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Review of Direct Anatomical Open Surgical Management of Atherosclerotic Aorto-Iliac Occlusive Disease

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KEYWORDS
Atherosclerotic aorto-iliac occlusive disease;
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Abstract *Background:* Aortofemoral bypass(AFB), iliofemoral bypass(IFB), and aortoiliac endarterectomy(AIE) are the three most common techniques for anatomical open surgical revascularisation for patients with aorto-iliac occlusive disease(AIOD), but the optimal method of reconstruction is unknown.
Aims: To review and compare mortality, morbidity and short- and long-term patency rates for AFB, IFB and AIE in patients with AIOD reported in the English language literature
Methods: A MEDLINE(1970–2007) and Cochrane Library search for articles relating to AFB, IFB, AIE and AIOD was undertaken. Studies were included if: a) patency rates based on life-tables were available, and b) patient/study characteristics were reported.
Results: 29 studies(5738 patients) for AFB, 11 studies(778 patients) for IFB and 11 studies(1490 patients) for AIE were included. Operative mortality was 4.1% for AFB, 2.7% for IFB and 2.7% for AIE ($p < 0.0001$). Systemic morbidity was 16.0% for AFB, 18.9% for IFB and 12.5% for AIE ($p < 0.05$). Overall 5-year primary patency rates were 86.3%, 85.3% and 88.3% for AFB, IFB and AIE, respectively ($p =$ NS).
Conclusion: Aorto-iliac endarterectomy was associated with significantly lower peri-operative morbidity and mortality rates compared with bypass grafting. All three techniques were equally effective in terms of long-term patency.

Introduction

Open surgical reconstruction represents the evidence-based treatment of choice for Trans-Atlantic Inter-Society Consensus (TASC) II type-C and D aortoiliac lesions.[1,2] Since the pioneering work by dos Santos in the area of aortoiliac endarterectomy, a variety of anatomical and extra-

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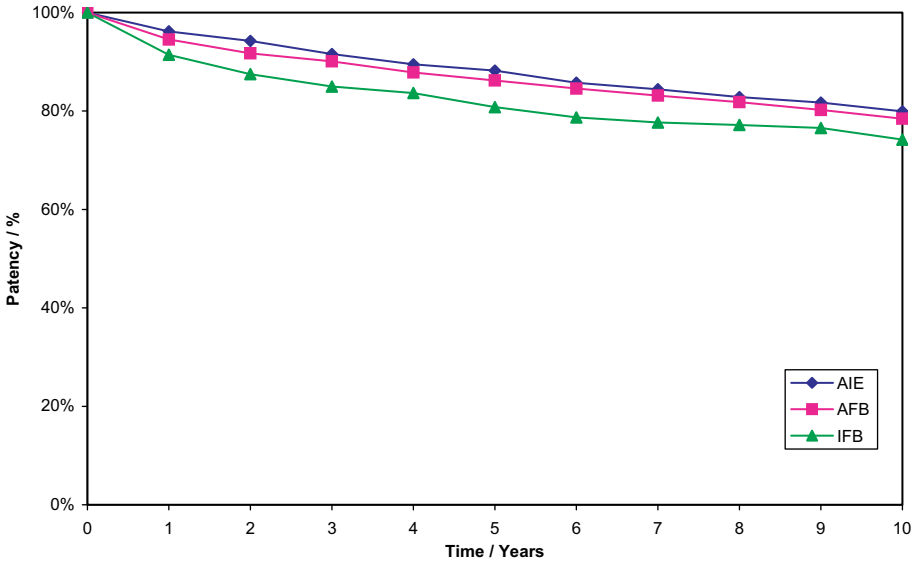


Interval	0	1	2	3	4	5	6	7	8	9	10
AFB	7521	6434	5545	4605	3774	2950	2211	1769	1404	1067	795
AIE	1971	1798	1602	1427	1250	1102	980	865	763	675	586
IFB	789	632	476	387	300	253	205	181	152	134	114

Figure 1 Cumulative patency for patients who underwent Aortofemoral Bypass, Iliofemoral Bypass and Aortoiliac Endarterectomy.

