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Percutaneous transluminal coronary angioplasty with stents versus coronary artery bypass grafting for people with stable angina or acute coronary syndromes (Review)

Bakhai A, Hill RA, Dunder Y, Dickson RC, Walley T

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Percutaneous transluminal coronary angioplasty with stents versus coronary artery bypass grafting for people with stable angina or acute coronary syndromes.

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Percutaneous transluminal coronary angioplasty with stents versus coronary artery bypass grafting for people with stable angina or acute coronary syndromes

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ABSTRACT

Background

Coronary artery bypass graft surgery (CABG) replaces obstructed vessels with ones from other parts of the body. Alternatively, obstructions are remodelled using catheter-based techniques such as percutaneous coronary angioplasty with the use of stents. Though less invasive, stenting techniques are limited by the re-narrowing of treated vessels (restenosis). We examined evidence on cardiac-related outcomes occurring after CABG or stenting, with implications for resource use, resource allocation and informing patient choice.

Objectives

To examine evidence from randomised controlled trials (RCTs) on benefit of stents or CABG in reducing cardiac events in people with stable angina or acute coronary syndrome (ACS).

Search methods

CENTRAL (Issue 2 2004), EMBASE (1990 to 2004), MEDLINE (1990 to 2004) and handsearching to July 2004.

Selection criteria

Only RCTs comparing stents used with PTCA with CABG were included. Participants were adults with stable angina or ACS and unstable angina and had either single or multiple vessel disease. Published and unpublished sources were considered.

Data collection and analysis

Outcomes included composite event rate (major adverse cardiac event, event free survival), death, acute myocardial infarction (AMI), repeat revascularisation and binary restenosis as well as information on design and baseline characteristics. Quality assessment was completed independently. Meta-analyses are presented as odds ratios, 95% confidence intervals (CI) using a fixed-effect model. Heterogeneity between trials was assessed.

Main results

Nine studies (3519 patients) were included. Four RCTs included patients with multiple vessel disease, five focused on single vessel disease. Four studies reported beyond 1 year. No statistical differences were observed between CABG and stenting for meta-analysis of mortality or AMI, but there was heterogeneity. Composite cardiac event and revascularisation rates were lower for CABG than for stents. Odds ratios resulting from meta-analysis of event rate data at 1 year were, odds ratio 0.43 (95% CI 0.35 to 0.54) and at 3 years, odds ratio 0.37 (95% CI 0.29 to 0.48). Odds ratios for revascularisation at 1 year were, odds ratio 0.18 (95% CI 0.13 to 0.25) and at 3 years, odds ratio 0.09 (95% CI 0.02 to 0.34). Binary restenosis at 6 months (single vessel trials) favoured CABG, odds ratio 0.29 (95% CI 0.17 to 0.51).

Authors' conclusions

CABG is associated with reduced rates of major adverse cardiac events, mostly driven by reduced repeat revascularisation. However, the RCT data are limited by follow-up, unrepresentative samples and rapid development of both surgical techniques and stenting. Research on real-world patient population or patient level data meta-analyses may identify risk factors and groupings who may benefit most from one strategy over the other.

PLAIN LANGUAGE SUMMARY

People who undergo bypass surgery for narrowed coronary vessels may be less likely to need re-intervention than those treated using angioplasty with stents

Narrowing of coronary arteries can be alleviated by complete replacement using bypass surgery or, alternatively, unblocking and supporting the vessels open using angioplasty and stents. Analysis of RCTs to 2004 indicates re-intervention (to alleviate subsequent narrowing) is needed less commonly after surgery than after stenting. Risk of death or heart attack following either treatment appeared the same, but this may be because too few trial participants were collected together in the review and variation between trials (heterogeneity) may be masking true differences. Further trials of new techniques in a greater variety of patients with subsequent systematic review are needed.

BACKGROUND

Coronary artery bypass graft (CABG) is the surgical technique used to treat critical obstructions in coronary arteries caused by atherosclerotic plaque disease. New conduits are fashioned during the procedures to bypass the obstructions by the use of either reversed saphenous veins harvested from the legs or by using arterial conduits such as the internal mammary arteries which can be diverted to the coronary vessels or by using portions of the radial artery harvested from the arm.

Surgery can provide relief from symptoms and prolong life, but being an invasive procedure, there is a risk of initial surgical mortality and morbidity with the need for a significant period of convalescence and surgical centres require specialised staff and facilities.

These disadvantages of CABG prompted researchers to identify

alternative treatments, such as Percutaneous Coronary Interventions (PCI), which include Percutaneous Transluminal Coronary Angioplasty (PTCA), PTCA with stenting, brachytherapy and atherectomy technologies. All involve methods for restoring blood flow in obstructed coronary vessels, but are performed generally under local anaesthetic through small vascular incisions in the groin or arm (percutaneously) without the need for major surgery except in the event of an emergency. These interventions can be completed in as little as 15 minutes and patients may return home the same day (Gunn 2003).

Although procedural success rates are high, complication rates low and most patients experience improvement in symptoms after intervention (Gunn 2003), rates of restenosis (re-narrowing of the treated vessel), which may require re-intervention has traditionally been a significant limitation of PCI. Restenosis following PTCA with the use of traditional (uncoated) stents, can result from the proliferation of smooth muscle cells into and around the stent.

Rates of significant restenosis in PTCA with stents are reported (in systematic reviews by Meads 2000 and by Dundar 2004) as ranging between 20 and 50%, depending on the size, location and complexity of the lesion and the amount of routine angiographic monitoring performed in the study.

There remains therefore the debate on whether surgery or PCI is the most appropriate treatment for some people, particularly those with multivessel disease (Gunn 2003; Serruys 2001). In assessing the two technologies one must consider the relative merits of an invasive surgical procedure with lasting benefits against less invasive PCI with traditionally higher rates of reintervention.

This review compares PTCA with the use of stents to CABG for the treating people with coronary artery disease and will include investigation of outcomes in people with single or multivessel disease at follow-up in the short and long term.

OBJECTIVES

To assess the clinical effects of the use of coronary artery stents (as part of Percutaneous Transluminal Coronary Angioplasty) compared to Coronary Artery Bypass Graft surgery for the treatment of people with coronary artery disease.

METHODS

Criteria for considering studies for this review

Types of studies

Randomised Controlled Trials (RCTs), published or unpublished, where the use of coronary artery stents (in conjunction with Percutaneous Transluminal Coronary Angioplasty techniques) to relieve narrowing(s) of the coronary arteries is compared with the application of Coronary Artery Bypass Graft (CABG) techniques.

Types of participants

Adults with stable angina or Acute Coronary Syndrome (including AMI (ST segment elevation and depression, Q wave and non-Q wave) and unstable angina).

Adults with single or multivessel coronary artery disease.

Types of interventions

Percutaneous transluminal coronary angioplasty with stents versus coronary artery bypass grafting surgery.

Types of outcome measures

Clinical

(1) Combined event rate or event free survival (e.g. Major Adverse Cardiac Events, Major Adverse Cardiac and Cerebrovascular Events, Target Vessel Failure or other composites of the events listed below);

(2) Death (both cardiac and non-cardiac death);

(3) Acute Myocardial Infarction (AMI);

(4) Target Vessel Revascularisation (TVR);

(5) Target Lesion Revascularisation (TLR);

(6) Repeat treatment (PTCA, stent or CABG).

Radiological

Binary restenosis (greater than 50% luminal narrowing compared to diameter at completion of the procedure).

Quality of life

Where quality of life (QoL) data were available the nature of the measures, timings of measurement and analytical tool used to assess QoL were recorded.

Search methods for identification of studies

The search incorporated a number of methods to identify completed or ongoing RCTs:

(1) Searching of electronic databases;

(2) Handsearching of recent journals and conferences in relevant fields;

(3) Subscription to e-mail-based information newsletters and regular examination of webpages (including those supported by stent manufacturers) relevant to the review topic;

(4) Searching of bibliographies of identified sources;

(5) Use of submissions to National Institute for Clinical Excellence (NICE), London, UK.

Electronic searches included MEDLINE, EMBASE and CENTRAL (Issue 2 2004 of *The Cochrane Library*) for the period from 1990 (as it was in the early 1990s that coronary artery stents were introduced into practice) to July 2004. Electronic bibliographic databases were searched according to the strategy detailed in Table 1; Table 2; Table 3. The search was not limited to English.

