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Bachoo P, Thorpe PA, Maxwell H, Welch K

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[Intervention Review]

Endovascular stents for intermittent claudication

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ABSTRACT

Background

Endovascular stents have been suggested as a means to improve the patency of arteries after angioplasty in patients with intermittent claudication. This is an update of a Cochrane review published in 2002.

Objectives

The null hypothesis to be tested by this review is that for individuals with claudication the use of an endovascular stent, in addition to percutaneous transluminal angioplasty, does not improve symptoms of life-style limiting claudication when compared to percutaneous angioplasty alone.

Search methods

For this update the Cochrane Peripheral Vascular Diseases Group searched their Specialised Register (last searched August 2009) and the Cochrane Central Register of Controlled Trials (CENTRAL) in *The Cochrane Library* (last searched 2009, Issue 3).

Selection criteria

Randomised trials comparing angioplasty alone versus angioplasty with endovascular stents in patients with intermittent claudication.

Data collection and analysis

Two authors independently assessed trial quality and extracted the data. Only published trial data were used but unpublished data were sought for the update. Effectiveness was measured by the pre-defined primary outcome measures restenosis or reocclusion rates and maximum walking distance.

Main results

Two studies were included involving a total of 104 participants. Both studies included only individuals with femoro-popliteal disease. They compared angioplasty and stenting with the Palmaz stent against angioplasty alone. Although one study showed a slight statistical advantage in arterial patency after angioplasty alone, this was not found when the two studies were combined. No differences in the secondary outcomes were detected in either study.

Authors' conclusions

The small number of relevant studies identified together with the small sample sizes and methodological weaknesses severely limit the usefulness of this review in guiding practice. The results from larger multicentre trials are needed.

PLAIN LANGUAGE SUMMARY

Endovascular stents for intermittent claudication

Intermittent claudication is a cramping leg pain that develops when walking and is relieved with rest. It is caused by inadequate blood flow to the leg muscles because of atherosclerosis (fatty deposits on the walls of the arteries blocking blood flow). People with mild-to-moderate claudication are advised to keep walking, stop smoking and reduce cardiovascular risk factors. Possible treatments include exercise, drugs, bypass surgery or angioplasty. Angioplasty involves expanding the narrowed artery. This can be done by inflating a 'balloon' inside the artery. Sometimes stents (thin metal sleeves) are inserted to keep the artery open.

The review authors identified two controlled studies in which a total of 104 participants (68 male and 36 female) with intermittent claudication were randomised to receive the same type of endovascular stent (Palmaz) or balloon angioplasty alone. This review found that there is not enough evidence from randomised controlled trials about the effects of using stents with angioplasty over angioplasty alone to treat intermittent claudication.

BACKGROUND

Intermittent claudication (IC) is pain in the legs on exercise, caused by an inadequate supply of oxygen to the muscles (ischaemia). It is associated with stenosis (narrowing) or occlusion of the arteries. The diagnosis is based on the classical symptom of pain or discomfort when walking at an ordinary pace on the level, which is aggravated by walking up an incline and relieved by rest ([Leng 1992](#)). In the United Kingdom, the prevalence of IC varies between 2.2% and 7.0 % of the general adult population aged between 45 and 74 years ([Hughson 1978](#); [Dewhurst 1991](#); [Fowkes 1991](#)). Individuals with IC have a reduced overall survival compared to controls due to increased mortality from ischaemic heart disease and non-haemorrhagic cerebrovascular accidents ([Leng 1996](#)).

Although the preferred management of individuals with IC remains a subject of discussion, if patients with IC still have unacceptable disability after modification of risk factors and the best available medical management ([SIGN 2006](#)), then interventional therapy may include either percutaneous transluminal balloon angioplasty (PTA) or operative by-pass surgery. PTA can lead to an immediate increase in the calibre of the arterial lumen that is secondary to disruption and compression of the atheromatous plaque and dilation of the native vessel ([Belli 1993](#)). With its versatility ([Ahn 1992](#)), patient preference and low complication rate ([O'Keeffe 1991](#); [Axisa 2002](#)), PTA has become an increasingly viable option for patient management ([Whyman 1996](#)). However, the results on primary arterial patency following PTA remain inconsistent ([Tegtmeyer 1991](#); [el-Bayar 1992](#); [Price 1996](#)).

In an attempt to improve the outcome of PTA, endovascular stents as originally described by ([Dotter 1989](#)) have been used ([Blum 1993](#); [Vorwerk 1995](#)). Since their introduction many different designs of stent have been developed, although all vascular stents remain either balloon or self-expanding. The focus of this review was to present the evidence from randomised clinical trials in which various outcomes were reported after the use of endovascular stents (either balloon-expandable or self-expanding) in the treatment of adults with intermittent claudication, compared to participants receiving angioplasty alone.

OBJECTIVES

The null hypothesis to be tested is that for individuals with claudication the use of an endovascular stent in addition to percutaneous transluminal angioplasty does not improve symptoms of life-style limiting claudication when compared to percutaneous angioplasty alone.

METHODS

Criteria for considering studies for this review

Types of studies

All randomised trials comparing angioplasty alone versus angioplasty combined with intra-luminal stent placement as treatments for intermittent claudication of the lower extremities.

Types of participants

All adults presenting with intermittent claudication (as defined by the trialist), with the diagnosis supported by appropriate

lesions affecting the aorto-iliac or femoro-popliteal segments on angiography.

Types of interventions

Trials comparing angioplasty alone versus angioplasty combined with intra-luminal stent placement as treatments for intermittent claudication of the lower extremities.

Types of outcome measures

There is a range of perspectives from which outcomes can be viewed and this is reflected in the list of measures below. Nevertheless, because of the dangers of multiple statistical testing and data-dependent reporting, two measures of poor outcome have been selected as primary measures.

Primary outcomes

- Restenosis or reocclusion rates after endovascular intervention, as defined by the trialist
- Maximum walking distance

Secondary outcomes

1. Patient-assessed measures of claudication

- Edinburgh claudication scale. This scale requires only four questions to be answered and has been shown to have a sensitivity of 91.3% and specificity of 99.3% together with excellent repeatability ([Leng 1992](#))

2. Clinical end points

- Post-intervention morbidity (bleeding, infection, chronic wound pain, intimal dissection, distal embolisation, arterial rupture and immediate re-occlusion)
- Length of hospital stay
- Failed treatment, evidenced by the need for repeat endovascular or surgical revascularisation
- Amputation rates
- Post-operative mortality

3. Physiological measures

- Ankle brachial pressure index (ABPI)
- Intra-arterial pressure changes
- Changes in blood flow rates

4. Health status measures

- Condition-specific health status measures
- Psychological measures (e.g. hospital anxiety and depression scale)
- General health measures (e.g. SF 36 ([Ware 1993](#)))

5. Health economics measures

- Cost utility
- Cost effectiveness

6. Other outcomes

- Non pre-specified outcomes judged to be important when performing the review

Search methods for identification of studies

Electronic searches

For this update, the Cochrane Peripheral Vascular Diseases Group searched their Specialised Register (last searched August 2009) and the Cochrane Central Register of Controlled Trials (CENTRAL) in *The Cochrane Library* (last searched 2009, Issue 3). See [Appendix 1](#) for details of the search strategy used to search CENTRAL. The Specialised Register is maintained by the Trials Search Co-ordinator and is constructed from weekly electronic searches of MEDLINE, EMBASE, CINAHL, AMED, and through handsearching relevant journals. The full list of the databases, journals and conference proceedings which have been searched, as well as the search strategies used, are described in the [Specialised Register](#) section of the Cochrane Peripheral Vascular Diseases Group module (*The Cochrane Library*).

