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Rita Silveira de Sousa

# Abordagem endovascular vs cirurgia aberta nos aneurismas poplíteos: uma revisão das taxas de preservação de membro e reintervenção

# Endovascular vs open repair for popliteal aneurysm: a review on limb salvage and reintervention rates

**Maio, 2020**

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**Doutor Armando Amilcar Pires Mansilha Rodrigues de Almeida**

**E sob a Coorientação de:**

**Dr. José Pedro Oliveira Pinto**

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Endovascular vs open repair for popliteal aneurysm: a review on limb salvage and reintervention rates

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# Endovascular vs open repair for popliteal aneurysm: a review on limb salvage and reintervention rates

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**ABSTRACT**

INTRODUCTION: Open repair remains the gold standard technique for popliteal aneurysm repair. However, the endovascular approach has gained increased popularity. Comparison between these techniques remain crucial to aid the physician choice, yet, data on mid term outcomes lack in literature. The present review aims to compare the limb salvage and reintervention rates in these different approaches.

EVIDENCE ACQUISITION: A comprehensive literature review was conducted to identify publications on endovascular treatment or open repair of popliteal artery aneurysms (PAAs). Primary endpoints were reintervention and limb salvage.

EVIDENCE SYNTHESIS: Twenty-seven studies were selected for analysis describing a total of 5425 patients: 1651 PAAs underwent endovascular repair and 4166 PAAs were treated with open surgery. The technical success rates varied between 83.3 to 100% in the endovascular group and 79 to 100% in the open repair. For endovascular repair, the limb salvage at 1 year ranged between 84.2 and 100%, at 3 years between 88.9 and 100%; and at 5 years between 64.7 and 100%. The reintervention rate at 1 year ranged between 3.7 and 21%, at 3 years between 18.9 and 28%, and at 5 years between 34.5 and 38%. For open repair, the limb salvage varied between 94.3 and 100% at 1 year,94.5 and 99 % at 3 years, and 86.4 to 97% at 5 years. Regarding the reintervention rate, at 1 year was 12.8 and 13%, at 3 years 3.6 and 12%, and at 5 years varied between 15.7 and 30%.

CONCLUSIONS: Both endovascular and open repair of popliteal aneurysms represent safe options for popliteal aneurysm repair. Yet, on mid-term, open repair is associated with greater limb salvage and fewer reintervention rates. Still, further studies are needed to access the long-term durability of this technique and its suitability in emergency settings.

Key words: Endovascular procedure; Artery, popliteal; Aneurysm; Limb salvage.

# TEXT

## Introduction

Popliteal artery aneurysms (PAAs) are the most commonly observed peripheral artery aneurysms [1], corresponding to 70 % of all the cases [2,3]. They are classified as aneurysmal when its diameter is more than 50% its normal measurement [4]. It affects mostly men and incidence increases with age. PAA occurs frequently bilaterally and may be associated with other peripheral artery aneurysms.

The majority of PAAs present themselves as asymptomatic, often identified incidentally through an imagiologic study, when evaluating another aneurysm [5,6] or through routine physical examination. When symptomatic, PAAs can manifest as acute or chronic ischemia [3]. Less frequently, patients can present with compressive symptoms. Rupture has rarely been reported [7,8].

There are two different possible approaches: open surgery, in which venous bypass graft is considered the "gold standard" [2,9]; or endovascular repair with covered stents, that since its first report, in 1994, has gained popularity [10].

The comparison between these two therapies is necessary in order to aid the physician selecting the best treatment available and to make individualized choices.

The present review aims to compare the limb salvage and reintervention rates in these different approaches.

## Evidence acquisition

The literature in the Medline database was searched for relevant articles published between 2009 and October 2019.The key words used were: "amputation OR limb salvage", "reintervention OR re-intervention", " endovascular OR stent", " open surgery" and "popliteal artery aneurysm", in combination with the Boolean operators AND or OR. Only articles with follow-up data were included and it was only collected data up to 5 years. We excluded all reviews and articles encompassing only women.