anatomical open surgical arterial reconstructions have been described for the management of patients with symptomatic aorto-iliac occlusive disease (AIOD).[3] The most widely utilised anatomical open surgical reconstructions are: aortofemoral bypass (AFB), iliofemoral bypass (IFB) and aortoiliac endarterectomy (AIE). Descending thoracic aortofemoral bypass (DTAF) has also been described but is predominantly reserved for patients in which the aforementioned reconstructions are unsuitable.[4,5] Bypass grafting is widely accepted as the anatomical procedure of choice for AIOD and aortoiliac endarterectomy has fallen out of favour with the majority of vascular surgeons. To date, no comparative study has been undertaken to determine the optimal method of anatomical reconstruction for AIOD.

The aims of this study were a) to review and compare the short- and long-term outcomes of AFB, IFB, AIE and DTAF for the treatment of AOID and b) to provide an evidence-based benchmark with which to compare the results of established and evolving endovascular therapies.

Materials and methods

We performed a MEDLINE, EMBASE and Cochrane Central Register of Controlled Trials (CENTRAL) databases search looking for English language articles relating to AFB, IFB, AIE, DTAF and AIOD between January 1970 and August 2007. The terms aorta, iliac artery and aortoiliac were included amongst others. These were linked with terms such as reconstruction, revascularisation, bypass, endarterectomy, atherosclerosis and occlusion. Further articles were identified by following MEDLINE links, by cross-referencing from the reference lists of major articles and by following citations for these studies.

Table 1 Overview of patient demographics, risk factors, peri-operative surgical and long-term outcomes.

	AFB	AIE	IFB	DTAF
Characteristics				
No of Studies	29	11	11	2
No. of Subjects	5738	1490	778	174
No. of Limbs	7521	1971	789	192
Mean age (years)	58.8	58.7	61.6	—
Female/%	24.4	21.0	21.8	—
Claudication/%	64.3	70.9	52.7	—
Ischaemia/%	35.7	29.1	47.3	—
Risk factors				
Smokers/%	89.9	95.0	77.9	—
Diabetes/%	17.4	10.9	15.6	—
IHD/%	41.4	28.9	42.1	—
Hypertensive/%	39.6	32.1	36.8	—
Surgical outcomes				
Operative Mortality/%	4.1	2.7	2.7	4.6
Early Systemic Morbidity/%	16.0	12.5	18.9	—
Early Local Morbidity/%	6.3	3.4	5.7	—
Early Graft-related Morbidity or intervention failure/%	3.1	3.8	4.2	4.5
Primary patency				
Overall 5 yr patency/%	86.3	88.3	85.3	79.6
Patency for Claudication/%	89.8	90.8	86.7	—
Patency for Ischaemia/%	79.8	81.7	74.1	—

Table 2 Patient demographics of Aortofemoral Bypass studies.