Handsearching of recent issues of cardiology journals and conference proceedings included American Heart Journal, American Journal of Cardiology, British Medical Journal, Catheterization and Cardiovascular Interventions, Circulation, European Heart Journal, Heart, International Journal of Cardiology, Journal of the American College of Cardiology, Journal of the American Medical Association, Journal of Thoracic and Cardiovascular Surgery, Lancet, New England Journal of Medicine, American College of Cardiology, American Heart Association, British Cardiac Society, European Society of Cardiology, Transcatheter Cardiovascular Therapeutics, Cardiovascular Revascularization Therapy.

Internet-based resources include:

<http://www.tctmd.com>

<http://www.theheart.org>
<http://www.crtonline.org>
<http://www.atherothrombosis.org>
<http://www.controlled-trials.com/>
<http://www.update-software.com/National/>

Stent manufacturer webpages.

Details of CENTRAL, EMBASE MEDLINE and search strategies are provided in [Table 1](#); [Table 2](#); [Table 3](#).

Selected triallists were contacted for further details of outcome data and trial progress. More information on contact with triallists will be provided by request to the corresponding author.

Date of the most recent search of the Group's specialised register: July 2004.

Data collection and analysis

Study selection and quality assessment

Two reviewers independently selected the trials to be included in the review. Firstly, reviewers independently scanned the titles and abstracts of references identified by searching (electronic databases or handsearching). Full details of selected studies were obtained and assessed for inclusion in the review and if included, methodological quality. In particular, reviewers examined details of the randomisation method, concealment of allocation, whether the trial was masked (blinded), whether intention-to-treat analyses were possible from the available data and whether the number of patients lost to follow up or subsequently excluded from the study was recorded.

While not totally impossible, the reviewers anticipated that studies comparing surgery and stenting would have difficulty masking (blinding) outcome assessors to the treatment applied to participants in trials.

Quality was assessed using a scheme based on [Schulz 1995](#), methods proposed by the Heart Collaborative Review Group ([Heart CRG](#)) and grading similar to that used in [Villanueva 2004](#).

Adequacy of the randomisation process

A - Adequate sequence generation is reported (such as computer generated random numbers and random number tables, whilst inadequate approaches will include the use of alternation, case record numbers, birth dates or days of the week);

B - Did not specify one of the adequate reported methods in (A) but mentioned randomisation method;

C - Other methods of allocation that appear to be unbiased.

Adequacy of the allocation concealment process

A - Adequate measures to conceal allocations. Concealment will be deemed adequate where randomisation is centralised or pharmacy-controlled, or where the following are used: serially numbered containers, on-site computer-based systems where assignment is unreadable until after allocation, other methods with robust methods to prevent foreknowledge of the allocation sequence to clinicians and patients;

B - Unclearly concealed trials, in which the authors either did not report an allocation concealment approach at all, or reported an approach that did not fall into one of the categories in (A);

C - Inadequately concealed trials, in which method of allocation is not concealed. Inadequate approaches will include: the use of alternation, case record numbers, days of the week, open random number lists and serially numbered envelopes even if opaque.

Potential for selection bias after allocation

A - Studies where an intention to treat analysis is possible and few exclusions (with adequate reporting of these exclusions);

B - Studies which reported exclusions as reported in (A), but exclusions were less than 10 percent;

C - No reporting of exclusions; exclusions of 10 percent or more or wide differences in exclusions between groups.

Adequacy of masking (see note on practicality of masking above)

A - Double (or triple) blind;

B - Single blind;

C - Non-blind;

D - Unclear.

If disagreement arose on the suitability of a trial for inclusion in the review or on its quality, the reviewers would attempt to reach a consensus by discussion and/or involve a third reviewer.

Data extraction

Data were extracted by one reviewer using pre-tested data extraction forms and checked by a second. Data extraction included the outcome measures (detailed above), as well as information on study design, participants (including baseline characteristics and co-morbidity in terms of diabetes and previous heart disease

Data synthesis

For binary outcome measures, data on the number of patients with each outcome event, by allocated treatment group, irrespective of compliance and whether or not the patient was later thought to be ineligible or otherwise excluded from treatment or follow-up were sought to allow an intention-to-treat analysis.

No suitable continuous outcome data was available, but if these data were incorporated into the review, either mean change from baseline for each group or mean post-treatment/intervention values and standard deviation for each group would be recorded. If clinically appropriate, a pooled estimate of treatment effect would be produced by calculating the weighted mean difference.

Time points for analysis of outcomes were 6 months, 1 year, 2 years, 2.5 to 3 years and 4 years. Given the restricted trial populations (see discussion of limitations, later) it was felt that CABG may have less favourable short term outcomes, but may have better long term outcomes. Therefore these multiple periods of follow-up were used in order to attempt to record differences in short and longer term outcomes between CABG the use of stents.

Heterogeneity between trial results was explored using a multi-step process whereby:

(1) Forest Plots were examined and the presence or absence of overlap in the confidence intervals noted. Lack of overlap of confidence intervals indicate heterogeneity;

(2) The chi-squared test for heterogeneity performed;

(3) The I^2 statistic obtained to describe the proportion of the variability due to heterogeneity;

(4) Data analysed using a fixed effect model with odds ratio and 95% confidence intervals. If quantitative heterogeneity between trials was indicated, analysis using a random effect model are presented in addition to the fixed effect estimate.

Data were analysed using a fixed effect model with odds ratio and 95% confidence intervals. Where quantitative heterogeneity between trials was indicated, analysis using a random effects model is presented in addition to the fixed effect estimate.

Studies are grouped in the meta-analysis plots according to whether the study recruited only patients with single vessel disease or a mix of patients with single or multiple vessel disease.

Where data were available, the following subgroups for analysis were proposed:

(1) Vessels involved: single or multivessel cardiovascular disease;

(2) Lesion characteristics: length, diameter of vessel, lesion category (American College of Cardiology/American Heart Association class: A, B1, B2 or C);

(3) Surgical invention: 'standard' CABG or minimally invasive surgery;

(4) Stent intervention: non drug-eluting stents or drug-eluting stents;

(5) Co-morbidity: diabetes.

Due to the lack of data specific to potential subgroups, only single and multivessel disease have been subject to separate analysis. Furthermore, even if data had been available subgroup analyses would only have been performed if judged to be clinically and methodologically appropriate.

Given the available trial reports we were also unable to separate out stable and unstable angina. However we would expect that as there was no stratification by presentation (with stable or unstable angina) at randomisation similar proportions of unstable patients are present in each arm of the trials. In practice most patients would have been semi-elective in that they were eligible for both techniques and few patients were truly unstable in the setting of an acute myocardial infarction. Thus the distinction may be somewhat less relevant to this review than we anticipated when designing the review protocol.

A current version of the Review Manager/RevMan Analyses application was used for data analysis.

RESULTS

Description of studies

Selection of included studies

As a result of our electronic searches, 957 non-duplicate records were identified, of which 48 records were selected for detailed examination for possible inclusion in the review. A total of 17 records were excluded after applying the inclusion/exclusion criteria, with the remaining 31 records attributed to a set of eight RCTs. The [Grip](#) study was identified by our examination of the bibliography of a systematic review ([Biondi-Zoccai 2003](#)) identified in the electronic search, resulting in our total number of included studies raising to nine.

Two studies broadly fulfilled the inclusion criteria, but were not ultimately included in our review because we were unable to determine outcome data for patients receiving stents. In the [AWESOME](#) study surgery was compared to a number of interventional procedures - of which 54% underwent procedures involving stents. During the development of our earlier health technology assessment ([Hill 2004](#)) we contacted the AWESOME trialists requesting information on those patients who received stents, but further information was not forthcoming. In [AMIST](#) all but one of the 48 people undergoing PTCA received a stent. As the study did not set out to compare elective (pre-determined) use of stents with surgery, and we are (at this time) unable to determine specific data where use of stenting was planned before initiation of the PTCA procedure. Authors of the AMIST report kindly provided information on the circumstances around stenting of individuals allocated to the PTCA arm of the study, but declined to release specific outcome data on only those electively stented. It is possible that this information may be made available through individual patient data (IPD) analysis of AMIST and other trials, which we believe is to be conducted by the AMIST trialists.

Details of other records/studies excluded from the review are detailed in *Characteristics of excluded studies*.

Included studies

Nine RCTs, involving a total of 3519 participants, are included in this review.

Our search identified peer-reviewed publications for all but one of these trials. Information on [Grip](#) was only available as a single conference abstract. Three studies included patients with multivessel disease ([ARTS](#); [ERACI II](#); [SOS](#)), five included only people with single vessel disease ([Cisowski](#); [Diegeler](#); [Drenth](#); [Grip](#); [SIMA](#)) and one included a mix of vessel involvement ([OCTOSTENT](#)). The review made no restrictions on type of surgical technique employed in the included trials. Techniques varied between and within some trials, with four studies using mainly minimally invasive methods ([Cisowski](#); [Diegeler](#); [Drenth](#); [Grip](#)), one internal mammary grafts ([SIMA](#)) and four employed an 'off-pump' procedure, without the use of cardiopulmonary bypass ([Diegeler](#); [Drenth](#); [Grip](#); [OCTOSTENT](#)). A variety of techniques were used within the remaining trials. All but two studies ([Drenth](#); [SIMA](#)) appeared to exclude patients who had undergone previous revascularisation.