The search strategy used to search CENTRAL for the 2002 version of the review is shown in [Appendix 2](#).

Searching other resources

For the original review, extensive MEDLINE and EMBASE searches (up to and including January 2001) were performed by the authors. The Journal of Vascular Interventional Radiology (1990 to 2001) was handsearched by one of the authors (PT). Further trial reports were sought through examination of proceedings from vascular, surgical and radiological society meetings (the Vascular Surgical Society of Great Britain and Ireland; the European Vascular Surgical Society; the North American Society of Vascular Surgery; the Society for Cardiovascular Interventional Radiology; the Cardiovascular and Interventional Radiology Society of Europe; and the British Society of Interventional Radiology). Contact was made with authors of published trials requesting information about any eligible unpublished trials and with manufacturers of endovascular stents. One stent manufacturer responded to written enquiries (Merck Pharmaceuticals, United Kingdom) however no published or unpublished data were available for the purposes of the review.

Data collection and analysis

Selection of studies

For the update, identified studies were assessed independently by two authors (HM, KW) using the checklist provided by the Cochrane Peripheral Vascular Diseases Review Group. An emphasis was placed on concealment of randomisation. Studies were excluded if they were not randomised, were quasi-randomised controlled trials, made comparisons other than those pre-specified by the review authors and included patients with either acute or critical ischaemia. Each review author assessed the methodological quality of selected trials without prior consideration of the results. Review authors were not blinded to the names of study authors, institutions or journals. Disagreements between the two authors were resolved by discussion followed, where necessary, by referral to the Co-ordinating Editor.

Data extraction and management

For the purposes of this review, studies investigating the role of endovascular stents for intermittent claudication were separated into two groups. In one group, all studies exploring the role of endovascular stents for supra-inguinal disease (symptomatic

aorto-iliac occlusive pathology) were evaluated. In the other group, studies examining the role of endovascular stents for infra-inguinal disease (femoro-popliteal occlusive pathology) were included. Data extraction from the included studies was performed independently by the same two authors using a proforma designed by the Cochrane Peripheral Vascular Diseases Review Group. Only published data have been used for the purposes of this review but unpublished data were sought. Differences of opinion relating to the data extraction process were again resolved by local discussion between the authors and referral to the Co-ordinating Editor for comment, where necessary.

Assessment of risk of bias in included studies

For the updated review, risk of bias was assessed independently by two review authors (HM, KW) in accordance with the guidelines given in the Cochrane Handbook for Systematic Reviews of Interventions, Version 5 ([Cochrane 2008](#)).

For each of the domains listed below there were three possible responses: 'yes', 'no', or 'unclear'. 'Yes' indicated a low risk of bias and 'no' indicated a high risk of bias. If insufficient detail was reported the judgement on risk of bias was 'unclear'. The new studies included in the updated review were assessed as well as the studies already included in the previous versions of the review.

- Sequence generation
- Allocation concealment
- Blinding
- Incomplete data assessment (loss of participants, for example with withdrawals, dropouts, protocol deviations)
- Selective outcome reporting
- Other sources of bias

Measures of treatment effect

Statistical analyses were performed according to the statistical guidelines for reviews outlined in the Cochrane Peripheral Vascular Diseases Group module ([PVD Group 2009](#)). Odds ratios were used as the measure of effect for each dichotomous outcome. Where sufficient data were available, a summary statistic for each outcome was calculated using a fixed-effect model. Where continuous scales of measurement were used to assess the effects of treatment, the data were analysed in continuous form (that is as mean differences).

If different scales were used in the different studies the results were standardised and then combined (as mean differences), where possible. If there had been sufficient trials to warrant subgroup analysis, some categories of participants may have been considered separately, for example groups prescribed different antiplatelet, anticoagulation, or lipid lowering regimes; individuals undergoing endovascular intervention at more than one site; the use of different types of endovascular stents; and variations in policy (routine versus selective stent insertion). Future updates of this review will incorporate these data, if available.

Assessment of heterogeneity

Heterogeneity was noted in the data and cautiously explored using previously identified characteristics of the studies, particularly assessments of quality.

Sensitivity analysis

Sensitivity analyses were undertaken to examine the stability of the results in relation to a number of factors including study quality, the source of the data, and patient type.

RESULTS

Description of studies

See [Characteristics of included studies](#), [Characteristics of excluded studies](#) tables.

Results of the search

For the original review, a total of 42 potentially relevant publication titles were identified and retrieved following the electronic

database search. Fourteen publications that referred to 10 studies were excluded ([Richter 1991](#); [Van Rij 1991](#); [Do-dai-Do 1992](#); [Palmaz 1992](#); [Richter 1992](#); [Richter 1993](#); [Dutch Trial 1998](#); [Zdanowski 1999](#); [Conroy 2000](#); [Cejna 2001](#)). A further 17 publications referred to studies in which the comparisons included an intervention not pre-specified by this review (three surgery, three conservative treatment, one laser therapy, six exercise, and four mechanical atherectomy), whilst 11 publications were irrelevant to this review. Handsearching by one author (PT) identified two potential trials of which one was included ([Grimm 2001](#)) and one excluded ([Conroy 2000](#)). One stent manufacturer responded to written enquiries (Merck Pharmaceuticals United Kingdom) however no published or unpublished data were available

For details of the search results for the 2009 update see the flowchart in [Figure 1](#)

Figure 1. Flow-chart of study selection

Flow-chart of study selection

Figure 1. (Continued)

Included studies

Two studies were identified which satisfied the inclusion criteria. They studied the outcome from angioplasty alone, or angioplasty and stent insertion in a total of 104 participants (68 male, 36 female) with intermittent claudication (Vroegindewij 1997; Grimm 2001). The number of participants in the two studies were similar and both recruited more men than women. Each study reported a similar inclusion criterion of disease confined to the femoropopliteal (above knee) artery as well as similar exclusion criteria: multisegmental disease, poor run-off, or disease in the below knee popliteal artery. Both study centres assessed the morphology and distribution of the arterial disease based on information obtained from intra-arterial digital subtraction angiography.

Although all participants in the experimental arm of both included studies received the same type of endovascular stent (Palmaz), the method with which it was deployed differed. One trial (Grimm 2001) preferred to pre-dilate the target lesion to 5 to 6 mm using balloon angioplasty prior to deploying the stent and confirmed the correct positioning of the stent with angiography on completion of the procedure whereas neither of these techniques were used by researchers in the study by (Vroegindewij 1997). Furthermore, in the study by (Grimm 2001) participants received an additional 5000 unit bolus of heparin prior to angioplasty followed by an intravenous heparin infusion for 48 hours, and oral warfarin for three months compared to the controls. Participants in the study

by (Vroegindewij 1997) received a bolus heparin load of 5000 units and 1g of intravenous aspirin prior to angioplasty. Further details are presented in the [Characteristics of included studies](#) table.