## Evidence synthesis

Twenty-seven studies, including 5425 patients, were included in the qualitative analysis (Figure 1). Eleven of the included studies compared both techniques (4727 PAAs and 4505

patients), four reported data only for open repair (538 PAAs and 426 patients) and 12 reports focused only on endovascular repair comprising a total of 552 PAAs and 494 patients.
Patient characteristics are depicted in Table I.[2,3,5-7,11-32]

Endovascular repair

Among the reviewed studies, a total of 1854 stents in 1006 PAAs were implanted.
Regarding the type of stent used the majority of the PAAs were treated with Viabahn-57%, while 6.6% were treated with Hemobahn and 31.4% with Hemobahn/ Viabahn.
The technical success rates reported ranged from 83.3% to 100% [2,3,7,11-16,18,19,24-26,28-32].
Nine perioperative deaths were recorded among these studies, accounting for a 30-day mortality between 0% and 6,4%.
Mean follow-up period ranged between 12-68 months after procedure.
The limb salvage at 1 year ranged between 84,2 and 100% [5-7,14,15,18,25,31], at 3 years between 88,9% and 100% [2,3,14,18,28,31], and at 5 years between 64,7 and 100% [13,14,16,31,32] (Table III).
Regarding the reintervention rate, at 1 year ranged between 3,7 and 21% [6,14,17,18,25], at 3 years between 18.9 and 28% [2,3,28], and at 5 years 34,5% [32] and 38 % [29].
In the emergent setting, limb salvage at 1 year was 82.6% [5] and 100% [18]; and at 3 years was 100% [18,28]. The reintervention rate at 1 year was 21% [18], and at 3 years was 26.7 [18] and 52% [28].

Open surgery

Patients submitted to open surgery tended to be younger than the ones submitted to endovascular repair with a mean age varying between 63.5 to 76.3 years in open surgery vs. 68.1 to 81 years in endovascular repair (Table I).
There was a higher percentage of emergent cases assigned to the open repair group (0-43%) in comparison with endovascular repair (0-38.7%). The emergent setting included cases of rupture and acute limb-threatening ischaemia due to chronic thrombosis, acute aneurysmal thrombosis and distal embolization.
Data regarding number of patients included, number of PAAs, perioperative deaths and mean follow –up is depicted in Table II. [2,3,5-7,11-32]
The technical success rate ranged between 79 and 100% [20,21,26,29-31].
Thirteen perioperative deaths were recorded among these studies for open surgery, accounting for a 30 day mortality ranging between 0% and 4.3%.

Follow-up period was heterogeneous among groups, with a median/mean follow-up time ranging between 12 and 137 months after procedure.

The limb salvage ranged at 1 year between 94,3 and 100% [5,6,25,31] ;3 years between 94,5% and 99% [28,30,31]; and at 5 years between 86,4% - 97% [21,22,31,32] (Table III).

Regarding reinterventions, 30-day reintervention rates ranged between 2,1-5,3% [22,24,27,28,32],at 1 year was 12,8%[6] and 13%[25],at 3 years was 3.6% [30] and 12% [28] , and at 5 years ranged between 15,7-30% [21,22,29,32] (Table III).

In the emergent setting, the limb salvage at 1 year was 93.2% [5] and at 3 years was 100%[28]. The reintervention rate was 43%[28] at 3 years.

**Discussion**

The present manuscript reviewed the limb salvage and reintervention rates after popliteal aneurysm repair comparing open surgery with the endovascular approach. Although both techniques revealed technically safe and effective for the treatment of popliteal aneurysms, there was a tendency towards a higher limb salvage and lower reintervention rate in the open repair group. In the context of emergency, in comparison with elective repair, the outcomes tend to be worse, with a higher risk of limb loss, complications and reinterventions [7,21,28].

Limb salvage following repair of the popliteal aneurysm depend on the runoff status, with a poor distal runoff predicting higher amputation rates [2,12,28,33] ; and on the nature of the patient's symptomatology, with a higher severity increasing the risk of amputation [22,33,34].Given that the open repair groups had patients with a more severe presentation and poorer runoff in comparison with endovascular repair, there may even be an underestimation of the real advantage of open surgery.

Regarding the reintervention rates, the endovascular repair group exhibited a higher frequency of reinterventions. Graft thrombosis, restenosis and endoleaks were some of the main causes of reintervention. Although endovascular repair is a less invasive treatment [22], associated with shorter hospital stays and a quicker recovery time [2,35], more reinterventions along with greater readmissions and costs may be anticipated in the long term[27]. Furthermore, the lack of long-term data may induce that there could be a even more dramatic difference between the two treatments.

The choice between either of the treatments needs to be individualized, taking into account the patient's clinical presentation, age, the surgical risk and their anatomy. [19,22] In a patient with several comorbidities, with a high perioperative risk, in a context of elective repair and

with a suitable anatomy the endovascular repair is preferable. In patients that don't have a high surgical risk, open repair is still the gold standard[10,18,24,30].

Endovascular repair in emergent settings showed a lower limb salvage and higher reintervention rates in comparison with open repair at 30 days [13,21,28].

To justify the use of endovascular repair in emergent settings a study encompassing a larger number of patients and a longer follow up period is necessary.

