and a full economic evaluation. The duration of such a trial should be long enough to capture important treatment differences over time.
2. Further research is also required to determine the most effective open preperitoneal repair technique in terms of both clinical efficacy and cost-effectiveness.
3. Further research is also required to identify longer-term resource use for people undergoing inguinal hernia repair in order to develop more robust cost estimates for the UK (especially for the treatment of chronic pain).

Study registration

This study is registered as PROSPERO CRD42014013510.

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