Reporting of outcomes extended beyond 1 year for [ARTS](#); [Drenth](#); [ERACI II](#); [SIMA](#); [SOS](#) ([SOS](#) reported median 2.0 years where

as mean follow-up was reported in ERACI II (18.5 months) and Drenth, at 'mid-range' 3 and 4 years), but were restricted to 6 months for [Cisowski](#); [Diegeler](#); [Grip](#). The Cisowski paper reported outcome data at 12 months, but for only half of those originally enrolled ([Cisowski](#)). As there was no clear explanation of why only a proportion of data were presented and with the possibility that the data were interim findings, we choose not to include these 12 month data in our analysis. Further details are provided in *Characteristics of included studies*.

Risk of bias in included studies

Eight studies have been published as peer-reviewed publications. As [Grip](#) was only available as a conference abstract, quality assessment was limited to the information provided that source. The randomisation process was described and appeared adequate for five trials ([ARTS](#); [Diegeler](#); [ERACI II](#); [OCTOSTENT](#); [SOS](#)), these studies also appeared to use adequate allocation concealment. The four other included studies ([Cisowski](#); [Drenth](#); [Grip](#); [SIMA](#)) did not provide details of the method of randomisation nor did they clearly describe steps taken to conceal allocation. There was little evidence of selection bias after allocation in the trials. An intention to treat analysis was presented for all studies and it was only [Cisowski](#) at 12 months that did not report on all but a few of those entering the trials. Potential for masking was limited in these studies due to the differing nature of the interventions involved. That being said, the [OCTOSTENT](#) trial implemented masking of treatment allocation from an independent committee of outcome assessors.

The results of the quality assessment are presented in [Table 4](#).

Effects of interventions

Studies reported death, AMI, repeat revascularisation rate and a hierarchical composite of these outcomes in the form of major adverse cardiac events (MACE) or event free survival. Three studies, all focusing on patients with single vessel disease, reported binary restenosis rates - the percentage of lesions with greater than 50% of luminal narrowing compared to diameter at completion of the procedure ([Cisowski](#); [Diegeler](#); [Drenth](#)).

Quality of life data were identified in five studies ([ARTS](#); [Grip](#); [OCTOSTENT](#); [SIMA](#); [SOS](#)).

Data synthesis

These syntheses report odds ratios using fixed effects comparisons. In the analyses, the studies are grouped according to whether they focused on multiple or single vessel disease.

Composite cardiac event rate

Event rates were significantly lower in the CABG arm at all time points analysed. For example, pooled effect estimates were odds ratio 0.43 (95% confidence interval 0.35 to 0.54) at 12 months

and odds ratio 0.37 (95% confidence interval 0.29 to 0.48) at follow-up within the 2.5 and 3.0 year category.

Death

Although stents appeared to be favoured in terms of lower mortality, these differences were not statistically different.

It is important to note that heterogeneity was apparent in analyses at 12 months and 1.5 to 2 years and that the SOS trial (which is included at these time points) experienced abnormally high rates of deaths in the stent arm (as apposed to only one cancer death in the CABG group). The uneven distribution of non-cardiac deaths in SOS would appear to contribute to it appearing to favour CABG and possibly to heterogeneity of these analyses. Within ERACI II a high number of deaths occurred in the CABG group early in the study (only 2 deaths in the stent group, but 13 in CABG). This high mortality in ERACI II could also be contributing to heterogeneity within the analyses of mortality. Application of random effects analysis, odds ratio 1.32 (95% confidence interval 0.45 to 3.86) at 12 months; odds ratio 1.04 (95% confidence interval 0.36 to 3.03) at 1.5 to 2 years, had little impact on effect size or statistical significance.

AMI

No significant difference observed, but there was moderate to high degree of heterogeneity at 36 days, 12 months and 2 years. Little difference was observed with application of random effects analysis. Trends within multiple and single vessel groups are discussed later.

Revascularisation

Repeat revascularisation procedures were less common in the CABG group within individual trials and the pooled analyses. This advantage was statistically significant in all but the early (up to 36 days) follow-up period where only two trials are included and considerable heterogeneity is indicated. Multiple vessel disease trials are included in the analysis at 12 months and 2 years, resulting in odds ratio 0.18 (95% confidence interval 0.13 to 0.25) and odds ratio 0.21 (95% confidence interval 0.15 to 0.27), respectively. Analysis at 2.5 years included only single vessel disease studies, producing an odds ratio 0.09 (95% confidence interval 0.02 to 0.34).

Binary restenosis

Binary restenosis rate was reduced with CABG, odds ratio 0.29 (95% confidence interval 0.17 to 0.51) in the three single vessel trials reporting this outcome at 6 months; random effects odds ratio 0.21 (95% confidence interval 0.06 to 0.70).

Quality of life

Generic quality of life (QoL) was reported in [OCTOSTENT](#) and [SIMA](#), based on SF-36 (Short Form 36), and [ARTS](#) and [OCTOSTENT](#), based on EQ-5D (EuroQol five Dimension). The [SOS](#) and [SIMA](#) trials report disease specific measures from the SAQ (Seattle Angina Questionnaire). The abstract for [Grip](#) re-

ferred to QoL data, but contained no clear information on the quality of life tool applied.

Improvements were recorded in studies comparing QoL immediately before and after treatment. Differences in generic QoL favouring of stents for SF-36 ([OCTOSTENT](#)) and EQ-5D ([ARTS](#); [OCTOSTENT](#)) were reported in the immediate period, post intervention. However, few differences were discernible at follow-up beyond 1 month ([ARTS](#); [OCTOSTENT](#); [SIMA](#)).

Overall, the available data do not permit conclusions to be drawn on between group differences in quality of life.

DISCUSSION

Key findings

The main findings of the meta-analysis are that over the duration of follow-up available from current RCTs, there is considerable benefit, in terms of reduction in repeat revascularisation rates, with CABG over stenting. These reductions were similar in single and multiple vessel disease studies and drove the differences seen in the composite cardiac event rates since revascularisation procedures account for approximately 75% of events and as a result also favour the CABG arms.

For the purposes of clinical decision making at the patient level, it is worth making further comment separately on observations for single and multivessel disease.

Multivessel disease

The four studies ([ARTS](#); [ERACI II](#); [OCTOSTENT](#); [SOS](#)) included in this meta-analysis demonstrate some differences in mortality between CABG and stent groups, however these did not reach statistical significance but showed considerable heterogeneity. Similarly, the rates of AMI were also not significantly different and after combination were almost equal in the two pooled intervention arms to 12 months. After 2 years the rates of AMI tend to favour surgery, but again this observation failed to reach statistical significance. The composite cardiac event endpoints favoured surgery at all time points compared to stenting, driven by the large differences in repeat revascularisation rates incurred by stenting. At 12 months the repeat revascularisation rates with CABG were approximately one fifth of the rates for stenting with an odds ratio 0.18; 95% confidence interval 0.13 to 0.25.

Single vessel disease

In the four single vessel studies ([Cisowski](#); [Diegeler](#); [Drenth](#); [Grip](#); [SIMA](#)), given that mortality rates in the short term were generally low and the small number of total participants, the difference did not reach statistical significance, but would appear to favour stenting in contrast to the multivessel disease studies. The AMI and combined endpoint results closely mimic the respective results seen in the multivessel studies with CABG appearing to be better than

stents in terms of composite event rate and repeat revascularisation at 6 months (odds ratio 0.27; confidence interval 0.14 to 0.51)

Clinical Interpretation

The mortality rate trend seen in the single vessel studies favouring stenting was not surprising given that stenting is performed under local anaesthetic and does not entail the general anaesthesia required for surgery. Although larger studies are needed here to confirm this assumption, substantiation might have been achieved by meta-analysis of single and multiple vessel studies, were it not for the mortality rates in the SOS trial. Among the multivessel trials at 12 months mortality differences vary, with the [SOS](#) trial having a higher mortality rate in the stent group (driven mainly by a large number of cancer deaths in the stent arm) contradictory to the results of [ERACI II](#) and [OCTOSTENT](#) with higher early mortality in the surgical groups, while [ARTS](#) had similar mortality rates for both arms.