Excluded studies

Fifteen studies were excluded (Richter 1991; Van Rij 1991; Do-dai-Do 1992; Palmaz 1992; Richter 1992; Richter 1993; Dutch Trial 1998; Zdanowski 1999; Conroy 2000; Cejna 2001; Becquemine 2003; Grenacher 2004; Fast 2007; Vienna Absolute 2007; Saxon 2008). The five additional studies which were excluded in the 2009 update (Becquemine 2003; Grenacher 2004; Fast 2007; Vienna Absolute 2007; Saxon 2008) included patients with intermittent claudication and critical limb ischaemia at baseline. The review authors tried to obtain outcome data from the study authors about those patients who only had intermittent claudication at baseline. Unfortunately these data were not available. One trial (Vienna Absolute 2007) is still in the follow-up stage and as such the data could not be made available to the review authors.

Ongoing studies

We identified four ongoing studies the details of which are given in the [Characteristics of ongoing studies](#) table.

Risk of bias in included studies

See [Figure 2](#) and [Figure 3](#).

Figure 2. Methodological quality graph: review authors' judgements about each methodological quality item presented as percentages across all included studies.

Figure 3. Methodological quality summary: review authors' judgements about each methodological quality item for each included study.

	Adequate sequence generation?	Allocation concealment?	Blinding?	Incomplete outcome data addressed?	Free of selective reporting?	Free of other bias?
Grimm 2001	?	?	-	?	+	+
Vroegindeweij 1997	?	?	-	+	+	+

Allocation

Both included studies were described as being randomised. Allocation concealment was by "numbered envelopes which were opened sequentially" in the (Vroegindeweij 1997) study and by sealed envelopes in the (Grimm 2001) study. Neither study reported whether opaque envelopes were used.

Blinding

Neither the surgical or radiological staff were blinded in the included studies and it remains unclear whether the participants were blinded.

Incomplete outcome data

In one study (Vroegindeweij 1997) intention to treat was carried out and patients with crossover treatments remained assigned to the treatment group of randomisation. In the (Grimm 2001) study intention-to-treat analysis was not stated. Losses during the follow-up period were given but without information on the statistical handling of missing data.

Selective reporting

All measures of technical and clinical success were reported in the two included studies.

Effects of interventions

Two studies (Vroegindeweij 1997; Grimm 2001) with a combined sample size of 104 participants were identified.

Although the authors of the two included studies reported statistically similar participant profiles at baseline for experimental and control groups, differences in reporting of each study posed a limit to possible comparisons of the outcomes. Restenosis was defined by (Grimm 2001) as:

1. increased systolic flow velocity within the vessel (at least 1.5 times greater than in the normal vessel),
2. an 'Alias' effect,
3. flash colour in the surrounding tissue.

In the other study (Vroegindeweij 1997) restenosis was described as:

1. increased systolic flow velocity greater than 2.5 times compared to a normal region, or
2. post-stenotic turbulence characterised by colour changes.

No studies investigating the role of endovascular stents for intermittent claudication caused by supra-inguinal aorto-iliac occlusive disease satisfied all our inclusion criteria.

There were two studies investigating the role of endovascular stents for intermittent claudication caused by femoro-popliteal occlusive disease (Vroegindewij 1997; Grimm 2001).

Primary outcome variables

Restenosis or occlusion after endovascular intervention, as defined by the trialist, was reported in both studies. One study (Grimm 2001) reported that seven of 30 participants had either restenosis or occlusion after angioplasty with stent insertion (PTAS) compared with four of 23 after angioplasty alone (PTA) (OR 1.45, 95% CI 0.37 to 5.69). The second study (Vroegindewij 1997) reported 16 of 24 in the PTAS group compared with 10 of 27 after PTA alone (OR 3.40, 95% CI 1.07 to 10.77) had either restenosis or occlusion, which was just statistically significant. Combining the results of these two studies suggested that, overall, no statistical difference could be found between the two groups (OR 2.37, 95% CI 0.99 to 5.71).

Maximum walking distance was reported by Grimm 2001. The mean walking distance after PTAS was 383.5 m compared with 466.7 m after PTA alone (MD -83.2 m, 95% CI -290.22 to 123.82), which failed to reach a statistically significant difference.

Secondary outcome measures

Three clinical end points were reported by Vroegindewij 1997 (number of embolic events, early thrombosis, and patient-reported clinical deterioration); one physiological end point (ankle brachial pressure index (ABPI)); and one non pre-defined measure (technical failure). One clinical end point was reported by Grimm 2001 (failed treatment requiring reintervention); one physiological end point (ABPI); and one non pre-defined measure (technical failure).

Clinical end points

In Vroegindewij 1997, PTAS was associated with one of 24 embolic events compared with zero of 27 after PTA alone (OR 3.51, 95% CI 0.14 to 90.33); zero of 24 thrombotic episodes compared to one of 27 after PTA (OR 0.36, 95% CI 0.01 to 9.28); and patient-reported deterioration at 12 months in nine of 24 after PTAS and eight of 27 after PTA (OR 1.43, 95% CI 0.44 to 4.58). None of these results reached statistical significance.

In Grimm 2001, reintervention following PTAS was associated with 10 of 30 participants compared with nine of 23 after PTA alone (OR 0.78, 95% CI 0.25 to 2.41), a non-statistically significant difference.

Physiological end points

In each study no statistically significant difference was noted in ABPI between PTAS and PTA groups: MD 0.06 (95% CI -0.05 to 0.17) (Grimm 2001); and MD -0.03 (95% CI -0.13 to 0.07) (Vroegindewij 1997).

Non pre-defined measures

Similarly, in both studies technical failure was not statistically significant between the PTAS and PTA groups. In the study by Grimm 2001 neither group recorded a failure while the other study (Vroegindewij 1997) reported four of 24 failures after PTAS and three of 27 after PTA (OR 1.6, 95% CI 0.32 to 8.01).

DISCUSSION

Summary of main results

Claudication is generally a benign condition in terms of symptom progression. The decision to implant a stent should result in long-term improvement in patency of the blood vessel and clinical improvement when compared to angioplasty alone, and should not result in additional morbidity. The clinical symptoms and the long-term outcome of critical ischaemia differ from those of claudication in that they are dependent on shorter-term patency of blood vessels and the effects of limb salvage. We therefore considered that it was essential to separate and exclude studies in which the patient population of the trial included both participants with claudication and critical ischaemia. A differing response to endoluminal therapy between the iliac and infra-inguinal vessels, resulting from different haemodynamic environments, would have necessitated separation of trials and analysis of results. As it was, the only controlled trials eligible for inclusion in this review concentrated on the femoro-popliteal segment. Neither study was able to convincingly identify a clinically significant advantage or disadvantage in arterial patency or walking ability associated with the use of endovascular stents. These null results from the reported primary outcomes are followed by similar data for secondary outcome variables, in particular post-interventional ABPI (Grimm 2001) and the need for repeat procedures during intermediate follow up.