The present review has limitations that warrant consideration. First, the selected studies exhibited important differences in terms of sample sizes. There was no homogeneity between studies regarding technique used and the indications to submit patients to endovascular vs. open repair. Patient characteristics were not equivalent to enable a fair comparison between both groups. Furthermore, each study had a different percentage of emergent cases, that are proved to be correlated with worse outcomes, and the data was presented as a total not indicating the percentage for elective vs. emergent setting. The open repair group tended to have a higher percentage of emergent cases in comparison with the endovascular group.

A multicenter randomized controlled trial with a longer follow-up period is, therefore, necessary to determine the roles of both strategies in the popliteal artery aneurysm repair [32,36].

## Conclusion

Both open and endovascular repair represent valid and safe options for PAA repair.

Although endovascular' s repair increased popularity, open repair still remains the gold standard for the treatment of PAAs.

Endovascular repair seems an effective option in selected patients.

Further studies encompassing a longer follow-up period are needed to clarify the long-term results of endovascular repair.

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**NOTES**

*Conflicts of interest.* The authors certify that there is no conflit of interest with any financial organization regarding the material discussed in the manuscript.

*Authors' contributions*. Rita S. Sousa:manuscript design and conception, article writing, final approval of the manuscript.José Oliveira-Pinto: manuscript design and conception, article writing, final approval of the manuscript. Armando Mansilha: manuscript design and conception, final approval of the manuscript.

**TABLES**

Table I.— Patient characteristics

| Article | Age(years) | Male | Smoker | Diabetes | Chronic kidney disease | Elective | Emergent | Stent type |
|---|---|---|---|---|---|---|---|---|
| Endovascular Repair | | | | | | | | |
| Midy et al. (2010) [2] | 72+/-11 | 96% | 82% | 16% | - | 89,5%: Asymptomatic-73.7% Symptomatic-15.8% | 10,5% | Hemobahn/Viabahn-73.7% Wallgraft-24.5% Passager-1.8% |
| Jung et al. (2010) [11] | 75+/-1.6 | 93% | 45% | 13% | - | 100%: Asymptomatic-87% Symptomatic-13% | 0% | Viabahn-100% |
| Garg et al. (2012)[12] | 74+/-9 | 90.5% | - | - | - | 100% Asymptomatic-62% Symptomatic-38% | 0% | Viabahn-100% |
| Trinidad-Hernandez et al. (2013) [7] | 81+/-5.9 | 96% | 24% | 16% | 52% | 61.2%: Asymptomatic-54.8% Symptomatic-6.5% | 38.7% | Viabahn-100% |

