Meta-analysis of open and endovascular repair of popliteal artery aneurysms

Andrew E. Leake, MD, Michael A. Segal, BS, Rabih A. Chaer, MD, Mohammad H. Eslami, MD, Georges Al-Khoury, MD, Michel S. Makaroun, MD, *and* Efthymios D. Avgerinos, MD, *Pittsburgh, Pa*

ABSTRACT

Objective: Endovascular popliteal artery aneurysm repair (EPAR) is increasingly used over open surgical repair (OPAR). The purpose of this study was to analyze the available literature on their comparative outcomes.

Methods: The PubMed and Embase databases were searched to identify studies comparing OPAR and EPAR. Studies with only one treatment and fewer than five patients were excluded. Demographics and outcomes were collected. Bias risk was assessed using a modified version of the Newcastle-Ottawa Scale. Results were computed from random-effects meta-analyses using the DerSimonian-Laird algorithm.

Results: A total of 14 studies were identified encompassing 4880 popliteal artery aneurysm repairs (OPAR, 3915; EPAR, 1210) during the last decade. OPAR patients were younger (standard mean difference, −0.798 [−0.798 to −1.108]; $P < .001$) and more likely to have worse tibial runoff (odds ratio [OR], 1.949 (1.15-3.31); $P = .013$) than EPAR patients. OPAR had higher odds of wound complications (OR, 5.182 [2.191-12.256]; $P < .001$) and lower odds of thrombotic complications (OR, 0.362 [0.155-0.848]; $P < .001$). OPAR had longer length of stay (standardized mean difference, 2.158 [1.225-3.090]; $P < .001$) and fewer reinterventions (OR, 0.275 [0.166-0.454]; $P < .001$). Primary patency was better for OPAR at 1 year and 3 years (relative risk, 0.607 [$P = .01$] and 0.580 [$P = .006$], respectively). There was no difference in secondary patency at 1 year and 3 years (0.770 [$P = .458$] and 0.642 [$P = .073$], respectively).

Conclusions: EPAR has a lower wound complication rate and shorter length of hospital stay compared with OPAR. This comes at the cost of inferior primary patency but not secondary patency out to 3 years. Studies reporting long-term outcomes are lacking and necessary. (J Vasc Surg 2017;65:246-56.)

Popliteal artery aneurysm (PAA) repair is performed prophylactically in asymptomatic aneurysms >2 cm or in symptomatic PAAs of any size to prevent ischemic complications from distal embolization or thrombosis that may lead to limb loss. During the last five decades, open repair of PAAs (OPAR) has proved to be extremely durable with excellent long-term patency (primary patency up to 76% at 5 years)[1,2] and is thus considered the "gold standard" for repair. As in all aspects of vascular surgery, endovascular repair of PAAs (EPAR) has gained in popularity because of the decreased early morbidity with endovascular procedures.

Since its reported use in 1994 by Marin et al,[3] EPAR has gained in popularity as a minimally invasive method to exclude PAAs with a stent graft. Early reports revealed high thrombotic complications,[4] but advances in technology and selection of patients have improved results.[5-7] The literature is limited to one randomized controlled trial[8] and numerous retrospective studies looking at outcomes of OPAR vs EPAR.[5,7,9-15]

The objective of this study was to evaluate all available comparative studies of OPAR vs EPAR by meta-analysis. Our hypothesis is that OPAR has superior patency outcomes with higher complications compared with EPAR. The results of this meta-analysis and our clinical experience will be used to propose a treatment algorithm for the management of PAA.

METHODS

Review protocol. The criteria for study selection, methods of analysis, and investigated outcomes were selected before analysis. The protocol was not registered at the International Prospective Register of Systematic Reviews. Meta-analysis of Observational Studies in Epidemiology guidelines were used to report methods and findings (Supplementary Table I, online only).[16] No funding was provided for this research.

Study eligibility criteria. Selection of studies was aimed at collecting all studies that included both treatment strategies of PAA, endovascular repair and open repair. The following eligibility criteria were specified: (1) the design was a randomized controlled trial, retrospective or prospective cohort study with a minimum of five patients in each group; (2) the population included adult patients undergoing repair of PAA; interventions

From the Department of Surgery, Division of Vascular Surgery, University of Pittsburgh Medical Center.

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Correspondence: Andrew E. Leake, MD, 200 Lothrop St, Ste A-1017, Pittsburgh, PA 15213 (e-mail: leakeae@gmail.com).

