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Abstract  Objective: Greater saphenous vein harvest for coronary and lower extremity bypass requires the longest incision of any surgical procedure. Endoscopic vein harvest allows better results in some clinical variables compared to open harvesting techniques. The objective of this study is to present the results of a systematic review of the scientific evidence about the efficiency of endoscopic saphenous vein harvest.

Methods: We performed a systematic review in the bibliographical databases Pubmed, National Health Service Economic Evaluation Database, and NHS Health Technology Assessment Database. The search strategy was “endoscopic AND harvesting”, in the period January 1970–December 2009.

Results: We identified only 3 economic evaluation studies, 2 cost analyses with some methodological limitations, and 1 cost–utility analysis. All of them suggest lower hospital costs for endoscopic harvesting.

Conclusions: Available evidence does not allow recommendations to be made based on the efficiency of endoscopic saphenous vein harvest, although it suggests lower costs for endoscopic harvesting. More scientific evidence about the long-term efficacy and the effectiveness of this technique is necessary, with studies measuring final outcomes, and carrying out complete and rigorous economic evaluations.

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One of the biggest changes in surgery during the last decade has been the move towards less invasive access to the human body and to minimising the length of incisions. The harvesting of the saphenous vein for lower extremity and coronary artery bypass surgery (CABG) involves the longest incision of any surgical procedure. Traditionally, the saphenous vein is removed from the lower leg, thigh or both, with standard surgical instruments and direct viewing, through a long incision and continuous or discontinuous longitudinal incisions throughout the course of the vein. Although major complications such as sepsis and amputations using open conventional harvesting are exceptional, minor complications such as haematoma, suture dehiscence, chronic oedema, cellulitis, skin necrosis and deep and superficial infections are common. In turn, these complications carry a delay in wound healing, increased hospital length of stay, increased costs of postoperative care and less patient satisfaction.

The introduction of minimally invasive techniques since 1996, both endoscopic and non-endoscopic, has had varying results. The introduction of endoscopic saphenous vein harvesting in 1999 has shown better results in some clinical variables, mainly the decline in the incidence of infections and wound complications. With this harvesting technique, the saphenous vein is extracted with endoscopic instruments through one or two small incisions that are usually made at the level of the knee.

The existing meta-analyses and systematic reviews comparing the efficacy of endoscopic and open saphenous vein harvesting showed that, compared with the open technique, endoscopic harvesting leads to less frequent wound infectious and non-infectious complications, increased quality of life and less intensive use of healthcare resources. However, long-term studies are still very scarce. The impact of this technique in terms of the health-care services used and the population affected is important, given the large number of patients undergoing CABG, with the consequent economic resources consumed.

In 2005, the International Society for Minimally Invasive Cardiac Surgery (ISMICS) held a consensus conference to discuss the role of endoscopic harvesting for CABG on adults. The consensus conference recommended endoscopic harvesting as the standard technique for patients undergoing coronary revascularisation procedures to reduce wound-related complications, postoperative pain, average hospital length of stay and resource consumption, and increase patient satisfaction. However, the consensus conference also noted that technical training is important for staff who are to perform endoscopic harvesting, and that there should be more research on the effectiveness and the cost-effectiveness of this technique compared with open harvesting. After the ISMICS consensus, new evidence on the effectiveness and cost-effectiveness of this technique has emerged, calling for an update of what is known in the field.

The purpose of this article is to systematically review the existing literature on the cost-effectiveness of endoscopic saphenous vein harvesting for patients undergoing cardiac or infra-inguinal bypass, compared with open harvesting.

## Materials and Methods

We conducted a bibliographic search using PubMed, the National Health Service Economic Evaluation Database (NHS EED) and the Health Technology Assessment (HTA) databases of the Centre for Reviews and Dissemination, with the search strategy 'endoscopic AND harvesting', in the period January 1970 to December 2009. After reading the abstracts of the references retrieved in the search, we selected those which were original economic evaluation studies, comparing endoscopic and open harvesting. The references included in the selected papers were checked. Review articles, editorials and abstracts were discarded, although their references were also checked.

To analyse the methodological quality and results of the studies, authors independently read the papers and identified the following variables in each of them: (1) author and year of publication; (2) indication; (3) type of analysis: cost analysis, cost-effectiveness analysis, cost–utility analysis or cost–benefit analysis; (4) reference year — year of measurement of costs; (5) discount rate — rate used to discount costs and express them in present value for the reference year; (6) unit of measure of results — monetary units, costs-effectiveness ratios, etc.; (7) effectiveness measures; (8) perspective of analysis — point of view from which the analysis was focussed (society, payer, insurer, hospital, primary health-care, family, and others); (9) time horizon — period of time that includes the costs and outcomes relevant for the study; (10) included costs; and (11) study results. Any discrepancies between reviewers were resolved by discussion.