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|---|---|---|---|---|---|---|---|---|
| Piazza et al. (2014)[13] | 78.1+/-11 | 86% | 64% | 14% | 21% | 93%<br>Asymptomatic-58%<br>Symptomatic-42% | 7% | Hemobahn-33%<br>Viabahn-52%<br>Viabahn+Advanta-2%<br>Heparin bonded Viabahn-13% |
| Saunders et al. (2014)[14] | 76 (62–88) | 96% | - | - | - | 68% | 32% | Hemobahn-35.4%<br>Viabahn-64.6% |
| Speziale et al. (2015)[3] | 73.6 +/-7.8 | 98.1% | 66% | 17% | 20.7% | 77.6% | 22.6% | Viabahn-100% |
| Golchehr et al (2016) [15] | 71.2 +/-8.5 | 93% | 40% | 4% | 37% | 90.3%<br>Asymptomatic-78%<br>Symptomatic-12.3% | 9.7% | Viabahn-100% |
| Maraglino et al. (2017)[16] | Men-74<br>Women-77 | 93% | 40% | 9.2% | 13.8% | 66%<br>Asymptomatic-60%<br>Symptomatic-6% | 34% | Hemobahn/Viabahn-100% |
| Golchehr et al. (2018)[17] | 68.1+/-9.4 | 97% | 63% | 14% | 14% | 94.3%<br>Asymptomatic-85.3%<br>Symptomatic-9.3% | 5.3% | Hemobahn-52%<br>Viabahn-48% |
| Ardita et al. (2018)[18] | 74.4+/-10.5 | 92% | 44% | 24% | 24% | 0% | 100% | Viabahn and/or Advanta V12-40%<br>Viabahn+BMS-60% |
| Guzzardi et | 74.2 (42–92) | 92% | 63% | - | - | 85.4% | 14.6% | Viabahn-100% |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| al. (2019)[19] | | | | | | Asymptomatic- 64.6% Symptomatic- 20.8% | | |
| Open Repair | | | | | | | | |
| Zimmermann et al. (2010)[20] | 71.5 (31-95) | 95.7% | 19.6% | 17.4% | - | 63% Asymptomatic- 63% | 30.3% | - |
| Dorweiler et al. (2014)[21] | 67+/- 11 | 96.1% | 48% | 15% | 14% | 78% Asymptomatic- 57% Symptomatic- 21% | 22% | - |
| Dorigo et al. (2015)[22] | 68.5+/- 9.9 | 95% | 77% | 10% | - | 71% Asymptomatic- 41.5% Symptomatic- 29.5% | 29% | - |
| Wagenhauser et al. (2015)[23] | 63.5 +/-10 | 93.3% | 50% | - | - | 100% Asymptomatic- 38.1% Symptomatic- 61.9% | 0% | - |
| Both | | | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Endovascular<br><br>Pulli et al. (2012)[24] | 74 | 100% | 71% | 10% | - | 80.5%<br>Asymptomatic-71%<br>Symptomatic-9.5% | 19% | Hemobahn/Viabahn: 95.24%<br>Cardiatis Multilayer 3D Stent:4.76% |
| Open repair | 73.4 | 95.35% | 81% | 10% | - | 68.3%<br>Asymptomatic-52%<br>Symptomatic-16.3% | 32.6% | - |
| Endovascular<br><br>Pulli et al. (2013) [25] | 74.9 +/- 7.9 | 9.5% | 70% | 21% | - | 91.8%<br>Asymptomatic-61.2%<br>Symptomatic-30.6% | 8.2% | Hemobahn/Viabahn-100% |
| Open repair | 70 +/-8.9 | 7.5% | 55% | 20.5% | - | 77%<br>Asymptomatic-35.5%<br>Symptomatic-41.5% | 23% | - |
| Endovascular<br><br>Stone et al. (2013)[26] | 76 +/- 9.80 | 95% | 70% | - | - | 70.8%<br>Asymptomatic-54.1%<br>Symptomatic-16.7% | 29% | Viabahn-100% |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Open repair | 65.96+/-12.56 | 100% | 69.2% | - | - | 65% Asymptomatic-44.4% Symptomatic-20.6% | 36.5% | - |
| Endovascular<br><br>Galinanes et al.(2013)[27] | 77.9+/-7.01 | 90.9% | - | - | - | - | - | - |
| Open repair | 76.3 +/-6.20 | 95% | - | - | - | - | - | - |
| Endovascular<br><br>Huang et al. (2014)[28] | 81 +/- 6.5 | 100% | - | - | 3% | 76.1% Asymptomatic-69% Symptomatic-7.1% | 23.8% | Viabahn-100% |
| Open repair | 71 +/- 9.6 | 99% | - | - | 3% | 86.6% Asymptomatic-52% Symptomatic-34.6% | 13% | - |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Endovascular<br><br>Cervin et al. (2015)[5] | Acute ischaemia: 70 (46-88)<br>Elective symptomatic: 78 (63-88)<br>Elective asymptomatic: 78 (63-88) | 93.7% | 77.9% | 15.8% | - | 71.6%<br>Asymptomatic-57.9%<br>Symptomatic-13.7% | 28.4% | - |
| Open repair | Acute ischaemia: 69 (42-102)<br>Elective symptomatic: 68 (46-93)<br>Elective asymptomatic: 68 (50-90) | 96.2% | 81% | 14% | - | 70.8%<br>Asymptomatic-51.8%<br>Symptomatic-19% | 29.2% | - |
| Endovascular<br><br>Ronchey et al. (2015)[29] | 71+/-6 | - | 56% | 28% | 36% | 84%<br>Asymptomatic-76%<br>Symptomatic-8% | 16% | Viabahn-100% |
| Open Repair | Group B: 66+/-10<br><br>Group C: 68+/-7 | - | 57.1% | 31% | 11.9% | 76.2%<br>Asymptomatic-59.5%<br>Symptomatic-16.7% | 23.8% | - |
| Endovascular | 72.7 | 96.7% | 31.6% | 22% | - | 88.2% | 11.8% | Viabahn-100% |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Leake et al. (2016)[30] | | | | | | | | |
| Open repair | 70.5 | 95.8% | 43.5% | 25% | - | 57% | 43% | - |
| Endovascular<br>Wrede et al. (2017)[6] | 69 (56-87) | 92.6% | 88.9% | 25.9% | 19.2% | 40.9% | 35.3% | Viabahn-100% |
| Open repair | 66 (48-81) | 100% | 82.1% | 10.3% | 17.9% | 59.1% | | - |
| Endovascular<br>Del Tatto et al .(2018)[31] | 70.4 (53-86) | 92.3% | 59% | 5.1% | 7.6% | 90%<br>Asymptomatic-84%<br>Symptomatic-6% | 10% | Viabahn-100% |
| Open repair | 69.4 (48-89) | 95.4% | 32.2% | 2.3% | 8% | 70.9%<br>Asymptomatic-60.2%<br>Symptomatic-10.7% | 29% | - |
| Endovascular<br>Dorigo et al. (2018)[32] | 74.1 +/-7.8 | 100% | 87.5% | 7% | - | 75%<br>Asymptomatic-69.6%<br>Symptomatic - 5.4% | 25% | Viabahn/Hemobahn: 98.2%<br>Cardiatis Multilayer 3D Stent:1.8% |
| | | | | | | 83.9% | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Open repair | 74.1 +/- 7.8 | 98.2% | 77% | 12.5% | - | Asymptomatic-66% Symptomatic-17.9% | 16% | - |