Such results are difficult to translate into clinical practice, where registry data has shown higher peri-procedural mortality for surgery compared to PTCA with or without stenting ([Clark 2004](#); [Srinivas 2002](#)). The observations contained in this review are challenged further by the knowledge that large numbers of patients were screened compared to the number of patients finally enrolled and that some of these trials excluded patients with impaired left ventricular function often seen in clinical practice ([ARTS](#); [OCTOSTENT](#)). Finally these trials are all relatively modest in size and are therefore not powered to look at mortality differences. To date, available trials report only medium term follow up (to 3 years), which may capture most of the repeat procedures needed with stent technology (i.e. restenosis in vessel treated by stenting) but do not have sufficient follow up to capture even 50% of venous graft failure which would require 10 years. Long-term studies are however unlikely to be performed as the rate of technological advancement is likely to make the results of such trials obsolete ([Bakhai 2000](#)).

The mortality differences may yet have been different if mortality had been further split into cardiovascular and non-cardiovascular causes, particularly since surgery is associated with higher rates of cerebrovascular events than percutaneous coronary intervention in the immediate post-procedural phase ([Pell 2001](#)).

The results with respect to myocardial infarction are also worthy of discussion. While there would appear to be no significant difference in myocardial infarction rates at any time point, there is a trend in favour of CABG in those studies with longer follow up. This may be attributed to a number of factors:

(1) the definitions for post-procedural infarctions are likely to have had different enzyme rise thresholds for the two techniques, with a higher threshold set for CABG. This is because it has previously been considered 'not unreasonable' to allow for some cardiac enzyme leak from the heart due to cardiac manipulation, without

defining this as an infarction. More sensitive markers such as troponins have not been universally used in these trials;

(2) grafts which are invariably placed distally on native vessels may occlude with less myocardial impact than vessels opened proximally by stent procedures;

(3) interventionists are more inclined to request cardiac enzymes on patients with post-PCI chest pains than surgeons who are inclined to accept a degree of chest pain from patients due to the nature of the operative procedure;

(4) finally, since the modest follow-up duration is likely to capture stent failure more fully as opposed to graft failure, the limited follow-up duration may introduce a bias against stenting.

Limitations

This review has a number of limitations which are related to the limits of the trial data currently available:

(1) patients entered into such studies had to be suitable for either intervention and were not typical of all patients seen by cardiologists or cardiothoracic surgeons;

(2) practice changed over the periods of the trials and so results from different procedures or devices may not be the same; for example the frequent use of Glycoprotein IIB/IIIA has in more recent practice reduced early stent thrombosis and the amount of Ischaemic enzyme release peri procedurally which would favour the stent arm of trials in which such agents are used - similarly, the increasing use of 'off pump' surgery may have reduced neurological defeats;

(3) we could not consider subgroups of patients in the current meta-analysis. There is potential for within and between study heterogeneity related to the patients entering the study. We understand that an IPD study is currently underway (SOS Investigators, Personal communication, January 2003);

(4) analysis of 'other' adverse events (for example, neurological complications) were not completed as these were not commonly or consistently reported.

For these reasons there are several factors which bias outcomes for and against each revascularisation technique compared to contemporary practice. There may therefore be limits to the generalisability of our review, but nonetheless it presents an up to date appraisal of available data.

Future directions

Stenting and surgical practice are developing and so, review of these evolving interventions should continue. Three RCTs comparing CABG to drug-eluting stents (DES) are underway or pending analysis.

(1) **CARDia** study included a DES subset and is expected to report within 2004;

(2) **FREEDOM** which is recruiting patients with diabetes and multiple vessel disease, all receive DES;

(3) **SYNTAX** trial (which is in the start-up phase) will utilise DES and stratify patients by number of vessels disease, diabetes and left main vessel disease.

We enquired as to the progress of release of CARDia data and contacted FREEDOM trialists, but did not receive replies. Surgical practice is also developing with the use of less invasive techniques and 'off-pump' procedures.

As in practice, most patients with single vessel disease receive stents and those with more than two vessels involved are allocated to surgery, the studies of patients with multivessel disease (especially two vessel disease) are therefore of particular interest, as they focus on areas where there is the greatest margin for change in practice.

It is generally expected that in the short term, traditional stenting may be less expensive, more patient friendly and incur lower peri-procedural mortality and morbidity, but in the longer term, CABG may be better value with reduced need for repeat revascularisations. Since differences in major clinical outcomes such as mortality or quality of life are not apparent with the current evidence base, this review demonstrates the need for consideration of larger trials with long-term data to fully populate clinical and economic data to allow formal lifetime cost-effectiveness models to determine whether resources should be put preferentially into stenting or CABG. Since such a rigorous scientific approach is likely to require large-scale nationally funded investment, we may never see appropriately powered and designed clinical trials answering the question - for whom is surgery and for whom is stenting a preferable choice?

Such paucity of data may have important implications as physicians, patients, policy makers and device manufacturers, who driven by their own personal enthusiasm or biases, can make choices unrestricted by the evidence base.

AUTHORS' CONCLUSIONS

Implications for practice

Considerably more data is needed to make firm long term conclusions on the implications for practice, but in the short to medium term, CABG has far less repeat revascularisation procedures than PTCA with stents currently in common clinical use.

Implications for research

Re-evaluation of these technologies will be required as the development of new surgical techniques and stent designs is ongoing. Although longer-term follow-up may be useful, interventions

are changing to such an extent that long-term data risks being inapplicable to what has become the subject of current research and/or practice. Future trials should recruit more realistic patient groupings, as the population selected for inclusion in the current review were prone to bias. In common with many clinical trials in this area, selection tended to focus on patients with generally less co-morbidities and with better left ventricular function than the overall population presenting for revascularisation in the real world setting. Reviews could undertake IPD analyses to examine subgroups.

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* Indicates the major publication for the study

CHARACTERISTICS OF STUDIES

Characteristics of included studies [ordered by study ID]

ARTS

Methods	cerebrovascular RCT Multicentre, International	
Participants	MVD 2 or more de novo lesion in different major arteries Total occlusion < 1month Lesion suitable for CABG or stenting	
Interventions	Palmaz-Schatz Crown/Cross flex (Cordis) - Conventional CABG Stents: 600 CABG: 605	
Outcomes	Absence of major MACE for 1 year; angina status; medications; costs and cost-effectiveness; QoL; combined end point of death, MI or stroke, death, MI, stroke, revascularisation procedures at 1 year	
Notes		
<i>Risk of bias</i>		
Bias	Authors' judgement	Support for judgement
Allocation concealment (selection bias)	Unclear risk	B - Unclear

Cisowski

Methods	RCT Single centre, Poland	
Participants	1VD ACC/AHA A or B lesion in proximal LAD Angina CCS II or higher Lesion diameter 3 mm or greater/length 20mm or greater Lesion suitable for CABG or Stenting	
Interventions	Tristar, Tera, Penta (Guidant) - MIDCAB (E-ACAB) Stent: 50 CABG: 50	
Outcomes	MACE (Death, MI, reoccurrence of angina pectoris); TVR; costs	
Notes		
<i>Risk of bias</i>		
Bias	Authors' judgement	Support for judgement
Allocation concealment (selection bias)	Unclear risk	B - Unclear

Diegeler

Methods	RCT Multicentre, Germany	
Participants	1VD Lesion =75% stenosis in proximal LAD or between origin of left circumflex and 1st septal branch	
Interventions	Various stents used - MIDCAB Stent: 110 CABG: 110	
Outcomes	Freedom from MACE within 6 months; cardiac death; MI; TVR; clinical status (CCS); need for antianginal drugs at 6 months; adverse events	
Notes		
<i>Risk of bias</i>		
Bias	Authors' judgement	Support for judgement
Allocation concealment (selection bias)	Unclear risk	B - Unclear

Drenth

Methods	RCT Single centre, Netherlands	
Participants	IVD Angina II Lesion (Grade B2 or C) of proximal LAD Suitable for CABG or stenting	
Interventions	Stent type not described - MICAB Stent: 51 CABG: 51	
Outcomes	Freedom from MACCE at 3 years; angiographic outcome at 6 months; angina class (CCS) ; antianginal medication; clinical events MACCE without revascularisation 6 months; clinical outcome	
Notes		
<i>Risk of bias</i>		
Bias	Authors' judgement	Support for judgement
Allocation concealment (selection bias)	Unclear risk	B - Unclear

ERACI II

Methods	RCT Multicentre, Argentina	
Participants	MVD Angina CSS III-IV; no angina but large area of heart at risk; unstable =1 vessel to be treated Lesion>3.0mm	
Interventions	Gianturco Robin II (Cook) Primary device - Conventional CABG Stents: 225 CABG: 225	
Outcomes	MACE	
Notes		
<i>Risk of bias</i>		
Bias	Authors' judgement	Support for judgement
Allocation concealment (selection bias)	Unclear risk	B - Unclear