Both studies evaluated the Palmaz balloon-expandable stent, a well proven but ageing design. More recently, manufacturers have made claims that newer stents are less prone to neointimal hyperplasia by virtue of their self-expanding design and lower metal content. The development of stents coated with cytostatic agents that suppress cell growth, is already showing promising improvements in patency in the coronary arteries. It is certain that further evaluation of stents in the treatment of claudication both above and below the groin is required. It may well be that this is an appropriate time to assess this new technology.

The results of this review fail to provide robust evidence in favour of either angioplasty and stenting or angioplasty alone for any primary or secondary outcome. The use of endovascular stents appears technically safe and does not in itself appear to compromise outcome.

Overall completeness and applicability of evidence

From this review it can be concluded that there has been inadequate scientific evaluation using randomised controlled trials of endovascular stents in the management of patients with purely intermittent claudication, in either the aorto-iliac or femoro-popliteal arterial segments. Unfortunately the review authors were unable to include any additional published trials because data on patients presenting with intermittent claudication at baseline were not available. Given this and the likelihood that there are unlikely to be such trials we would recommend that the scope of this review be broadened to include patients with both intermittent claudication and critical limb ischaemia. This would allow the evidence from many of the excluded studies (Dutch Trial 1998; Zdanowski 1999; Cejna 2001; Becquemin 2003; Grenacher 2004; Fast 2007; Vienna Absolute 2007; Saxon 2008) and ongoing studies (Baumgartner 2007; Chalmers 2007; Dake 2007) to be considered for inclusion. The review authors recommend that the amended review be written

when the results of the ongoing studies are published, which is in the near future.

Quality of the evidence

Methodological weaknesses in the included studies compromised the value of their results. The two included studies were both small with imprecise estimates of treatment differences. They provided no priori power calculation, reported outcomes after a relatively short follow-up period, and there was no reporting of blinding of outcome assessors to reduce bias. Data reported by the trials appear to be predominantly limited to secondary outcome measures, whilst potentially relevant outcome measures such as quality of life and economic impact of stenting were not reported at all. The issue of additional anticoagulation amongst participants in the stented group remains a confounding variable and potential source of bias. Vascular laboratory investigation, duplex scanning in particular, is routinely used as a surrogate measure of clinical outcome when comparing different interventions. Whilst this is a useful diagnostic procedure, its use as a proxy measure of outcome must be cautioned as inter-observer variation, scanning technique, and machine type may all affect the accuracy of the data. It is also noted that intravascular sonography may in fact be the most accurate means of identifying in-stent restenosis ([Schwarzenberg 1998](#)).

Potential biases in the review process

Many trials ([Dutch Trial 1998](#); [Zdanowski 1999](#); [Cejna 2001](#); [Becquemin 2003](#); [Grenacher 2004](#); [Fast 2007](#); [Vienna Absolute 2007](#); [Saxon 2008](#)) had to be excluded from this review update because patients with critical limb ischaemia and intermittent claudication were included in the analyses and could not be stratified.

AUTHORS' CONCLUSIONS

Implications for practice

Despite the different perspectives from which the use of endovascular stents could be assessed (patient-orientated, clinical, physiological, anatomical, or radiological), this review failed to convincingly demonstrate that the use of stents in intermittent claudication improved outcome, from any perspective. There is no clear scientific evidence to recommend the use of angioplasty and stenting in preference to angioplasty alone in patients with intermittent claudication in either the aorto-iliac or femoro-

popliteal segments. We have been unable to challenge our hypothesis that angioplasty alone is inferior to angioplasty with endovascular stenting in any part of the arterial tree. We are unable to recommend any specific stent as superior to any other. Although it is appreciated that endovascular stents present important economic considerations, our review cannot present any economic data.

Implications for research

Future trials should be designed to improve upon many of the methodological flaws identified. These include the following.

1. Analysis of results is performed separately for aorto-iliac and femoro-popliteal disease.
2. All target lesions are classified using a standardised system, the Trans-Atlantic Inter Society Consensus (TASC) classification.
3. All participants in the trial have similar pre and post-intervention pharmacotherapy.
4. All participants in the trial have equal management of known risk factors and receive similar advice regarding lifestyle changes.
5. Outcome measures must be relevant and include quality of life assessments, standardised walking tests, disease-specific health status questionnaires, economic analysis, adverse events and objective measurements of arterial patency.
6. Consideration should be given to a multicentre study for the purpose of recruiting sufficient numbers of participants to answer the research question and ensure the generalisability of the study findings.
7. It may be interesting to investigate whether patency rates in the superficial femoral artery could be improved in response to a strategy of selectively stenting either a suboptimal angioplasty or a lesion with specific pre-defined morphological or anatomical characteristics.

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REFERENCES

References to studies included in this review

Grimm 2001 {published data only}

Grimm J, Muller-Hulsbeck S, Jahnke T, Hilbert C, Brossmann J, Heller M. Randomized study to compare PTA alone versus PTA with Palmaz stent placement for femoropopliteal lesions. *Journal of Vascular and Interventional Radiology* 2001;**12**(8):935-41.

Vroegindeweij 1997 {published data only}

* Vroegindeweij D, Vos LD, Tielbeek AV, Buth J, Harrie CM, vd Bosch HC. Balloon angioplasty combined with primary stenting versus balloon angioplasty alone in femoropopliteal obstructions: A comparative randomized study. *Cardiovascular and Interventional Radiology* 1997;**20**(6):420-5.

References to studies excluded from this review

Becquemin 2003 {published data only}

Becquemin JP, Favre JP, Marzelle J, Nemoz C, Corsin C, Leizorovicz A. Systematic versus selective stent placement after superficial femoral artery balloon angioplasty: a multicenter prospective randomized study. *Journal of Vascular Surgery* 2003;**37**(3):487-94.

Cejna 2001 {published data only}

Cejna M, Thunher S, Illiasch H, Horvath W, Waldenberger P, Hornik K, et al. PTA versus Palmaz stent placement in femoropopliteal artery obstructions: a multicenter prospective randomized study. *Journal of Vascular and Interventional Radiology* 2001;**12**(1):23-31.

Conroy 2000 {published data only}

Conroy RM, Gordon IL, Tobis JM, Hirot T, Kasaoka S, Stemmer EA, et al. Angioplasty and stent placement in chronic occlusion of the superficial femoral artery: technique and results. *Journal of Vascular and Interventional Radiology* 2000;**11**(8):1009-20.

Do-dai-Do 1992 {published data only}

Do-dai-Do, Triller J, Walpoth BH, Stirnemann P, Mahler F. A comparison study of self-expandable stents vs balloon angioplasty alone in femoropopliteal artery occlusions. *Cardiovascular and Interventional Radiology* 1992;**15**(5):306-12.

Klein WM, Van der Graaf Y, Seegers J, Spithoven JH, Buskens E, van, et al. Dutch iliac stent trial: long-term results in patients randomized for primary or selective stent placement. *Radiology* 2006;**238**(2):734-44.

Dutch Trial 1998 {published data only}

Bosch JL, Tetteroo E, Mali WP, Hunink MG. Iliac arterial occlusive disease: Cost effectiveness analysis of stent placement versus percutaneous transluminal angioplasty. *Radiology* 1998;**208**(3):641-8.