Group B: great saphenous vein bypass; Group C: prosthetic graft bypass

Table II.— Study characteristics

| Article | Patients | PAAs | Perioperative deaths (<30days) | Mean follow-up(months) |
|---|---|---|---|---|
| **Endovascular:12 articles** | | | | |
| **Midy et al. (2010)[2]** | 50 | 57 | 0 | 36+/-19,4 |
| **Jung et al. (2010)[11]** | 13 | 15 | 0 | 54(42-70) |
| **Garg et al. (2012)[12]** | 21 | 26 | 0 | 22+/-17 |
| **Trinidad - Hernandez et al.(2013)[7]** | 25 | 31 | Overall:2/31(6,4%)<br>Elective:0<br>Emergent:2/12(16,7%) | 21,3 (1-75) |
| **Piazza et al. (2014)[13]** | 42 | 46 | 0 | 56+/-21 |
| **Saunders et al. (2014)[14]** | 26 | 34 | 0 | 40 (4–86) |
| **Speziale et al. (2015)[3]** | 53 | 53 | 0 | 37.4 +/- 29.3 |
| **Golchehr et al. (2016)[15]** | 70 | 72 | 0 | 13 (0-63) |
| **Maraglino et al. (2017)[16]** | 57 | 65 | 0 | 35 +/- 25 |
| **Golchehr et al. (2018)[17]** | 64 | 75 | 0 | 68 (2-187) |
| **Ardita et al. (2018)[18]** | 25 | 30 | 0 | 21.8+/-15.8 |
| **Guzzardi et al. (2019)[19]** | 48 | 48 | 0 | 24.5 (6–72) |
| **Open Surgery:4 articles** | | | | |
| **Zimmermann et al.** | 46 | 56 | 2/46(4,3%) | 20.5 (0.73) |

| | | | | |
|---|---|---|---|---|
| **(2010)[20]** | | | | |
| **Dorweiler et al. (2014)[21]** | 154 | 206 | 3/154(2%) | 137 (1-185) |
| **Dorigo et al. (2015)[22]** | 196 | 234 | 2/196(1%) | 62 (1-312) |
| **Wagenhauser et al.(2015)[23]** | 30 | 42 | 0 | 38.7+/- 29.2 |
| **Both:11 articles** | | | | |
| **Pulli et al. (2012)[24]** | 59 | 64: 43OR 21ER | OR:0 ER:1/21(4,7%) | 22.5(1-60). |
| **Pulli et al. (2013)[25]** | 249 | 312: 178OR 134ER | OR:0 ER:2/134(1,5%) | OR: 27 (1-156) ER: 35(1-124) |
| **Stone et al. (2013)[26]** | 72 | 88: 64OR 24ER | OR:1/63(1,6%) ER:0 | OR: 29.2 (0-116) ER: 22.4 (0-105) |
| **Galinanes et al. (2013)[27]** | 2962 | 2962: 2413OR 549ER | NR | NR |
| **Huang et al. (2014)[28]** | 120 | 149: 107OR 42ER | OR:1/107(0,9%) ER:2/42(4,7%) | OR:45.6 (1-100.8) ER: 31.2 (1-78) |
| **Cervin et al. (2015)[5]** | 499 | 592 473OR 95ER | OR:2/473(0,42%) ER:1/95(1%) | 12 |
| **Ronchey et al. (2015)[29]** | 67 | 67: 42OR 25ER | 0 | 49(1-145) |
| **Leake et al. (2016)[30]** | 156 | 186: 110OR 76ER | OR:2/110(1,8%) ER:0 | OR: 34.9+/- 28.6 ER: 28.3+/- 25.8 |
| **Wrede et al. (2017)[6]** | 87 | 102: 39OR 27ER 36AR | 0 | OR:39 ER:24 |

| | | | | |
|---|---|---|---|---|
| **Del Tatto et al. (2018)[31]** | 126 | 153: 103OR 50ER | 0 | 45.6 |
| **Dorigo et al. (2018)[32]** | 108 matched | 309 250OR 59ER (matched 56OR 56ER) | OR:0 ER:1/56(1,8%) | OR: 71.5 +/- 10.4 ER: 36.4 +/- 3.4 |