Grip

Methods	RCT Sweden	
Participants	IVD engaging LAD Stable or unstable angina	
Interventions	Stent type not described - MIDCAB Stent: 28 CABG: 25	
Outcomes	QoL; Clinical events at 6 months	
Notes		
<i>Risk of bias</i>		
Bias	Authors' judgement	Support for judgement
Allocation concealment (selection bias)	Unclear risk	B - Unclear

OCTOSTENT

Methods	RCT Multicentre, Europe	
Participants	M/IVD Moderate LV function CABG or stenting to be considered feasible	

OCTOSTENT (Continued)

Interventions	Stent type not described - OPCAB Stent: 138 CABG: 142	
Outcomes	Absence MACCE for 1 year (Death, stroke, TIA, reversible ischaemic neurological deficits, non fatal MI, repeat revascularisation by PCI or surgery) Angina status Medications Costs and cost-effectiveness QOL Combined end point of death, MI or stroke, death, MI, stroke, revascularisation procedures at 1 year	
Notes		
<i>Risk of bias</i>		
Bias	Authors' judgement	Support for judgement
Allocation concealment (selection bias)	Unclear risk	B - Unclear

SIMA

Methods	RCT Multicentre, Europe	
Participants	1VD Symptomatic or silent ischaemia 1 LAD lesion Ejection fraction >45% Vessel >3.0mm	
Interventions	Any CE marked, but Palmaz-Schatz recommended - Conventional CABG/MIDCAB (10% of surgical procedures) Stent: 62 treated CABG: 59 treated	
Outcomes	Event free survival; angina functional class; exercise tolerance; antianginal medication; QoL; post procedural drug regimen	
Notes		
<i>Risk of bias</i>		
Bias	Authors' judgement	Support for judgement
Allocation concealment (selection bias)	Unclear risk	B - Unclear

SOS

Methods	RCT Multicentre, International	
Participants	MVD Symptomatic 1 or more vessel suitable for stenting	
Interventions	No restriction on type of stent or surgical technique (3% of procedures OPCAB) Stent: 488 CABG: 500	
Outcomes	Rate of repeat revascularisation; death Q-wave MI; all-cause mortality; angina (CCS); cardiac medication; LVF	
Notes		
<i>Risk of bias</i>		
Bias	Authors' judgement	Support for judgement
Allocation concealment (selection bias)	Unclear risk	B - Unclear

MVD: multiple vessel disease; 1VD: single vessel disease; MIDCAB: minimally invasive direct coronary artery bypass (off-pump procedure); E-ACAB: endoscopic atraumatic coronary artery bypass grafting; OPCAB: off-pump coronary artery bypass; MACE: major adverse cardiac event; MACCE: major adverse cardiac or cerebrovascular event; MI: myocardial infarction; TVR: target vessel revascularisation; QoL: Quality of Life; CCS: Canadian Cardiovascular Society classification; LVF: Left ventricular ejection fraction

Characteristics of excluded studies [ordered by study ID]

Study	Reason for exclusion
AMIST	PTCA versus CABG, unable to determine outcome data for those electively stented
AWESOME	PCI versus CABG, unable to determine outcome data for those stented
Berger 2001	PTCA versus CABG, no stent data (BARI)
Biondi-Zoccai 2003	Systematic review
Fischman 1994	Stent versus PTCA study
Iakovou 2002	Non RCT
Kapelak 1998	Non RCT
Kim 2000	Non RCT

(Continued)

Mathew 2000	Non RCT
Murtaza 2001	Correspondence about ARTS (not ARTS authors, no data)
Pohl 2002	Intervention involved application of both stenting and surgery procedures to individuals
Ryan 2001	Editorial about ERACI II
Serruys 1994	Stent versus PTCA study
Shirai 2004	Non RCT
Taggart 2001	Correspondence about ARTS (not ARTS authors, no data)
Weintraub 1997	Non RCT
Yock 2000	Health Economics study (using PTCA versus CABG trial, BARI)

Characteristics of ongoing studies *[ordered by study ID]*

CARDia

Trial name or title	CARDia
Methods	
Participants	600 patients with diabetes, suitable for revascularisation by stenting or CABG, UK and Ireland
Interventions	PCI (with randomisation between non DES and Sirolimus-eluting stents) CABG (few protocol restrictions on operative techniques)
Outcomes	Primary end point composite of death, MI, and cerebrovascular accident at 1 year. Data on cost effectiveness, QoL, neurocognitive function also collected. 30 days, 6 months, 1, 2, and 5 years
Starting date	Start date: 01/05/2002 End date: 31/01/2004
Contact information	Dr. Akhil Kapur a.kapur@ic.ac.uk Department of Cardiology National Heart and Lung Institute at Hammersmith Hospital Imperial College School of Medicine Du Cane Road London W12 0HS, UK. Tel: +44 (0) 20 8383 1000 bleep 9136

CARDia (Continued)

	Fax: +44 (0) 20 3383 2120
Notes	

FREEDOM

Trial name or title	FREEDOM
Methods	
Participants	2400 patients with diabetes and multi-vessel coronary disease
Interventions	DES CABG
Outcomes	Not known
Starting date	2004, 5 year project
Contact information	Dr. Valentin Fuster valentin.fuster@msnyuhealth.org The Zena and Michael A. Wiener Cardiovascular Institute The Mount Sinai Medical Center One Gustave L. Levy Place, Box 1030 New York , NY, USA 10029-6574 Tel: 212-241-7911
Notes	

SYNTAX

Trial name or title	SYNTAX
Methods	
Participants	Patients stratified by vessels disease, diabetes and left main vessel disease)
Interventions	DES CABG
Outcomes	MACCE at 1 year (all cause mortality, MI, CVA, Repeat revascularisation)
Starting date	2004, in start-up phase

SYNTAX (Continued)

Contact information	To follow. Basic information presented 2004 at: http://www.europcr.com/
Notes	

SYNTAX - presented by Serruys, PCR 2004?

DATA AND ANALYSES

Comparison 1. Event Rate

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
2 Event Rate: 6 months	3		Odds Ratio (M-H, Fixed, 95% CI)	Subtotals only
2.2 Single vessel	3	418	Odds Ratio (M-H, Fixed, 95% CI)	0.32 [0.18, 0.55]
3 Event Rate: 12 months	4	2575	Odds Ratio (M-H, Fixed, 95% CI)	0.43 [0.35, 0.54]
3.1 Multiple vessel	3	2473	Odds Ratio (M-H, Fixed, 95% CI)	0.44 [0.35, 0.55]
3.2 Single vessel	1	102	Odds Ratio (M-H, Fixed, 95% CI)	0.28 [0.08, 0.93]
4 Event Rate: 2 years	1		Odds Ratio (M-H, Fixed, 95% CI)	Subtotals only
4.1 Multiple vessel	1	1205	Odds Ratio (M-H, Fixed, 95% CI)	0.41 [0.31, 0.54]
5 Event Rate: 2.5 to 3.0 years	3	1428	Odds Ratio (M-H, Fixed, 95% CI)	0.37 [0.29, 0.48]
5.1 Multiple vessel	1	1205	Odds Ratio (M-H, Fixed, 95% CI)	0.40 [0.30, 0.52]
5.2 Single vessel	2	223	Odds Ratio (M-H, Fixed, 95% CI)	0.24 [0.11, 0.53]
6 Event Rate: 4 years	1	102	Odds Ratio (M-H, Fixed, 95% CI)	0.29 [0.09, 0.87]
6.2 Single vessel	1	102	Odds Ratio (M-H, Fixed, 95% CI)	0.29 [0.09, 0.87]