Results are shown in evidence tables and the most important findings are resumed and discussed.

## Results

### Results of the bibliographic search

The search on PubMed retrieved a total of 799 articles. Of these, only three were economic evaluation studies, including one cost–utility analysis. The search on HTA identified five evaluation reports, none of which addressed the topic in question. The search on NHS EED database found 23 items, but only two met the inclusion criteria and had already been identified in PubMed. The information extracted from each article is presented in Table 1.

### Description of the economic evaluation studies

The study by Rao et al. is the only one that performed a cost–utility analysis, while the other two studies performed simple cost analyses. The target population in the Rao et al. study was a simulated cohort of 10 000 patients undergoing CABG for which there is no description. The study included the cost of the harvesting procedure, length of stay and costs of endoscopic harvesting equipment. The harvesting time and hospital length of stay were derived from the literature, while the associated cost was derived from the rate of reimbursement and accounting of the hospital. The cost of the harvesting equipment was supplied.
by the manufacturer, accounted in US dollars — although the reference year is not stated — and it was not necessary to use a discount rate because the time horizon was less than a year. The authors stated that they used the perspective of analysis of the national health system; however, they seem to have used the hospital perspective. The time horizon was not explicit, although it is mentioned that they took into account the costs and effectiveness up to 6 weeks after harvesting. Results are measured in terms of incremental dollars per quality-adjusted life year (QALY), and QALYs were measured using a standardised tool (EuroQol-5D).

Brandt’s study\textsuperscript{16} retrospectively reviewed medical records from 1909 Medicare patients and 1485 patients with other types of insurance undergoing CABG between May 1999 and December 2001. The groups had no significant differences in their demographic and preoperative characteristics, except for the prevalence of morbid obesity which was more frequent in the endoscopic harvesting group. The study included non-specific hospital costs and home visits. Hospital cost data came from the finance departments of the hospitals participating in the study, and costs of home care were provided by the firm providing the service. Costs were measured in US dollars. The reference year and the discount rate were not explicit. Neither the perspective of analysis nor the time horizon was explicit, although it could be assumed from reading the article that they used the hospital perspective, and defined their time horizon as the time until discharge of the patient, either from hospital or from home care.

The study by Illig et al.\textsuperscript{17} included all patients undergoing an infra-inguinal bypass, with either endoscopic or open harvesting, in the period from March 1999 to December 2001. The two groups were not significantly different in terms of their demographic characteristics. The study included the costs incurred by patients (equipment and disposable material), as well as an estimate of fixed costs of personnel. Estimates of the extra costs of endoscopic harvesting, and complications were added. All costs came from the accounting systems of the hospital, and were converted to 2001 dollars using an unspecified consumer price index. Neither the perspective of analysis nor the time horizon was explicit, although it could be assumed that the hospital perspective is used and time horizon refers to the length of hospital stay.

**Results of the economic evaluation studies**

Regarding the two studies on CABG, the one by Rao et al. found that endoscopic removal is the most cost-effective procedure for harvesting the saphenous vein. The incremental cost-effectiveness ratio was $19\,858.87/QALY. The sensitivity analysis shows, with a probability of 95.6%, that endoscopic harvesting would be cost effective (with a ratio below $50\,000/QALY).\textsuperscript{15} Brandt et al. found that hospital costs were not significantly different between the open and the endoscopic harvesting groups,\textsuperscript{16} with no differences, either in the number of visits or in the cost of home care. By contrast, for inguinal bypass, Illig et al. concluded that total hospital costs were significantly higher in the group of open harvesting ($17\,456 vs. $6203), mainly due to higher costs of postoperative care.\textsuperscript{17} However, the costs of operating room, intensive care, laboratory, pharmacy and the cost per day of stay were not statistically different. The costs of readmissions for wound complications at 30 days were higher in the open harvesting group ($17\,046 vs. $7932).  

**Discussion**

This study has reviewed the evidence provided by economic evaluation studies of endoscopic saphenous vein harvesting. In all cases, there are methodological limitations that compromise the validity of the results. One key fact is that two of the three studies identified performed cost analyses, and did not take into account the effectiveness of treatments. Such studies, often termed 'partial economic evaluation studies', are less useful in guiding decision making, because they only measure the costs of...
technologies and not their effectiveness. This is important since both variables—cost and effectiveness—may not go in the same direction, or increase at the same rate. The only cost–utility analysis we found, which also had some methodological limitations, concluded that endoscopic harvesting is more efficient than open harvesting.