Bosch JL, van der Graaf Y, Hunink MG. Health related quality of life after angioplasty and stent placement in patients with iliac artery occlusive disease: results of a randomized controlled

clinical trial. The Dutch Iliac Stent Trial Group. *Circulation* 1999;**99**(24):3155-60.

Kamphuis AG, van Engelen AD, Tetteroo E, Hunink MG, Mali WP. Impact of different haemodynamic criteria for stent placement after suboptimal iliac angioplasty. Dutch Iliac Stent Trial Study Group. *Journal of Vascular and Interventional Radiology* 1999;**10**(6):741-6.

Klein WM, Van der Graaf Y, Seegers J, Spithoven JH, Buskens E, van, et al. Dutch iliac stent trial: long-term results in patients randomized for primary or selective stent placement. *Radiology* 2006;**238**(2):734-44.

Klein WM, van der Graaf Y, Seegers J, Moll FL, Mali WP. Long-term cardiovascular morbidity, mortality, and reintervention after endovascular treatment in patients with iliac artery disease: The Dutch Iliac Stent Trial Study. *Radiology* 2004;**232**:491-8.

Tetteroo E, Haaring C, van der Graaf Y, van Schaik JPJ, van Engelen AD, Mali WP. Intraarterial pressure gradients after randomized angioplasty or stenting of iliac artery lesions. *Cardiovascular and Interventional Radiology* 1996;**19**(6):411-7.

* Tetteroo E, van der Graaf Y, Bosch JL, van Engelen AD, Hunink MG, Eikelboom BC, et al. Randomised comparison of primary stent placement versus primary angioplasty followed by selective stent placement in patients with iliac-artery occlusive disease. Dutch Iliac Stent Trial Study Group. *Lancet* 1998;**351**(9110):1153-9.

Fast 2007 {published data only}

Bosiers M, Peeters P, Krakenberg H. The Femoral Artery Stenting Trial (FAST): 12-month outcomes. Abstracts from the 2006 Vascular Annual Meeting 2006.

Krakenberg H. FAST (Femoral Artery Stenting Trial): Current evidence in femoral stenting: insights from the FAST trial acute results and 6-month outcomes. Leipzig Interventional Course; Jan 26-28; Leipzig. 2006.

Krakenberg H. FAST: No advantage to nitinol stents in short lesions. Transcatheter Cardiovascular Therapeutics; 2006 Oct 22-27; Washington DC, USA. 2006.

Krakenberg H. Randomized comparison of PTA versus femoral artery stenting (FAST): Acute results. *Journal of Endovascular Therapy* 2005; Vol. 12 Suppl 1:21-2.

* Krakenberg H, Schluter M, Steinkamp HJ, Burgelin K, Scheinert D, Schulte KL, et al. Nitinol stent implantation versus percutaneous transluminal angioplasty in superficial femoral artery lesions up to 10 cm in length: the femoral artery stenting trial (FAST). *Circulation* 2007;**116**(3):285-92.

Peeters P, Bosiers M. Femoral Artery Stenosis Trial (FAST). http://bibamed.agcl.com/cx_2005/1720Peeters.pdf [accessed 17 Feb 2009]. 2005.

Grenacher 2004 {published data only}

Grenacher L, Saam T, Geier A, Muller-Hulsbeck S, Cejna M, Kauffmann, et al. [PTA versus Palmaz stent placement in femoropopliteal artery stenoses: results of a multicenter prospective randomized study (REFSA)]. *ROFO: Fortschritte auf dem Gebiete der Röntgenstrahlen und der Nuklearmedizin* 2004;**176**(9):1302-10.

Palmaz 1992 {published data only}

Palmaz JC, Laborde JC, Rivera FJ, Encarnacion CE, Lutz JD, Moss JG. Stenting of the iliac arteries with the Palmaz stent: experience from a multicenter trial. *Cardiovascular and Interventional Radiology* 1992;**15**(5):291-7.

Richter 1991 {published data only}

Richter GM, Roeren TK, Noeldge G, Landwehr P, Brambs HJ, Kauffmann GW, et al. Iliac balloon expandable stent placement versus regular PTA: Long term results of a randomized multicenter trial. *Journal of Vascular and Interventional Radiology* 1991;**2**(1):6.

Richter 1992 {published data only}

Richter GM, Roeren T, Noeldge G, Landwehr P, Allenberg JJ, Kauffmann GW, et al. Prospective randomized trial: Iliac stenting versus PTA. *Angiology* 1992;**43**(3):268.

Richter 1993 {published data only}

Richter GM, Roeren T, Brado M, Noeldge G. Further update of the randomized trial: iliac stent placement versus PTA - Morphology, clinical success rates, and failure analysis. *Journal of Vascular and Interventional Radiology* 1993;**4**(1):30-1.

Saxon 2008 {published data only}

Saxon RR, Coffman JM, Gooding JM, Natuzzi E, Ponc DJ. Long-term results of ePTFE stent-graft versus angioplasty in the femoropopliteal artery: Single center experience from a prospective, randomized trial. *Journal of Vascular and Interventional Radiology* 2003;**14**(3):303-11.

Saxon RR, Dake MD, Volgelzang RL, Katzen BT, Becker GJ. Randomized, multicenter study comparing expanded polytetrafluoroethylene-covered endoprosthesis placement with percutaneous transluminal angioplasty in the treatment of superficial femoral artery occlusive disease. *Journal of Vascular and Interventional Radiology* 2008;**19**(6):823-32.

Van Rij 1991 {published data only}

Van Rij, Packer SGK, Morrison N. A randomized controlled study of percutaneous angioplasty for claudicants with femoropopliteal disease. *Journal of Cardiovascular Surgery* 1991;**32**:34.

Vienna Absolute 2007 {published data only}

Minar E, Schillinger M. Stenting vs PTA for complex femoropopliteal obstructions: Results from a randomized trial. Leipzig Interventional Course; 2006 Jan 26-28; Leipzig. 2006.

Sabeti S, Czerwenka-Wenkstetten A, Dick P, Schlager O, Amighi J, Mlekusch I, et al. Quality of life after balloon angioplasty versus stent implantation in the superficial femoral artery: findings from a randomized controlled trial. *Journal*

of Endovascular Therapy: Official Journal of the International Society of Endovascular Specialists 2007;**14**(4):431-7.

Schillinger M. Long-term SFA stenting trial results are encouraging. *Vascular News* 2007; Vol. 34:2-4.

Schillinger M. Vienna Absolute trial: Balloon angioplasty versus stenting in the superficial femoral artery. <http://clinicaltrials.gov/ct/show/NCT00281060?order=1> [accessed Feb 09] 2006.

Schillinger M, Sabeti S, Dick P, Amighi J, Mlekusch W, Schlager O, et al. Sustained benefit at 2 years of primary femoropopliteal stenting compared with balloon angioplasty with optional stenting. *Circulation* 2007;**115**(21):2745-9.

Schillinger M, Sabeti S, Loewe C, Dick P, Amighi J, Mlekusch W, et al. Balloon angioplasty versus implantation of nitinol stents in the superficial femoral artery. [see comment]. *New England Journal of Medicine* 2006;**354**(18):1879-88.