Comparison 2. Mortality

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Mortality: up to 36 days	3	673	Odds Ratio (M-H, Fixed, 95% CI)	4.16 [1.38, 12.56]
1.1 Multiple vessel	1	450	Odds Ratio (M-H, Fixed, 95% CI)	6.84 [1.52, 30.66]
1.2 Single vessel	2	223	Odds Ratio (M-H, Fixed, 95% CI)	1.54 [0.25, 9.41]
2 Mortality: 6 months	4		Odds Ratio (M-H, Fixed, 95% CI)	Subtotals only
2.2 Single vessel	4	471	Odds Ratio (M-H, Fixed, 95% CI)	2.08 [0.51, 8.40]
3 Mortality: 12 months	4		Odds Ratio (M-H, Fixed, 95% CI)	Subtotals only
3.1 Multiple vessel	4	2923	Odds Ratio (M-H, Fixed, 95% CI)	1.26 [0.80, 2.00]
4 Mortality: 1.5 to 2 years	3	2643	Odds Ratio (M-H, Fixed, 95% CI)	1.01 [0.67, 1.53]
4.1 Multiple vessel	3	2643	Odds Ratio (M-H, Fixed, 95% CI)	1.01 [0.67, 1.53]
5 Mortality: 2.4 to 3.0 years	3	1428	Odds Ratio (M-H, Fixed, 95% CI)	1.35 [0.78, 2.33]
5.1 Multiple vessel	1	1205	Odds Ratio (M-H, Fixed, 95% CI)	1.27 [0.72, 2.25]
5.2 Single vessel	2	223	Odds Ratio (M-H, Fixed, 95% CI)	2.43 [0.35, 16.75]
6 Mortality: 4 years	1	102	Odds Ratio (M-H, Fixed, 95% CI)	7.43 [0.37, 147.67]
6.2 Single vessel	1	102	Odds Ratio (M-H, Fixed, 95% CI)	7.43 [0.37, 147.67]
7 Mortality: 12 months - Random Effects Model	4	2923	Odds Ratio (M-H, Random, 95% CI)	1.32 [0.45, 3.86]
7.1 Multiple vessel	4	2923	Odds Ratio (M-H, Random, 95% CI)	1.32 [0.45, 3.86]
8 Mortality: 1.5 to 2 years - Random Effects Model	3	2643	Odds Ratio (M-H, Random, 95% CI)	1.04 [0.36, 3.03]
8.1 Multiple vessel	3	2643	Odds Ratio (M-H, Random, 95% CI)	1.04 [0.36, 3.03]

Comparison 3. Myocardial Infarction: Any Reported

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Myocardial infarction - any up to 36 days	3	787	Odds Ratio (M-H, Fixed, 95% CI)	2.83 [1.17, 6.81]
1.1 Multiple vessel	1	450	Odds Ratio (M-H, Fixed, 95% CI)	6.84 [1.52, 30.66]
1.2 Single vessel	2	337	Odds Ratio (M-H, Fixed, 95% CI)	1.24 [0.37, 4.14]
2 Myocardial infarction - any: 6 months	4		Odds Ratio (M-H, Fixed, 95% CI)	Subtotals only
2.2 Single vessel	4	471	Odds Ratio (M-H, Fixed, 95% CI)	0.78 [0.29, 2.14]
3 Myocardial infarction - any: 12 months	3		Odds Ratio (M-H, Fixed, 95% CI)	Subtotals only
3.1 Multiple vessel	3	2473	Odds Ratio (M-H, Fixed, 95% CI)	1.08 [0.76, 1.53]
4 Myocardial infarction - any: 2.0 years	2		Odds Ratio (M-H, Fixed, 95% CI)	Subtotals only
4.1 Multiple vessel	2	2193	Odds Ratio (M-H, Fixed, 95% CI)	1.08 [0.76, 1.52]
5 Myocardial infarction - any: Typically 2.5 to 3.0 years	3	1428	Odds Ratio (M-H, Fixed, 95% CI)	0.69 [0.44, 1.07]
5.1 Multiple vessel	1	1205	Odds Ratio (M-H, Fixed, 95% CI)	0.75 [0.47, 1.19]
5.2 Single vessel	2	223	Odds Ratio (M-H, Fixed, 95% CI)	0.37 [0.10, 1.42]
6 Myocardial infarction - any: 4 years	1	102	Odds Ratio (M-H, Fixed, 95% CI)	0.18 [0.02, 1.63]
6.2 Single vessel	1	102	Odds Ratio (M-H, Fixed, 95% CI)	0.18 [0.02, 1.63]
7 Myocardial infarction - any: 12 months - Random Effects Model	3	2473	Odds Ratio (M-H, Random, 95% CI)	1.10 [0.65, 1.88]
7.1 Multiple vessel	3	2473	Odds Ratio (M-H, Random, 95% CI)	1.10 [0.65, 1.88]
8 Myocardial infarction - any: 2.0 years - Random Effects Model	2	2193	Odds Ratio (M-H, Random, 95% CI)	1.09 [0.53, 2.26]
8.1 Multiple vessel	2	2193	Odds Ratio (M-H, Random, 95% CI)	1.09 [0.53, 2.26]

Comparison 4. Revascularisation: Any Reported

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Any Revascularisation Procedure: up to 36 days	2	666	Odds Ratio (M-H, Fixed, 95% CI)	0.69 [0.20, 2.31]
1.1 Multiple vessel	1	450	Odds Ratio (M-H, Fixed, 95% CI)	0.11 [0.01, 2.04]
1.2 Single vessel	1	216	Odds Ratio (M-H, Fixed, 95% CI)	2.04 [0.37, 11.37]
2 Any Revascularisation Procedure: 6 months	4		Odds Ratio (M-H, Fixed, 95% CI)	Subtotals only
2.2 Single vessel	4	471	Odds Ratio (M-H, Fixed, 95% CI)	0.27 [0.14, 0.51]
3 Any Revascularisation Procedure: 12 months	3		Odds Ratio (M-H, Fixed, 95% CI)	Subtotals only
3.1 Multiple vessel	3	2473	Odds Ratio (M-H, Fixed, 95% CI)	0.18 [0.13, 0.25]

Percutaneous transluminal coronary angioplasty with stents versus coronary artery bypass grafting for people with stable angina or acute coronary syndromes (Review)

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4 Any Revascularisation Procedure: 2.0 years	2		Odds Ratio (M-H, Fixed, 95% CI)	Subtotals only
4.1 Multiple vessel	2	2193	Odds Ratio (M-H, Fixed, 95% CI)	0.21 [0.15, 0.27]
5 Any Revascularisation Procedure: 2.5 to 3.0 years	2		Odds Ratio (M-H, Fixed, 95% CI)	Subtotals only
5.2 Single vessel	2	223	Odds Ratio (M-H, Fixed, 95% CI)	0.09 [0.02, 0.34]
6 Any Revascularisation Procedure: 4 years	1	102	Odds Ratio (M-H, Fixed, 95% CI)	0.29 [0.07, 1.15]
6.2 Single vessel	1	102	Odds Ratio (M-H, Fixed, 95% CI)	0.29 [0.07, 1.15]

Comparison 5. Binary Restenosis Rate

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Binary Restenosis Rate: 6 months	3		Odds Ratio (M-H, Fixed, 95% CI)	Subtotals only
1.2 Single vessel	3	404	Odds Ratio (M-H, Fixed, 95% CI)	0.29 [0.17, 0.51]
2 Binary Restenosis Rate: 6 months - Random Effects Model	3	404	Odds Ratio (M-H, Random, 95% CI)	0.21 [0.06, 0.70]
2.2 Single vessel	3	404	Odds Ratio (M-H, Random, 95% CI)	0.21 [0.06, 0.70]

Analysis 1.2. Comparison 1 Event Rate, Outcome 2 Event Rate: 6 months.

Review: Percutaneous transluminal coronary angioplasty with stents versus coronary artery bypass grafting for people with stable angina or acute coronary syndromes

Comparison: 1 Event Rate

Outcome: 2 Event Rate: 6 months

Analysis 1.3. Comparison 1 Event Rate, Outcome 3 Event Rate: 12 months.

Review: Percutaneous transluminal coronary angioplasty with stents versus coronary artery bypass grafting for people with stable angina or acute coronary syndromes

Comparison: 1 Event Rate

Outcome: 3 Event Rate: 12 months

Analysis 1.4. Comparison 1 Event Rate, Outcome 4 Event Rate: 2 years.

Review: Percutaneous transluminal coronary angioplasty with stents versus coronary artery bypass grafting for people with stable angina or acute coronary syndromes

Comparison: 1 Event Rate

Outcome: 4 Event Rate: 2 years

Analysis 1.5. Comparison 1 Event Rate, Outcome 5 Event Rate: 2.5 to 3.0 years.

Review: Percutaneous transluminal coronary angioplasty with stents versus coronary artery bypass grafting for people with stable angina or acute coronary syndromes

Comparison: 1 Event Rate

Outcome: 5 Event Rate: 2.5 to 3.0 years

(Continued ...)

Analysis 1.6. Comparison 1 Event Rate, Outcome 6 Event Rate: 4 years.

Review: Percutaneous transluminal coronary angioplasty with stents versus coronary artery bypass grafting for people with stable angina or acute coronary syndromes

Comparison: 1 Event Rate

Outcome: 6 Event Rate: 4 years

Analysis 2.1. Comparison 2 Mortality, Outcome 1 Mortality: up to 36 days.