There are several methodological limitations in the studies reviewed. The first is the limited time horizon considered. This was always short, corresponding to the time that patients are in hospital, which means that all costs that may occur after discharge, such as long-term home care or readmissions for complications, are not taken into account, potentially biasing the results. Another limitation is that the perspective of analysis is never made explicit, although it seems to be that the hospital perspective is being used. The use of a narrow perspective excludes other costs that may be important, such as additional care, pharmaceuticals, medical visits, indirect costs for sick leave of patients, etc. Clearly, the exclusion of such costs again skews the results towards those interventions with lower hospital costs. Another issue is that many important parameters of the analyses, such as included costs and data sources, are not explicit or described in sufficient detail.

As any review study, one could not rule out any misreading of the information contained in the papers, or bias in the bibliographic search and selection of the studies. These factors have been minimised using explicit inclusion criteria and a prespecified evidence table to collect the parameters of interest, and using an extensive bibliographic search. Our bibliographic search was purposely not limited using economic evaluation descriptors. Given the novelty of the technique studied (introduced in hospitals in the United States in 1999), we anticipated that there would be very few papers existing, and these could have been lost using a narrower search strategy.

More important than the above is the effectiveness of the two procedures for saphenous vein harvesting. The economic evaluation studies that were identified based their calculations on short-term results of five randomised clinical trials, none of them included long-term outcomes. Regarding efficacy data, there are several meta-analyses in the literature comparing the efficacy of endoscopic and open saphenous vein harvesting. Their results showed that, compared with open harvesting, endoscopic harvesting leads to less frequent wound infections and non-infectious wound complications, such as dehiscence, haematoma or necrosis, as well as improvement in the incidence of pain, neuralgia and patient satisfaction. Results also showed that there are no statistically significant differences in postoperative myocardial infarction, stroke, repeated surgery for recurrence of angina or ischaemia and mortality. Regarding the quality of the extracted vein, results suggest that the veins endoscopically harvested required more repairs prior to use than veins removed openly, and reduced long-term graft patency. For other related outcomes (length of the vein, proportion of the vein requiring repair, macroscopic vein quality and rate of postoperative myocardial infarction), differences are not statistically significant. Finally, regarding the use of resources, there are contradictory results: one meta-analysis showed longer operating times

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<tr>
<th>Author, year</th>
<th>Type of analysis</th>
<th>Reference year</th>
<th>Unit of measure</th>
<th>Effectiveness measures</th>
<th>Author, year</th>
<th>Time horizon</th>
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<th>Indication</th>
<th>Disclosure</th>
<th>Discount rate</th>
<th>Author, year</th>
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<td>Rao C et al., 2008</td>
<td>Cost–utility analysis</td>
<td>2008</td>
<td>US dollars/QALY</td>
<td>QALY</td>
<td>Rao C et al., 2008</td>
<td>Not explicit: 6 weeks</td>
<td>Hospital</td>
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Table 1 Evidence table of the reviewed studies.
using endoscopic harvesting (average ~15 min longer)\(^8\) and shorter average hospital length of stay (~1.04 and ~0.85 days)\(^7,11\) and lower number of readmissions (odds ratio (OR) = 0.53)\(^18\) while another meta-analysis showed no statistical difference for vein harvest time, and length of stay.\(^11\) A recently published systematic review showed that there is good-quality evidence (‘grade A’) to assert that wound infections and non-infectious complications of the injuries are minor in the case of endoscopic harvesting, but the quality of extracted vein is lower compared with open harvesting.\(^19\) There is fair-quality evidence (‘grade B’) that the postoperative pain mobility are lower in the case of endoscopic removal. There is insufficient evidence (‘grade C’) to discern whether the patient satisfaction and costs are higher or lower.\(^19\)

These studies and conclusions are based only on relatively short-term follow-up of patients; however, the results of the first long-term studies are emerging.\(^13\) Although coming from an observational study, they suggest that endoscopic vein-graft harvesting is independently associated with vein-graft failure and adverse clinical outcomes. The authors call for randomised clinical trials to further evaluate the long-term safety and effectiveness of this harvesting technique.

Thus, in light of the results of this literature review it could be said that available evidence does not allow conclusions to be made on the efficiency of endoscopic saphenous vein harvesting. More evidence is needed on the efficacy and long-term effectiveness of this technique, with studies measuring final outcomes, such as vein-graft failure, myocardial infarction, mortality or repeated revascularisation. Existing clinical consensus should revise their recommendations in the light of this evidence. Given the scarcity of economic evaluation studies in this area and their methodological problems, we recommend that economic evaluation studies (cost-effectiveness or cost—utility analysis) be carried out, in a rigorous manner, which include the results of existing systematic reviews and meta-analysis, and long-term outcomes data. In that manner, high-quality studies could be produced, which are sound on their methods and useful for clinicians to make informed decisions regarding vein harvesting.

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**References**