Author	Study years	Patients	Limbs	Female (%)	Mean age (yr)	Claud (%)	Isch (%)	A(F/I)2	A(F/I)1	Other	Iliac (%)
Bowes[10]	1976–1990	26	52	54	59	65	35	26	0	0	13
Brewster[52]	1963–1977	341	657	27	58	56	44	316	25	0	29
Couch[14]	1972–1985	111	208	–	–	68	32	97	14	0	–
Dunn[15]	1968–1979	192	384	28	60	64	36	192	0	0	3
Friedman[16]	1986–1989	60	120	37	68	67	33	60	0	0	58
Harris[18]	1979–1984	200	377	26	58	71	29	177	23	0	0
Jackson[21]	1992–2003	111	222	37	49	42	58	111	0	0	0
Jensen[22]	1979–1986	56	112	68	45	80	20	40	2	14	33
Johnson[23]	1965–1975	88	176	–	53	66	34	88	0	0	–
Lau[26]	1977–1998	94	176	12	58	39	61	82	12	0	0
Littooy[27]	1977–1988	224	440	1	59	63	37	216	8	0	2
Martinez[28]	1967–1977	376	752	33	58	72	28	376	0	0	0
Mason[29]	1980–1985	59	114	–	59	75	25	55	4	0	0
Meister[30]	1989–1992	150	300	9	59	66	34	150	0	0	0
Melliere[31]	1977–1996	108	108	8	–	72	28	0	108	0	0
Mingoli[32]	1973–1990	238	476	23	58	39	61	476	0	0	34
Mulcare[33]	1964–1975	114	228	32	–	54	46	114	0	0	50
Naylor[34]	1975–1984	241	476	29	60	71	29	235	6	0	0
Hsiang[19]	1970–1984	80	–	35	55	70	30	–	–	0	0
Passman[39]	1988–1993	139	278	1	68	58	42	139	0	0	0
Piotrowski[41]	1975–1985	32	64	6	59	63	37	32	0	0	0
Prager[42]	1991–1998	149	298	30	59	67	33	149	0	0	0
Prediville[43]	1978–1989	145	285	–	64	30	70	140	5	0	0
Schneider[45]	1986–1991	119	238	36	61	45	55	119	0	0	0
Sladen[46]	1968–1980	100	196	29	59	100	0	96	4	0	0
Szilagy[47]	1954–1983	1748	3010	–	–	66	34	1262	41	445	6
Timaran[48]	1996–2001	60	102				17	42	6	12	46
Van der Vliet[49]	1976–1987	350	700	18	59	80	20	350	0	0	–
Yamazaki[51]	1992–1995	27	40	7	70	78	22	13	14	0	–
All studies		5738	10 589	24	59	64	36	5153	272	471	9

Studies reporting long-term primary patency data following open anatomical repair of aorto-iliac occlusive disease were included if a) the results for patients with AIOD were reported separately; b) the primary patency data were presented in a life-table format that met the Society for Vascular Surgery/International Society for Cardiovascular Surgery ISCVS/SVS criteria, using yearly or smaller intervals, or such life-tables could be reconstructed from the presented data; c) the patient demographics and study characteristics were reported in sufficient detail to allow for adjustment for the case-mix and the reporting methods in the analysis; and d) the study cohort was greater than 10 patients. In instances whereby more than one publication from the same cohort was available, we

Table 3 Patient demographics of Iliofemoral Bypass studies.

Author	Study years	Patients	Limbs	Female (%)	Mean Age (yr)	Claud (%)	Isch (%)	IF	Other
Cham[13]	1972–1986	105	105	15	62	46	54	105	0
Harrington[17]	1965–1991	68	68	48	66	44	56	68	14
Jorgensen[24]	1980–1982	62	62	35	61	19	81	62	0
Kalman[25]	1976–1985	50	50	38	59	56	44	50	0
Mason[29]	1980–1985	39	50	–	62	31	69	50	0
Melliere[55]	1977–1996	144	144	13	–	69	31	144	0
Ng[35]	1984–1990	72	75	19	65	63	37	75	0
Oliveira[37]	1981–1991	16	16	0	65	31	69	16	0
Perler[40]	–	21	22	29	64	53	47	22	0
Piotrowski[41]	1975–1985	17	17	29	50	47	53	17	0
Van der Vliet[49]	1976–1987	184	114	15	60	61	39	114	70
All studies		778	723	22	62	53	47	723	84

Table 4 Patient demographics of Aortoiliac Endarterectomy studies.

Author	Study years	Patients	Limbs	Female (%)	Mean age (yr)	Claud (%)	Isch (%)	AIFE	IFE	Other
Aguiar[9]	Not stated	71	128	24	57	59	41	107	21	0
Brewster[52]	1963–1977	241	448	27	58	56	44	448	0	0
Butcher[12]	Not stated	100	185	23	–	78	22	144	41	0
Inahara[20]	1962–1978	201	321	21	65	59	41	321	0	0
Melliere[31]	1977–1996	108	108	6	–	74	26	0	108	0
Naylor[34]	1974–1984	57	109	39	53	86	14	109	0	0
Hsiang[19]	1970–1987	45	–	35	55	70	30	45	0	0
Oertli[2]	1959–1972	415	514	15	58	81	20	84	430	0
Oskam[38]	1971–1990	94	163	29	52	85	15	163	0	0
Radoux[44]	1982–1995	98	121	8	57	71	29	0	121	0
Vitale[50]	1966–1988	60	70	40	67	65	35	0	70	0
All studies		1490	2167	21	59	71	29	1421	791	0

included only the most recent publication unless; a) evidence was available that the patient population did not overlap and b) the most recent publication was unsuitable for data extraction or a more complete data set was available from previous publications.