ER: Endovascular Repair; OR: Open Repair; PAAs: Popliteal artery aneurysms; AR: Acute repair

Table III.— Mid-term outcomes

| Article | Procedure | Technical success rate | Reintervention | Limb Salvage |
|---|---|---|---|---|
| **Midy et al. (2010)[2]** | endovascular | 56/57(98,2%) | 36+/- 19.4 months: 14/57(24,56%) | 36+/- 19.4 months:55/57(96,5%) |
| **Jung et al. (2010)[11]** | endovascular | 15/15(100%) | 54 months(42-70):2/12(16,7%) | 54months(42-70): 15/15 (100%) |
| **Garg et al. (2012)[12]** | endovascular | 25/26(96%) | NS | 22+/- 17 months: 26/26(100%) |
| **Trinidad - Hernandez et al. (2013)[7]** | endovascular | 30 /31(97%) | 21,3months (1-75): Overall:9/31(29%) Elective:6/19(31,6%) Emergent: 3/12(25%) | 1year:30/31(97%) |
| **Piazza et al. (2014)[13]** | endovascular | 45/46 (98%) | NS | 5 years :45/46(98%) |
| **Saunders et al. (2014)[14]** | endovascular | 34/34 (100%) | 1year: 4/34(12%) | 1year:32/34(94,1%) 3years:18/18(100%) 5years:5/5(100%) |
| **Speziale et al. (2015)[3]** | endovascular | 53/53(100%) | 37.4months+/-29.3 :10/53(18,9%) | 37.4months+/-29.3: 53/53(100%) |
| **Golchehr et al. (2016)[15]** | endovascular | 72/72 (100%) | NS | 13 months (0-63): 72/72(100%) |
| **Maraglino et al. (2017)[16]** | endovascular | 64/65(98,5%) | NS | 5years:54/65(83%) |
| **Golchehr** | | | | |

| | | | | |
|---|---|---|---|---|
| **et al. (2018)[17]** | endovascular | NS | 14months (1-47):12/75 (16%) | 68 months (2-187) = 75/75(100%) |
| **Ardita et al. (2018)[18]** | endovascular | 30/30(100%) | 1 year:6 /30(21%)<br>3 year:8 /30(26,7%) | 1 year:30/30(100%)<br>3 year: 30/30(100%) |
| **Guzzardi et al. (2019)[19]** | endovascular | 48/48(100%) | 24.5 months (6–72): 3/48(6,25%) | 24.5 months (6–72) =48/48(100%) |
| **Zimmer-mann et al. (2010)[20]** | open surgery | 54/54(100%) | 20.5 months (0.73):5/31(16,1%) | 20.5 months (0.73):31/31(100%) |
| **Dorweiler et al. (2014)[21]** | open surgery | 200/206(97%) | 5years:32/206(15,7%)<br>10years:62/206(30,2%) | Overall:5 and 10 years-200/206(97%); emergent:5 and 10 years-41/45(91,1%); elective:5 and 10 years-159/161(98,6%) |
| **Dorigo et al. (2015)[22]** | open surgery | NS | 5years:55/210(26,2%)<br>10years:77/210(36,5%)<br>13years:80/210(38%) | 5years:191/210(91,2%)<br>10years:180/210(86%)<br>13years:180/210(86%) |
| **Wagen-hauser et al. (2015)[23]** | Open surgery | NS | NS | 30days: Overall:(100+86,7) /2 (93,3%)<br>Symptomatic: -/- (86,7%)<br>Asymptomatic:16/16 (100%) |
| **Pulli et al. (2012)[24]** | open surgery | NS | 2years:9/43 (21%) | 22,5months (1-60):38/41(92,7%) |
| | endovascular | 21/21(100%) | 2years: - /- (38,5%) | 22,5months (1-60):19/20(95%) |
| **Pulli et al. (2013)[25]** | open surgery | NS | 1year:22/168(13%)<br>2years:-/-(13,9%)<br>4years:-/-(27,5%) | 1years: -/-(94,3%)<br>2years:-/-(92,6%)<br>4years:-/-(89,7%) |
| | endovascular | 134/134 (100%) | 1year:-/-(19,4%)<br>2years:-/-(22,8%)<br>4years:-/-(25%) | 1year:-/- (98,1%)<br>2years:-/-(96,9%)<br>4years:-/-(96,9%) |
| **Stone et al. (2013)[26]** | open surgery | 50/63(79%) | NS | 29,2months:58/64 (90,6%) |
| | endovascular | 20/24(83.3%) | 2years:2/24 (8,3%) | 22,4months:24/24 |