Schillinger M, Sabeti S, Loewe C, Dick P, Amighi J, Mlekusch W, et al. Percutaneous transluminal angioplasty versus stenting in the superficial femoral artery. *Cardiovascular and Interventional Radiological Society of Europe, CIRSE* 2006 2006.

Zdanowski 1999 {published data only}

Zdanowski Z, Albrechtsson U, Lundin A, Jonung T, Ribbe E, Thorne J, et al. Percutaneous transluminal angioplasty with or without stenting for femoropopliteal occlusions? A randomized controlled study. *International Angiology* 1999;**18**(4):251-5.

References to ongoing studies
Baumgartner 2007 {published data only}

Baumgartner I, Amann B. The SIT-UP Study: Swiss Investigation of the S.M.A.R.T. Nitinol Self-Expandable Stent in Superficial Femoral Artery Occlusions Versus Balloon Angioplasty. <http://clinicaltrials.gov/ct2/show/NCT00309595?term=NCT00309595&rank=1> [accessed 2 Sep 2009].

Chalmers 2007 {published data only}

Chalmers N, Cowling M. SUPER UK: The Super Study - Superficial Femoral Artery Stent Versus Angioplasty Study. <http://clinicaltrials.gov/ct2/show/NCT00232843?term=NCT00232843&rank=1> [accessed 2 Sep 2009].

Dake 2007 {published data only}

Dake M. Evaluation of the Zilver PTX Drug-Eluting Stent in the Above-the-Knee Femoropopliteal Artery. [www.http://clinicaltrials.gov/ct2/show/NCT00120406?order=1](http://clinicaltrials.gov/ct2/show/NCT00120406?order=1) [accessed 2 Sep 2009].

Reekers 2007 {published data only}

Reekers J. The Duravest Study: Dutch Randomised Angioplasty Versus Stent Trial for the Treatment of Superficial Femoral Artery Occlusions. <http://clinicaltrials.gov/ct2/show/NCT00289055?term=NCT00289055&rank=1> [accessed 2 Sep 2009].

Additional references

Ahn 1992

Ahn SS, Eton D, Moore WS. Endovascular surgery for peripheral arterial occlusive disease. A critical review. *Annals of Surgery* 1992;**216**(1):3-16.

Axisa 2002

Axisa B, Fishwick G, Bolia A, Thompson MM, London NJ, Bell PR, et al. Complications following peripheral angioplasty. *Annals of the Royal College of Surgeons of England* 2002;**84**(1):39-42.

Belli 1993

Belli AM, Jackson JE, Allison DJ. Interventional radiological procedures. In: Clement DL, Shepherd JT editor(s). *Vascular disease in the limbs. Mechanisms and principles of treatment*. St. Louis: Mosby Year Book, 1993:239-58.

Blum 1993

Blum U, Gabelmann A, Redecker M, Noldge G, Dornberg W, Grosser G, et al. Percutaneous recanalization of iliac artery occlusions: results of a prospective study. *Radiology* 1993;**189**(2):536-40.

Cochrane 2008

Higgins JPT, Green S (editors). *Cochrane Handbook for Systematic Reviews of Interventions* Version 5.0.1 [updated September 2008]. The Cochrane Collaboration, 2008. Available from www.cochrane-handbook.org.

Dewhurst 1991

Dewhurst G, Wood DA, Walker F, Lampe FC, Jeffreys M, Cooper M, et al. A population survey of cardiovascular disease in elderly people: design, methods and prevalence results. *Age and Ageing* 1991;**20**(5):353-60.

Dotter 1989

Dotter CT, Judkins MP. Transluminal treatment of arteriosclerotic obstruction. Description of a new technic and a preliminary report of its application. *Radiology* 1989;**172**(3 part 2):904-20.

el-Bayar 1992

el-Bayar H, Roberts A, Hye R, Davis G, Freischlag J. Determinants of failure in superficial femoral artery angioplasty. *Angiology* 1992;**43**(11):877-85.

Fowkes 1991

Fowkes FG, Housley E, Cawood EH, Macintyre CC, Ruckley CV, Prescott RJ. Edinburgh Artery Study: prevalence of asymptomatic and symptomatic peripheral arterial disease in the general population. *International Journal of Epidemiology* 1991;**20**(2):384-92.

Hughson 1978

Hughson WG, Mann JI, Garrod A. Intermittent claudication: prevalence and risk factors. *British Medical Journal* 1978;**1**(6124):1379-81.

Leng 1992

Leng GC, Fowkes FG. The Edinburgh claudication questionnaire: An improved version of the WHO/Rose questionnaire for use in epidemiological surveys. *Journal of Clinical Epidemiology* 1992;**45**(10):1101-9.

Leng 1996

Leng GC, Lee AJ, Fowkes FG, Whiteman M, Dunbar J, Housley E, et al. Incidence, natural history and cardiovascular events in symptomatic and asymptomatic peripheral arterial disease in the general population. *International Journal of Epidemiology* 1996;**25**:1172-81.

O'Keeffe 1991

O'Keeffe ST, Woods BO, Beckmann CF. Percutaneous transluminal angioplasty of the peripheral arteries. In: Breslin DJ editor(s). *Cardiology Clinics. Peripheral Vascular Disease in the Elderly*. Philadelphia: Saunders, 1991:519-21.

Price 1996

Price JF, Fowkes FGR. Effectiveness of percutaneous angioplasty for lower limb atherosclerosis. In: Greenhalgh RM, Fowkes FGR editor(s). *Trials and tribulations in vascular surgery*. London: WB Saunders, 1996.

PVD Group 2009

Fowkes FGR, Fletcher J, Hiatt WR, Kleijnen J, Leng GC, Maxwell H, Middeldorp S, Moneta G, Price JF, Prins MH, Stansby G, Tisi P, Wakefield TW, Watson L, Welch K. Cochrane Peripheral Vascular Diseases Group. About The Cochrane Collaboration (Cochrane Review Groups (CRGs)). 2009, Issue 3. Art. No.: PVD.

Schwarzenberg 1998

Schwarzenberg H, Muller-Hulsbeck S, Gluer CC, Wesner F, Heller M. Restenosis of peripheral stents and stent grafts as revealed by intravascular sonography: in vivo comparison with angiography. *American Journal of Roentgenology* 1998;**170**(5):1181-5.

SIGN 2006

Diagnosis and management of peripheral arterial disease. A national clinical guideline. No. 89. Scottish Intercollegiate Guidelines Network (SIGN) October 2006.

Tegtmeyer 1991

Tegtmeyer CJ, Hartwell GD, Selby JB, Robertson R Jr, Kron IL, Tribble CG. Results and complications of angioplasty in aortoiliac disease. *Circulation* 1991;**83**(2 Suppl):153-60.

Vorwerk 1995

Vorwerk D, Gunther RW, Schurmann K, Wendt G, Peters I. Primary stent placement for chronic iliac artery occlusions: follow-up results in 103 patients. *Radiology* 1995;**194**(3):745-49.

Ware 1993

Ware JE, Snow KK, Kosinski M, Gandek B. SF-36 Health survey manual interpretation guide. New England Medical Center, Health Institute, Boston MA 1993.