Table 5 Patient risk factors for Aortofemoral Bypass studies.

Author	Risk factors			
	Smoker (%)	Diabetes (%)	IHD (%)	HT (%)
Bowes[10]	73	27	58	27
Brewster[52]	100	12	40	35
Couch[14]	77	14	46	53
Dunn[15]	–	9	29	41
Friedman[16]	73	22	50	50
Harris[18]	–	8	–	–
Jackson[21]	98	22	29	63
Jensen[22]	–	–	–	–
Johnson[23]	–	–	–	–
Lau[26]	90	21	30	53
Littooy[27]	89	–	48	44
Martinez[28]	87	24	–	30
Mason[29]	–	21	57	–
Meister[30]	97	27	37	49
Melliere[31]	–	8	15	26
Mingoli[32]	88	31	62	54
Mulcare[33]	–	–	–	–
Naylor[34]	–	–	–	–
Hsiang[19]	86	11	33	29
Passman[39]	82	19	38	–
Piotrowski[41]	75	19	53	22
Prager[42]	88	22	–	–
Prediville[43]	97	11	16	33
Schneider[45]	97	20	41	56
Sladen[46]	99	–	–	–
Szilagy[47]	–	18	47	35
Timaran[48]	83	21	60	62
Van der Vliet[49]	87	11	24	45
Yamazaki[51]	–	–	–	–
All studies	90	17	41	40

A proforma was used to extract the data from the articles; these data included study design, reporting methods, patient risk factors, operative morbidity/mortality and primary and secondary patency rates. The patient demographics, risk factors, and short- and long-term outcomes used in this study were previously identified as relevant factors by other studies.[6,7]

The definition of 'peri-operative' period varied between studies, but was generally defined as within 30 days of the index intervention. Thus, we defined operative mortality as death within this period. A systemic complication was defined as a dysfunction of one or more major organ systems within 30 days of the index procedure. A local complication was defined as a non-fatal complication limited to the site of operation and occurring within 30 days of the index procedure. Graft-related complication was defined as all non-fatal damage or disease related to the graft including intervention failures (i.e. failed procedures). For AIE, as no prosthetic graft was used, we only collected data for intervention failures (i.e. failed endarterectomy).

In order to calculate primary patencies, data from the studies needed to be presented or able to be converted to a life-table format. In 49% of the studies (22/45), patency

Table 6 Patient risk factors for Iliofemoral Bypass studies.

Author	Risk factors			
	Smoker (%)	Diabetes (%)	IHD (%)	HT (%)
Cham[13]	–	10	–	26
Harrington[17]	68	32	63	60
Jorgensen[24]	–	6	26	–
Kalman[25]	–	18	38	–
Mason[29]	–	26	69	–
Melliere[55]	–	11	20	19
Ng[35]	–	17	91	45
Oliveira[37]	100	25	44	63
Perler[40]	69	31	–	69
Piotrowski[41]	76	0	41	24
Van der Vliet[49]	83	15	28	44
All studies	78	16	42	37

Table 7 Patient risk factors for Aortoiliac Endarterectomy studies.

Author	Risk factors			
	Smoker (%)	Diabetes (%)	IHD (%)	HT (%)
Aguiar[9]	99	17	27	48
Brewster[52]	100	12	40	35
Butcher[12]	–	16	23	17
Inahara[20]	94	6	25	25
Melliere[31]	–	9	17	23
Naylor[34]	–	–	–	–
Hsiang[19]	86	11	33	29
Oertli[36]	–	–	–	–
Oskam[38]	–	–	–	–
Radoux[44]	91	10	27	43
Vitale[50]	88	12	32	52
All studies	95	11	29	32

data were presented in life-table formats. In the remaining studies, life-tables were reconstructed from survival curves with sufficient data. We assumed that the lowest point at each time interval in a survival curve represented the patency rate of the observed unit at that time.