| | | | | |
|---|---|---|---|---|
| | | | | (100%) |
| **Galinanes et al . (2013)[27]** | open surgery | NS | 30days:51/2413(2,11%)<br>90days:110/2413(4,55%) | NS |
| | endovascular | NS | 30days:41/549(7,42%)<br>90days:65/549(11,84%) | NS |
| **Huang et al. (2014)[28]** | open surgery | NS | 30days<br>Overall:4/107(4%)<br>Elective:1/93(1%)<br>Emergent:3/14(21,4%)<br>3years<br>Overall:18/107(16,8%)<br>Elective:12/93(12%)<br>Emergent:6/14(43%) | 3years<br>Overall:106/107(99%)<br>Elective:92/93(99%)<br>Emergent:14/14(100%) |
| | endovascular | 41/42(98%) | 30days<br>Overall:5/42(12%)<br>Elective:1/32(3%)<br>Emergent:4/10(40%)<br>3 years<br>Overall:14/42(33,3%)<br>Elective:9/32(28%)<br>Emergent:5/10(52%) | 3years<br>Overall:42/42(100%)<br>Elective:32/32(100%)<br>Emergent:10/10(100%) |
| **Cervin et al. (2015)[5]** | open surgery | NS | NS | Acute Ischaemia:<br>1year-109/117(93,2%)<br>Symptomatic:<br>1year-74/81(91,4%)<br>Asymptomatic:<br>1year-218/220(99%)<br>Overall:<br>1year-401/418(95,9%) |
| | endovascular | NS | NS | Acute Ischaemia:<br>1year-19/23(82,6%)<br>Symptomatic:<br>1year-9/9(100%)<br>Asymptomatic:<br>1year-49/50(98%)<br>Overall:<br>1year-77/82(93,9%) |
| **Ronchey et al. (2015)[29]** | Open surgery-GSV bypass | 28/28 (100%) | 49 months (1-145):<br>5/28(17,8%)<br>5years:-/-(16%) | 49months (1-145):<br>27/28(96,4%) |
| | Open surgery-Prosthetic garft bypass | 14/14 (100%) | 49months (1-145):<br>3/14(21,4%)<br>5years:-/-(30%) | 49 months(1-145):<br>14/14 (100%) |

| | | | | |
|---|---|---|---|---|
| | endovascular | 25/25 (100%) | 49 months (1-145): 4/25(16%) 5years:-/-(38%) | 49months(1-145): 25/25(100%) |
| **Leake et al. (2016)[30]** | open surgery | 110/110(100%) | 34.9months+/- 28.6 :4/110 (3,6%) | 34.9months+/- 28.6 :106/110(96,3%) |
| | endovascular | 76/76(100%) | 28.3months+/- 25.8 :7/76(9,2%) | 28.3months+/- 25.8 :75/76(98,7%) |
| **Wrede et al. (2017)[6]** | open surgery | NS | 1year:5/39(12,8%) | 1year:36/36(100%) |
| | endovascular | NS | 1year:1/27(3,7%) | 1year:16/19(84,2%) |
| **Del Tatto et al. (2018)[31]** | open surgery | 103/103(100%) | NS | 1year:-/-(94,5%) 3years:-/-(94,5%) 5years:-/-(89,5%) |
| | endovascular | 50/50(100%) | NS | 1year:-/-(97,7%) 3years:-/-(88,9%) 5years:-/-(64,7%) |
| **Dorigo et al. (2018)[32]** | open surgery | NS | 5years:-/-(24%) | 5years:-/-(86,4%) |
| | endovascular | 56/56(100%) | 5years:-/-(34,5%) | 5years:-/-(94%) |