Review: Percutaneous transluminal coronary angioplasty with stents versus coronary artery bypass grafting for people with stable angina or acute coronary syndromes

Comparison: 2 Mortality

Outcome: 1 Mortality: up to 36 days

Analysis 2.2. Comparison 2 Mortality, Outcome 2 Mortality: 6 months.

Review: Percutaneous transluminal coronary angioplasty with stents versus coronary artery bypass grafting for people with stable angina or acute coronary syndromes

Comparison: 2 Mortality

Outcome: 2 Mortality: 6 months

Analysis 2.3. Comparison 2 Mortality, Outcome 3 Mortality: 12 months.

Review: Percutaneous transluminal coronary angioplasty with stents versus coronary artery bypass grafting for people with stable angina or acute coronary syndromes

Comparison: 2 Mortality

Outcome: 3 Mortality: 12 months

Analysis 2.4. Comparison 2 Mortality, Outcome 4 Mortality: 1.5 to 2 years.

Review: Percutaneous transluminal coronary angioplasty with stents versus coronary artery bypass grafting for people with stable angina or acute coronary syndromes

Comparison: 2 Mortality

Outcome: 4 Mortality: 1.5 to 2 years

Analysis 2.5. Comparison 2 Mortality, Outcome 5 Mortality: 2.4 to 3.0 years.

Review: Percutaneous transluminal coronary angioplasty with stents versus coronary artery bypass grafting for people with stable angina or acute coronary syndromes

Comparison: 2 Mortality

Outcome: 5 Mortality: 2.4 to 3.0 years

Analysis 2.6. Comparison 2 Mortality, Outcome 6 Mortality: 4 years.

Review: Percutaneous transluminal coronary angioplasty with stents versus coronary artery bypass grafting for people with stable angina or acute coronary syndromes

Comparison: 2 Mortality

Outcome: 6 Mortality: 4 years

Analysis 2.7. Comparison 2 Mortality, Outcome 7 Mortality: 12 months - Random Effects Model.

Review: Percutaneous transluminal coronary angioplasty with stents versus coronary artery bypass grafting for people with stable angina or acute coronary syndromes

Comparison: 2 Mortality

Outcome: 7 Mortality: 12 months - Random Effects Model

Analysis 2.8. Comparison 2 Mortality, Outcome 8 Mortality: 1.5 to 2 years - Random Effects Model.

Review: Percutaneous transluminal coronary angioplasty with stents versus coronary artery bypass grafting for people with stable angina or acute coronary syndromes

Comparison: 2 Mortality

Outcome: 8 Mortality: 1.5 to 2 years - Random Effects Model

Analysis 3.1. Comparison 3 Myocardial Infarction: Any Reported, Outcome 1 Myocardial infarction - any up to 36 days.

Review: Percutaneous transluminal coronary angioplasty with stents versus coronary artery bypass grafting for people with stable angina or acute coronary syndromes

Comparison: 3 Myocardial Infarction: Any Reported

Outcome: 1 Myocardial infarction - any up to 36 days

Analysis 3.2. Comparison 3 Myocardial Infarction: Any Reported, Outcome 2 Myocardial infarction - any: 6 months.

Review: Percutaneous transluminal coronary angioplasty with stents versus coronary artery bypass grafting for people with stable angina or acute coronary syndromes

Comparison: 3 Myocardial Infarction: Any Reported

Outcome: 2 Myocardial infarction - any: 6 months

Analysis 3.3. Comparison 3 Myocardial Infarction: Any Reported, Outcome 3 Myocardial infarction - any: 12 months.

Review: Percutaneous transluminal coronary angioplasty with stents versus coronary artery bypass grafting for people with stable angina or acute coronary syndromes

Comparison: 3 Myocardial Infarction: Any Reported

Outcome: 3 Myocardial infarction - any: 12 months

Analysis 3.4. Comparison 3 Myocardial Infarction: Any Reported, Outcome 4 Myocardial infarction - any: 2.0 years.

Review: Percutaneous transluminal coronary angioplasty with stents versus coronary artery bypass grafting for people with stable angina or acute coronary syndromes

Comparison: 3 Myocardial Infarction: Any Reported

Outcome: 4 Myocardial infarction - any: 2.0 years

Analysis 3.5. Comparison 3 Myocardial Infarction: Any Reported, Outcome 5 Myocardial infarction - any: Typically 2.5 to 3.0 years.

Review: Percutaneous transluminal coronary angioplasty with stents versus coronary artery bypass grafting for people with stable angina or acute coronary syndromes

Comparison: 3 Myocardial Infarction: Any Reported

Outcome: 5 Myocardial infarction - any: Typically 2.5 to 3.0 years

Analysis 3.6. Comparison 3 Myocardial Infarction: Any Reported, Outcome 6 Myocardial infarction - any: 4 years.

Review: Percutaneous transluminal coronary angioplasty with stents versus coronary artery bypass grafting for people with stable angina or acute coronary syndromes

Comparison: 3 Myocardial Infarction: Any Reported

Outcome: 6 Myocardial infarction - any: 4 years

Analysis 3.7. Comparison 3 Myocardial Infarction: Any Reported, Outcome 7 Myocardial infarction - any: 12 months - Random Effects Model.

Review: Percutaneous transluminal coronary angioplasty with stents versus coronary artery bypass grafting for people with stable angina or acute coronary syndromes

Comparison: 3 Myocardial Infarction: Any Reported

Outcome: 7 Myocardial infarction - any: 12 months - Random Effects Model

Analysis 3.8. Comparison 3 Myocardial Infarction: Any Reported, Outcome 8 Myocardial infarction - any: 2.0 years - Random Effects Model.

Review: Percutaneous transluminal coronary angioplasty with stents versus coronary artery bypass grafting for people with stable angina or acute coronary syndromes

Comparison: 3 Myocardial Infarction: Any Reported

Outcome: 8 Myocardial infarction - any: 2.0 years - Random Effects Model

Analysis 4.1. Comparison 4 Revascularisation: Any Reported, Outcome 1 Any Revascularisation Procedure: up to 36 days.

Review: Percutaneous transluminal coronary angioplasty with stents versus coronary artery bypass grafting for people with stable angina or acute coronary syndromes

Comparison: 4 Revascularisation: Any Reported

Outcome: 1 Any Revascularisation Procedure: up to 36 days

Analysis 4.2. Comparison 4 Revascularisation: Any Reported, Outcome 2 Any Revascularisation Procedure: 6 months.

Review: Percutaneous transluminal coronary angioplasty with stents versus coronary artery bypass grafting for people with stable angina or acute coronary syndromes

Comparison: 4 Revascularisation: Any Reported

Outcome: 2 Any Revascularisation Procedure: 6 months

Analysis 4.3. Comparison 4 Revascularisation: Any Reported, Outcome 3 Any Revascularisation Procedure: 12 months.

Review: Percutaneous transluminal coronary angioplasty with stents versus coronary artery bypass grafting for people with stable angina or acute coronary syndromes

Comparison: 4 Revascularisation: Any Reported

Outcome: 3 Any Revascularisation Procedure: 12 months

Analysis 4.4. Comparison 4 Revascularisation: Any Reported, Outcome 4 Any Revascularisation Procedure: 2.0 years.

Review: Percutaneous transluminal coronary angioplasty with stents versus coronary artery bypass grafting for people with stable angina or acute coronary syndromes

Comparison: 4 Revascularisation: Any Reported

Outcome: 4 Any Revascularisation Procedure: 2.0 years

Analysis 4.5. Comparison 4 Revascularisation: Any Reported, Outcome 5 Any Revascularisation Procedure: 2.5 to 3.0 years.

Review: Percutaneous transluminal coronary angioplasty with stents versus coronary artery bypass grafting for people with stable angina or acute coronary syndromes

Comparison: 4 Revascularisation: Any Reported

Outcome: 5 Any Revascularisation Procedure: 2.5 to 3.0 years

Analysis 4.6. Comparison 4 Revascularisation: Any Reported, Outcome 6 Any Revascularisation Procedure: 4 years.

Review: Percutaneous transluminal coronary angioplasty with stents versus coronary artery bypass grafting for people with stable angina or acute coronary syndromes

Comparison: 4 Revascularisation: Any Reported

Outcome: 6 Any Revascularisation Procedure: 4 years

Analysis 5.1. Comparison 5 Binary Restenosis Rate, Outcome 1 Binary Restenosis Rate: 6 months.