Patient demographics and risk factors from each study were pooled for analysis. Statistical comparison of aggregated patency data was based on Cox proportional hazard regression. Spearman correlation was used to quantify the association of each of the outcomes with patient demographics and risk factors. Life-table analysis was carried out. A covariate, symptomatic status of patients prior to interventions, was included for further sub-analysis using methodology previously described by Hunink and Wong.[8] This methodology allows the combination of failure-time data from various sources, adjusting for differences in case-mix among studies. It is based on the proportional-hazards model and the actuarial life-table approach. Two-sided *p*-values are reported and differences in results were considered to be ''statistically significant'' if the p-value was <0.05. Microsoft Excel 2000 and the statistical package Graphpad Prism® version 5.00 were utilised for analysis.

Results

590 studies were identified, 331 (56%) studies were excluded from their abstracts alone, resulting in 259 (44%) articles being retrieved. A further 214 (36%) publications

Table 8 Short and long-term outcomes for Aortofemoral Bypass studies.

Author	Early morbidity				
	Operative morality (%)	Systemic (%)	Local (%)	Graft related (%)	5-year patency rate
Bowes[10]	7.7	4.2	–	3.8	92.0
Brewster[52]	2.6	–	–	1.2	90.5
Couch[14]	1.0	16.1	–	–	–
Dunn[15]	3.1	17.2	3.1	5.7	86.0
Friedman[16]	0.0	8.3	11.7	0.0	95.5
Harris[18]	3.5	–	–	–	91.0
Jackson[21]	1.6	19.4	21.0	3.6	78.0
Jensen[22]	0.0	5.4	14.3	3.6	–
Johnson[23]	5.7	–	–	–	76.9
Lau[26]	8.7	–	–	–	89.0
Littooy[27]	4.9	4.0	9.8	4.5	87.6
Martinez[28]	5.6	25.3	4.0	0.5	88.3
Mason[29]	6.8	30.5	5.2	3.6	–
Meister[30]	2.0	14.0	14.0	–	91.8
Melliere[31]	0.9	–	0.0	3.7	82.0
Mingoli[32]	3.4	3.8	6.7	2.5	82.5
Mulcare[33]	8.8	–	–	5.3	–
Naylor[34]	–	–	–	–	92.8
Hsiang[19]	–	–	–	–	86.5
Passman[39]	0.7	19.4	12.4	1.4	74.0
Piotrowski[41]	3.0	13.0	22.0	–	97.0
Prager[42]	4.0	–	–	–	89.0
Prediville[43]	3.0	–	–	–	90.5
Schneider[45]	0.8	–	–	4.2	62.5
Sladen[46]	0.0	–	–	2.0	83.0
Szilagy[47]	5.0	18.0	4.3	3.7	85.3
Timaran[48]	–	5.0	1.7	1.7	86.0
Van der Vliet[49]	4.9	13.4	8.0	–	86.4
Yamazaki[51]	11.1	–	–	3.7	85.9
All AFB studies	4.1	16.0	6.3	3.1	86.3

Table 9 Short and long-term outcomes for Iliofemoral Bypass studies.

Author	Early morbidity				
	Operative morality (%)	Systemic (%)	Local (%)	Graft related (%)	5-year patency rate
Cham[13]	1.9	–	–	–	86.0
Harrington[17]	2.9	–	–	4.4	73.4
Jorgensen[24]	5.0	–	–	–	83.0
Kalman[25]	0.0	–	–	–	–
Mason[29]	0.0	11.1	–	–	–
Melliere[55]	1.4	–	0.7	2.1	73.0
Ng[35]	5.6	35.7	11.0	9.3	75.0
Oliveira[37]	12.5	–	6.3	–	64.0
Perler[40]	9.0	16.9	14.0	0.0	88.0
Piotrowski[41]	0.0	18.0	6.0	–	48.0
Van der Vliet[49]	1.6	11.4	7.0	–	87.9
All studies	2.7	18.9	5.7	4.2	85.3

were excluded for various reasons. Thus, 45 (8%) articles were included in the process of data extraction and analysis (Fig. 3).[4,5,9–51]

Of the 45 studies included, 29 studies (5738 patients) included data for AFB, 11 studies (778 patients) for IFB and 11 studies (1490 patients) for AIE. Two studies (174 patients) were identified for DTAF.[4,5] Six studies included data for both AFB and IFB and one study included data for AFB, IFB and AIE[19,29,34,41,49,52] (Tables 1–7).