NS: Not stated; GSV: great saphenous vein

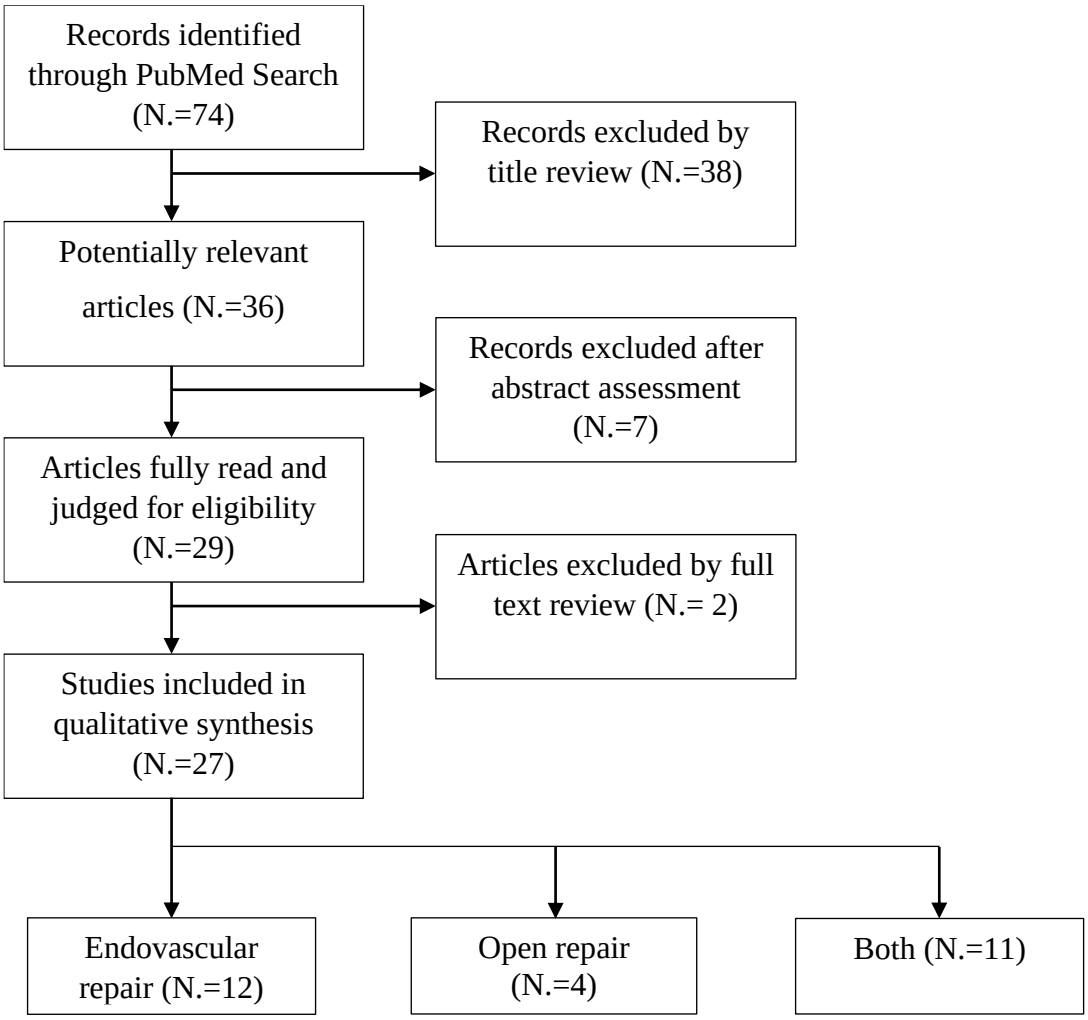


Figure 1.— Flowchart summarizing literature screening process.

# INTERNATIONAL ANGIOLOGY

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Sutherland DE, Simmons RL, Howard RJ. Intracapsular technique of transplant nephrectomy. Surg Gynecol Obstet 1978;146:951-2.

- Organization as author

International Committee of Medical Journal Editors. Uniform requirements for manuscripts submitted to biomedical journals. Ann Int Med 1988;108:258-65.

- Issue with supplement

Payne DK, Sullivan MD, Massie MJ. Women's psychological reactions to breast cancer. Semin Oncol 1996;23(1 Suppl 2):89-97.

Books and monographs

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- Chapter from book

De Meester TR. Gastroesophageal reflux disease. In: Moody FG, Carey LC, Scott Jones R, Ketly KA, Nahrwold

DL, Skinner DB, editors. Surgical treatment of digestive diseases. Chicago: Year Book Medical Publishers; 1986. p. 132-58.
- Congress proceedings
Kimura J, Shibasaki H, editors. Recent advances in clinical neurophysiology. Proceedings of the 10th International Congress of EMG and Clinical Neurophysiology; 1995 Oct 15-19; Kyoto, Japan. Amsterdam: Elsevier; 1996.
Electronic material
- Standard journal article on the Internet
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Sutherland DE, Simmons RL, Howard RJ. Intracapsular technique of transplant nephrectomy. Surg Gynecol Obstet 1978;146:951-2.
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Payne DK, Sullivan MD, Massie MJ. Women's psychological reactions to breast cancer. Semin Oncol 1996;23(1 Suppl 2):89-97.

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- Congress proceedings
Kimura J, Shibasaki H, editors. Recent advances in clinical neurophysiology. Proceedings of the 10th International Congress of EMG and Clinical Neurophysiology; 1995 Oct 15-19; Kyoto, Japan. Amsterdam: Elsevier; 1996.

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| *Table body* | *Table body* | *Table body* | *Table body* |
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