Whyman 1996

Whyman MR, Fowkes FG, Kerracher EM, Gillespie IN, Lee AJ, Housley E, et al. Randomised controlled trial of percutaneous transluminal angioplasty for intermittent claudication. *European Journal of Vascular and Endovascular Surgery* 1996;**12**(2):167-72.

References to other published versions of this review

Cochrane 2003

Bachoo P, Thorpe PA. Endovascular stents for intermittent claudication.. *Cochrane Database of Systematic Reviews* 2003, Issue Issue 1 . Art. No.: CD003228. DOI: 10.1002/14651858.CD003228.

* Indicates the major publication for the study

CHARACTERISTICS OF STUDIES

Characteristics of included studies [ordered by study ID]

Grimm 2001

Methods	Study design: single centre, randomised controlled trial with 2 parallel groups. No power calculation.
Participants	Country: Germany Sample size 53: 32 males, 21 females Mean age (SE) years: experimental group 70.5 (9.8) years, control group 68.1 (8.4) years <i>Inclusion criteria</i> Intermittent claudication. Femoro-popliteal lesion at least 1cm distal to the common femoral artery bifurcation with normal mid and distal popliteal artery. Lesion: stenosis > 70% of vessel diameter and < 5cm in length. <i>Exclusion criteria</i> Lesion > 5cm, multifocal disease, occlusions not negotiated by guidewire, mid-popliteal disease or poor run off, fresh thrombus or contraindications for surgery or anticoagulation.
Interventions	Experimental group: balloon angioplasty and Palmaz stent, n=30 Control group: balloon angioplasty, n=23
Outcomes	Primary outcome: arterial restenosis Secondary outcomes: maximum walking distance, number of additional procedures, ABPI Follow-up regime: clinical examination and duplex scan at 3, 6 and 12 months followed by annual re-view thereafter for both groups. Experimental group participants in addition each underwent angiography at 6 months. Primary and secondary patency rates after 12, 24 and 39 months in both groups. Maximum follow-up period of 39 months for both groups.
Notes	Recruitment period: not stated Only experimental group offered peri-operative i.v. heparin bolus of 5000 units and 1g aspirin. All patients received i.v. heparin for 24 hours after the procedure and 100mg/d aspirin for the remainder of their lives. Mean follow up: experimental group 20.9 months, control group 29.1 months.
Risk of bias	
Bias	Authors' judgement Support for judgement

Grimm 2001 (Continued)

Adequate sequence generation?	Unclear risk	"The written result of the randomization was sealed in an envelope, which was numbered according to the patient's number".
Allocation concealment?	Unclear risk	Sealed envelopes. Not clear if opaque envelopes. The envelope was opened after diagnostic angiography.
Blinding? All outcomes	High risk	There was no mention of blinding.
Incomplete outcome data addressed? All outcomes	Unclear risk	Intention-to-treat analysis not stated. Losses during follow-up period were given but no information given on the statistical handling of missing data.
Free of selective reporting?	Low risk	All measures of technical and clinical success reported.
Free of other bias?	Low risk	No significant difference between groups of baseline risk factors or clinical status.

Vroegindeweij 1997

Methods	Study design: single centre, randomised controlled trial with 2 parallel groups. Recruitment period two years. No power calculation
Participants	Country: the Netherlands Sample size 51: 36 males, 15 females=15 Mean age (range): experimental group 65 (46-78) years, control group 64 (41-82) years Inclusion criteria: intermittent claudication; above knee femoropopliteal stenosis or occlusions, maximal length of lesion 5cm; no previous interventions in ipsilateral femoropopliteal segment. Exclusion criteria: multisegmental disease, poor run off, unable to comply with follow-up protocol .
Interventions	Experimental group: primary stenting using a balloon expanded Palmaz stent, n=24. Control: balloon angioplasty, n=27.
Outcomes	Primary outcome: restenosis or reocclusion Secondary outcome Clinical: ABI, technical failure, embolic episodes, clinical deterioration and thrombosis.
Notes	Only experimental group offered post-interventional anticoagulant heparin pharmacotherapy. All patients started on oral coumadin after the procedure for the first three months, thereafter the treatment was changed to aspirin 80 mg/d indefinitely.

Risk of bias

Bias	Authors' judgement	Support for judgement
Adequate sequence generation?	Unclear risk	Described as randomised; numbered envelopes opened sequentially.

Vroegindewei 1997 (Continued)

Allocation concealment?	Unclear risk	Not clear if opaque envelopes.
Blinding? All outcomes	High risk	Neither the surgical or radiological staff were blinded and it remains unclear whether the subjects were themselves blinded.
Incomplete outcome data addressed? All outcomes	Low risk	"intention to treat".. "patients with crossover treatments remained assigned to the treatment group of randomization".
Free of selective reporting?	Low risk	All measures of technical and clinical success reported.
Free of other bias?	Low risk	No significant difference between groups of baseline risk factors or clinical status.

ABPI = ankle brachial pressure index

g = gram

i.v. = intravenous

Characteristics of excluded studies [ordered by study ID]

Study	Reason for exclusion
Becquemin 2003	Analysis of results included 21% of patients with critical limb ischaemia.
Cejna 2001	Analysis of results included 23% of participants (46 of 141) who presented with critical limb ischaemia.
Conroy 2000	Not a randomised controlled trial.
Do-dai-Do 1992	Not a randomised controlled trial.
Dutch Trial 1998	There were multiple reports of this trial. See list of excluded studies. Analysis of results included 8% of participants (20 of 152) with critical limb ischaemia.
Fast 2007	Analysis of results included patients with intermittent claudication 96.3% and ischaemia 3.7%. Outcome data could not be obtained for those patients with intermittent claudication.
Grenacher 2004	Analysis of results included 17% of patients with Fontaine stage 4 in the PTA group and 16% in the stent group. Outcome data could not be obtained for those patients with intermittent claudication.
Palmaz 1992	Not a randomised controlled trial.
Richter 1991	Abstract only. No details regarding inclusion and exclusion criteria for control or experimental groups. No response from author.
Richter 1992	Abstract only. No details regarding inclusion and exclusion criteria for control or experimental groups. No response from author.
Richter 1993	Abstract only. No details regarding inclusion and exclusion criteria for control or experimental groups. No response from author.
Saxon 2008	Analysis of results included 12% of patients in the PTA group and 9% in the stent graft group who had chronic limb ischaemia.

Study	Reason for exclusion
Van Rij 1991	Control group received no treatment.
Vienna Absolute 2007	Analysis of results included 12% of patients in the stent group and 13% in the angioplasty group with Rutherford stage 4 or 5 disease. Data were not available from authors because the trial follow up is still on-going.
Zdanowski 1999	Analysis of results included 84% of participants (27 of 32) who were diagnosed with critical limb ischaemia.