Review: Percutaneous transluminal coronary angioplasty with stents versus coronary artery bypass grafting for people with stable angina or acute coronary syndromes

Comparison: 5 Binary Restenosis Rate

Outcome: 1 Binary Restenosis Rate: 6 months

Analysis 5.2. Comparison 5 Binary Restenosis Rate, Outcome 2 Binary Restenosis Rate: 6 months - Random Effects Model.

Review: Percutaneous transluminal coronary angioplasty with stents versus coronary artery bypass grafting for people with stable angina or acute coronary syndromes

Comparison: 5 Binary Restenosis Rate

Outcome: 2 Binary Restenosis Rate: 6 months - Random Effects Model

ADDITIONAL TABLES

Table 1. MEDLINE (Ovid, 1966 to June Week 4 2004)

1 exp stents/ (18094)
2 stent\$.tw. (21006)
3 or/1-2 (24524)
4 exp coronary disease/ (138520)
5 exp myocardial infarction/ (95563)
6 exp angina pectoris/ (29604)
7 coronary.tw. (165294)
8 angina.tw. (29588)
9 myocardial infarction.tw. (71346)
10 or/4-9 (289171)
11 3 and 10 (7736)
12 exp Coronary Artery Bypass/ (28297)
13 (coronary adj4 bypass\$.tw. (21860)
14 cabg.tw. (5482)
15 or/12-14 (34720)
16 11 and 15 (1491)

Table 1. MEDLINE (Ovid, 1966 to June Week 4 2004) (Continued)

17 randomized controlled trial.pt. (190066)
18 controlled clinical trial.pt. (66483)
19 Randomized controlled trials/ (32727)
20 random allocation.sh. (50941)
21 double blind method.sh. (78441)
22 single-blind method.sh. (8165)
23 or/17-22 (321732)
24 exp animal/ not human/ (2813909)
25 23 not 24 (305055)
26 clinical trial.pt. (384488)
27 exp Clinical trials/ (155323)
28 (clin\$ adj25 trial\$).ti,ab. (100437)
29 ((singl\$ or doubl\$ or trebl\$ or tripl\$) adj (blind\$ or mask\$)).ti,ab. (75050)
30 placebos.sh. (23062)
31 placebo\$.ti,ab. (84456)
32 random\$.ti,ab. (286327)
33 research design.sh. (38205)
34 or/26-33 (675439)
35 34 not 24 (627741)
36 35 not 25 (332926)
37 comparative study.sh. (1126924)
38 exp evaluation studies/ (489332)
39 follow up studies.sh. (284482)
40 prospective studies.sh. (174378)
41 (control\$ or prospectiv\$ or volunteer\$).ti,ab. (1448168)
42 or/37-41 (2896137)
43 42 not 24 (2216327)
44 43 not (25 or 36) (1777113)
45 25 or 36 or 44 (2415094)
46 16 and 45 (868)
47 limit 46 to yr=1990 - 2004 (859)

Table 2. EMBASE (Ovid, 1980 to 2004 Week 27)

1 coronary stent/ (4773)
2 stent\$.tw. (19964)
3 or/1-2 (21140)
4 exp Coronary Artery Disease/ (52238)
5 exp Coronary Artery Obstruction/ (10060)
6 exp coronary artery/ (17237)
7 exp heart infarction/ (76177)
8 exp angina pectoris/ (28196)
9 coronary.tw. (135313)
10 angina.tw. (24098)
11 myocardial infarction.tw. (58860)
12 or/4-11 (209182)
13 3 and 12 (7595)

Table 2. EMBASE (Ovid, 1980 to 2004 Week 27) (Continued)

14 coronary artery bypass graft/ (17131)
 15 (coronary adj4 bypass\$.tw. (18718)
 16 cabg.tw. (4807)
 17 or/14-16 (25814)
 18 13 and 17 (1482)
 19 random\$.ti,ab. (252525)
 20 factorial\$.ti,ab. (5072)
 21 (crossover\$ or cross over\$ or cross-over\$).ti,ab. (30031)
 22 placebo\$.ti,ab. (80297)
 23 (double\$ adj blind\$).ti,ab. (65025)
 24 (singl\$ adj blind\$).ti,ab. (5414)
 25 assign\$.ti,ab. (73603)
 26 allocat\$.ti,ab. (23112)
 27 volunteer\$.ti,ab. (75264)
 28 Crossover Procedure/ (15069)
 29 Double Blind Procedure/ (52125)
 30 Randomized Controlled Trial/ (85815)
 31 Single Blind Procedure/ (4797)
 32 or/19-31 (449620)
 33 exp animal/ (79612)
 34 nonhuman/ (2423534)
 35 exp animal experiment/ (1040385)
 36 or/33-35 (2661811)
 37 exp human/ (4657871)
 38 36 not 37 (2340844)
 39 32 not 38 (394258)
 40 18 and 39 (239)

Table 3. CENTRAL (The Cochrane Library Issue 2 2004)

#1 STENTS
 #2 stent*
 #3 (#1 or #2)
 #4 CORONARY DISEASE
 #5 CORONARY CIRCULATION
 #6 MYOCARDIAL REVASCULARIZATION
 #7 CORONARY VESSELS
 #8 coronary
 #9 angina
 #10 (myocardial next infarction)
 #11 (heart next infarction)
 #12 (#4 or #5 or #6 or #7 or #8 or #9 or #10 or #11)
 #13 (#3 and #12)
 #14 CORONARY ARTERY BYPASS
 #15 (coronary near bypass*)
 #16 cabg

Table 3. CENTRAL (The Cochrane Library Issue 2 2004) (Continued)

#17 (#14 or #15 or #16)
#18 (#17 and #13)

Table 4. Quality assessment

Study name	Adeq. Randomisation	Adeq. Concealment	Selection Bias	Adeq. Masking	Notes
ARTS	A	A	A	C	
Cisowski	B	B	A*	C*	
Diegeler	A	A	A	C	
Drenth	B	B	A	C	
ERACI II	A	A	A	C	
Grip	B	B	A	C	
OCTOSTENT	A	A	A	B/C **	
SIMA	B	B	A	C	
SOS	A	A	A	C	
			*Few exclusions up to 6 month (A); but 12 months data included only half of those allocated to treatments - suspect data are interim reporting, so not considered in quality assessment	* Angiographic outcomes were assessed by a committee 'not involved' in the study. This outcome may have been masked. ** An 'independent committee blinded to... allocation evaluated all events.' Therefore it would appear that there may have been non-blinded and blinded assessment of outcomes	

WHAT'S NEW

Last assessed as up-to-date: 1 November 2004.

Date	Event	Description
12 May 2017	Amended	This review is no longer maintained. A review with a similar title (Coronary artery bypass grafting surgery versus percutaneous coronary intervention for coronary artery disease) has been registered to provide up-to-date information

HISTORY

Protocol first published: Issue 1, 2004

Review first published: Issue 1, 2005

Date	Event	Description
13 December 2012	Review declared as stable	Review team unable to update and Cochrane Heart Group was unable to find new review team. This review requires a new team to take this work forward
9 September 2008	Amended	Converted to new review format.
1 November 2004	New citation required and conclusions have changed	Substantive amendment

CONTRIBUTIONS OF AUTHORS

All reviewers listed below contributed to the development of the protocol, data selection and analysis. All reviewers took part in the editing and production of the completed review.

Specific contributions of reviewers:

AB lead reviewer, clinical advisor

RH co-ordination, data input, analysis and display

YD search strategy development, information management

RD methodological advisor, review management

TW review management, data interpretation

DECLARATIONS OF INTEREST

Ameet Bakhai has worked on projects involving Abbott Vascular Devices, Bristol Myers Squibb and Merck & Co. USA. Through his appointment with the Harvard Clinical Research Institute (Boston, USA), he was a member of an academic department which is involved in collaborations with Boston Scientific and Guidant Corporation.

No further relevant competing interests exist.

SOURCES OF SUPPORT

Internal sources

- No sources of support supplied

External sources

- NCCHTA Project Ref: 02/16/01 (NICE appraisal of Coronary Artery Stents), UK.

NOTES

This review 'topic' has been included in work being carried out as part of a Health Technology Assessment commissioned by the National Institute for Clinical Excellence in England and Wales.

Details of this research is available via www.nice.org.uk and www.nchta.org

This review is no longer maintained. A review with a similar title (Coronary artery bypass grafting surgery versus percutaneous coronary intervention for coronary artery disease) has been registered to provide up-to-date information.

INDEX TERMS

Medical Subject Headings (MeSH)

*Coronary Artery Bypass; *Stents; Angina Pectoris [therapy]; Angioplasty, Balloon, Coronary [*methods]; Coronary Disease [*therapy]; Myocardial Infarction [therapy]; Randomized Controlled Trials as Topic; Syndrome

MeSH check words

Humans