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for nonaneurysmal indications (occlusive disease, trauma) were excluded; (3) the study included both interventions, OPAR (no limitations to surgical technique) and EPAR (with stent graft, no limitation to other technical details); studies with only one treatment type were excluded; and (4) the study reported adequate outcomes for analysis. All studies meeting these criteria were included, regardless of the symptomatic status of the patient at presentation.

Outcome measures. Primary and secondary patency rates at 1 year and 3 years were the primary outcomes of interest. Secondary outcomes included complications, length of stay, reinterventions, amputations, and 30-day mortality. Complications were self-reported in each study. Total complications included all complications defined by individual studies. There was variation in the definition of complications among studies (eg, wound complications), and when they were subdivided, they were collected and reported separately.

Search methods. The authors searched electronic databases including MEDLINE and Embase during January 2016. Search dates were limited from January 1994 to January 2016 as publications before 1994 would not have included EPAR. The search terms used medical subject headings including "popliteal," "artery," and "aneurysm." The only limitation used was a restriction to journals published in English. No contact with authors of manuscripts was necessary.

Two reviewers (A.E.L., M.A.S.) independently screened the titles and abstracts of all records. Before data collection, an electronic spreadsheet was created to collect variables of interest. Two reviewers extracted the study variables independently. All discrepancies were resolved by consensus led by the senior author (E.D.A.). Reviewers were trained health researchers and physicians, with immediate access to senior authors as needed.

Assessment of risk for bias. The risk of bias was assessed using a modified version of the Newcastle-Ottawa Scale, which accommodates observational and randomized trials.[17,18] Two reviewers (A.E.L., M.A.S.) independently assessed the risk of bias using the scale consisting of three categories (selection, comparability, and outcome), with each category consisting of questions corresponding to the quality of the study. A study received a star in each category when it met the definition for high quality. Studies were deemed low quality (0-6 stars), medium quality (7-8 stars), and high quality (9 stars). Newcastle-Ottawa Scale scores are shown in Table I and broken down by category in Supplementary Table II (online only).

Statistical analysis. The meta-analyses were performed through the user-programmed metan procedure in Stata 14 (StataCorp LP, College Station, Tex). With the exception of length of stay and PAA size, the outcome variables were dichotomous, and in most cases effects were presented as odds ratio (OR). As outlined in Borenstein et al,[19] we employed random-effects models, estimating between-study variance through the DerSimonian-Laird method. There is no universally accepted way to report patency variables from Kaplan-Meier curves for interpretation in meta-analysis. Patency rates were analyzed as risk ratios (RRs), where "risk" was the Kaplan-Meier estimate subtracted from 1. The sample totals of subjects were captured from the total number of patients included in a given study, as has previously been performed.[20] A corresponding 95% confidence interval (CI) is presented for each variable. For each outcome, we provide z-tests for the estimated overall effect; the χ^2 test for between-study variability; and the I^2 statistic, which gives the estimated percentage of between-study variation in the effect size that is true variation (as opposed to random). P values $< .05$ were considered statistically significant.

RESULTS

Results of search. A total of 614 articles were identified and reviewed for inclusion. Full-text articles were carefully reviewed, and a total of 14 studies met the approved selection criteria (Fig 1).[5-7,9-15,26-29]

Included studies. Studies included in the analysis are shown in Table I. The studies ranged from 2005 to 2016, with almost half of the studies published in the last year of analysis. The studies consist of retrospective single-center studies,[5,7,9-15] retrospective multicenter studies,[28] retrospective administrative data sets,[29] self-reported registries,[26,27] and randomized controlled trials.[6] The pooled total number of PAA repairs was 4880, with 3915 (80%) undergoing OPAR and 1210 (20%) undergoing EPAR. There was considerable variation in the outcomes reported in each study, as shown in Table I. PAA presentation varied with each study; three studies reported on asymptomatic patients only,[6,26,29] one study did not report symptomatic status,[15] and the remaining studies had various proportions of symptomatic patients ranging from 18% to 53%. Symptomatic status was ill-defined; the studies typically included patients with acute ischemia and symptoms (claudication, compression, and rupture). The overall quality of studies was low, with the exception of a single prospective randomized controlled trial.[6]

Demographics. Demographic information is shown in Table II. OPAR patients were more likely to be younger (standard mean difference [SMD], −0.798; $P < .001$) with no other differences in comorbidities compared with EPAR. There was significant heterogeneity in several of the demographic variables reported across the studies; however, the weighted means were overall similar. OPAR was more likely to have worse runoff (OR, 1.949; $P = .01$),