Characteristics of ongoing studies [ordered by study ID]

Baumgartner 2007

Trial name or title	The SIT-UP study: Swiss investigation of the S.M.A.R.T. nitinol self-expandable stent in superficial femoral artery occlusions versus balloon angioplasty.
Methods	Multicentre prospective, randomised, two-arm study.
Participants	120 symptomatic peripheral vascular disease patients with SFA occlusions.
Interventions	Cordis SMART™ nitinol stent system compared to balloon angioplasty.
Outcomes	Primary outcome measures: binary restenosis by Duplex ultrasound.
Starting date	December 2005
Contact information	
Notes	NCT00309595 Cordis Corporation May 2009 (Final data collection date for primary outcome measure)

Chalmers 2007

Trial name or title	The study to treat superficial femoral artery occlusions (SUPER UK).
Methods	Randomised, open label.
Participants	150 patients with de novo or restenotic native SFA occlusions (5-22 cm) with reference vessel of ≥ 4.0 to ≤ 6.0 mm in diameter.
Interventions	Cordis SMART™ nitinol self-expanding stent or angioplasty.
Outcomes	Primary outcome measures: binary restenosis as demonstrated by Duplex ultrasound.
Starting date	March 2005
Contact information	
Notes	NCT00232843

Chalmers 2007 (Continued)

Cordis Corporation

April 2009 (Final data collection date for primary outcome measure)

Dake 2007

Trial name or title	Evaluation of the Zilver PTX drug-eluting stent in the above-the-knee femoropopliteal artery.
Methods	Randomised, open label.
Participants	Phase 1 enrolling patients with lesions less than 7 cm long. Phase 2 of the trial will include longer lesions (up to 14 cm long).
Interventions	Zilver® PTX™ drug-eluting vascular stent or angioplasty.
Outcomes	Event-free survival rate and the patency rate at 6 and 12-month follow up.
Starting date	March 2005
Contact information	
Notes	NCT00120406 William Cook Europe MED Institute, Incorporated Cook Japan Incorporated. Estimated completion date November 2013

Reekers 2007

Trial name or title	The Study to Compare the Treatment of Angioplasty and Stents in SFA Occlusions. (DURAVEST)
Methods	Randomised, open label.
Participants	Symptomatic peripheral vascular disease patients with SFA occlusions.
Interventions	Cordis SMART™ nitinol self-expanding stent as compared to balloon angioplasty.
Outcomes	Primary outcome measures: primary patency.
Starting date	November 2005
Contact information	
Notes	This study has been terminated (lack of enrolment). NCT00289055

DATA AND ANALYSES

Comparison 1. Primary outcome measure

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Duplex scan confirmed stenosis or occlusion	2	104	Odds Ratio (M-H, Fixed, 95% CI)	2.37 [0.99, 5.71]

Analysis 1.1. Comparison 1 Primary outcome measure, Outcome 1 Duplex scan confirmed stenosis or occlusion.

Comparison 2. Walking distance

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Post intervention treadmill walking distance	1	53	Mean Difference (IV, Fixed, 95% CI)	-83.20 [-290.22, 123.82]

Analysis 2.1. Comparison 2 Walking distance, Outcome 1 Post intervention treadmill walking distance.

Comparison 3. Clinical end points

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Post intervention morbidity	1	102	Odds Ratio (M-H, Fixed, 95% CI)	1.12 [0.15, 8.21]
1.1 Embolic event	1	51	Odds Ratio (M-H, Fixed, 95% CI)	3.51 [0.14, 90.33]
1.2 Early thrombosis	1	51	Odds Ratio (M-H, Fixed, 95% CI)	0.36 [0.01, 9.27]
2 Failed treatment requiring re-intervention	1	53	Odds Ratio (M-H, Fixed, 95% CI)	0.78 [0.25, 2.41]
3 Patient reported deterioration at 12 months post intervention	1	51	Odds Ratio (M-H, Fixed, 95% CI)	1.43 [0.44, 4.58]

Analysis 3.1. Comparison 3 Clinical end points, Outcome 1 Post intervention morbidity.

Analysis 3.2. Comparison 3 Clinical end points, Outcome 2 Failed treatment requiring reintervention.

Analysis 3.3. Comparison 3 Clinical end points, Outcome 3 Patient reported deterioration at 12 months post intvention.

Comparison 4. Physiological measures

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 ABPI	2	104	Mean Difference (IV, Fixed, 95% CI)	0.01 [-0.06, 0.08]

Analysis 4.1. Comparison 4 Physiological measures, Outcome 1 ABPI.

Comparison 5. Other non pre-defined outcome measures

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Technical failure	2	104	Odds Ratio (M-H, Fixed, 95% CI)	1.6 [0.32, 8.01]

Analysis 5.1. Comparison 5 Other non pre-defined outcome measures, Outcome 1 Technical failure.

APPENDICES

Appendix 1. Search strategy used to search CENTRAL for 2009 update

#1	MeSH descriptor Arterial Occlusive Diseases explode all trees	4575
#2	MeSH descriptor Peripheral Vascular Diseases explode all trees	1953
#3	peripheral near (vascular or arter*) or atherosclerosis or arteriosclerosis or PVD or PAOD or PAD	15469
#4	arter* near occlus*	2108
#5	obstruct* near arter*	557
#6	MeSH descriptor Intermittent Claudication explode all trees	617
#7	claudica*	1213
#8	(limb* or leg) near isch*	649
#9	(#1 OR #2 OR #3 OR #4 OR #5 OR #6 OR #7 OR #8)	19418
#10	MeSH descriptor Stents explode all trees	2134
#11	stent*	3519
#12	(#10 OR #11)	3519

(Continued)

#13

(#9 AND #12)

668

Appendix 2. Search strategy used to search CENTRAL 2002

INTERMITTENT-CLAUDICATION*:ME
(INTERMITTENT and CLAUDICATION)
(#1 or #2)
ANGIOPLASTY*:ME
ANGIOPLASTY
(#4 or #5)
STENTS*:ME
(INTRA and (LUMINAL and STENT))
(#7 or #8)
(#6 or #9)
(#3 and #10)

WHAT'S NEW

Date	Event	Description
26 August 2009	New search has been performed	Searches were run and five additional studies were found but had to be excluded from the review because data could not be separated for patients with intermittent claudication. Risk of bias tables were added to the review. A recommendation was made that the review should be updated as soon as the results of recently completed studies are published but that the scope of the review should be broadened to include patients with intermittent claudication and critical limb ischaemia.
26 August 2009	New citation required but conclusions have not changed	Change in authors.

HISTORY

Protocol first published: Issue 3, 2001
Review first published: Issue 1, 2003

Date	Event	Description
16 April 2008	Amended	Converted to new review format.

CONTRIBUTIONS OF AUTHORS

For this update:

HM and KW selected trials, assessed trial quality, extracted data;

PB wrote the text of the review;

PT searched electronic databases, handsearched journals and conference proceedings, assessed trial quality, extracted data and contributed to the text for the original review.

DECLARATIONS OF INTEREST

None known.

SOURCES OF SUPPORT

Internal sources

- No sources of support supplied

External sources

- Chief Scientist Office, Scottish Government Health Directorates, The Scottish Government, UK, UK.

INDEX TERMS

Medical Subject Headings (MeSH)

*Angioplasty, Balloon; *Stents; Intermittent Claudication [*therapy]; Randomized Controlled Trials as Topic; Recurrence

MeSH check words

Adult; Humans