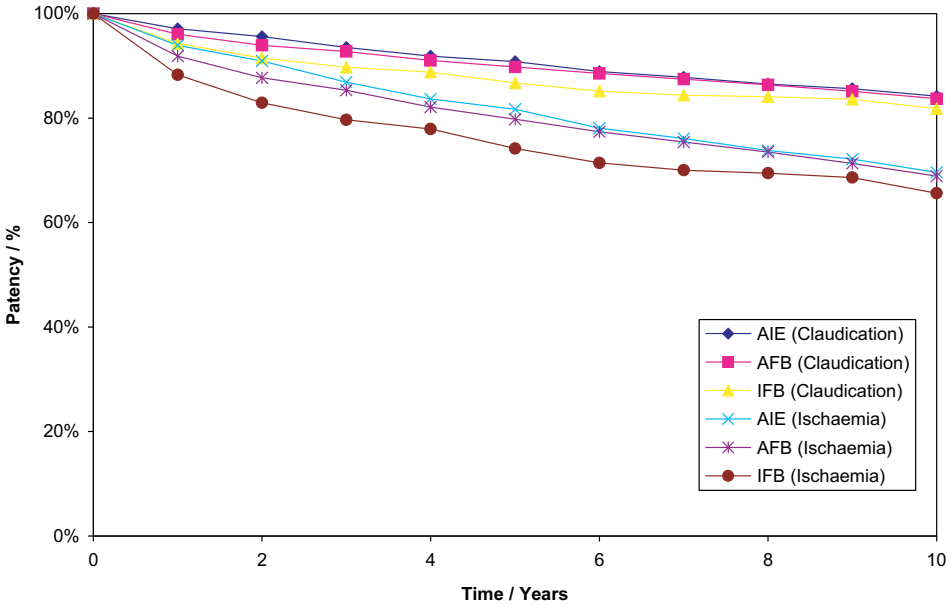
More patients underwent AFB than AIE or IFB. The majority of these patients were male (76.5%) and their main indication for intervention was intermittent claudication (IC). There were significant inter-study differences for patient demographics and risk factors: male:female ratio ($p < 0.02$), smoking history, diabetes, ischaemic heart disease (IHD) and hypertension (HT) (all $p < 0.0001$). The AFB cohort had the highest proportion of patients with diabetes and HT while the IFB cohort had the highest proportion of patients with IHD and CLI as the indication for surgery. The AIE cohort had the highest proportion of smokers. There were insufficient data to analyse mean age between the cohorts (Table 1).

The operative mortality rate for AFB, IFB and AIE was reported in 93% (42/45) of the studies and was 4.1%, 2.7% and 2.7%, respectively ($p < 0.0001$). Systemic morbidity was reported in 56% (25/45) of studies, local morbidity in 51% (23/45) and graft-related morbidity/failed endarterectomy in 71% (32/45). The systemic morbidity rate was 16% for AFB, 18.9% for IFB and 12.5% for AIE ($p < 0.0001$). The local morbidity rate was 6.3% for AFB, 5.7% for IFB and 3.4% for AIE ($p < 0.003$). There was no correlation between operative mortality and systemic or local morbidity, and patient demographics or risk factors. The graft-related morbidity/intervention failure rates for AFB, IFB and AIE were 3.1%, 4.2% and 3.8%, respectively ($p = 0.31$). For AFB, 8 studies (2619 patients) quoted graft infection rates and the combined rate was calculated to be 0.7%. As for IFB, only 3 studies (237 patients) mentioned graft infection rates specifically and was calculated to be 0.4%. There are insufficient data to analysis the severity of these infections.

Patency criteria were defined in 58% (26/45) of studies and these varied from clinical symptomatology/examination to radiological assessment. All studies except one[23]

Table 10 Short and long-term outcomes for Aortoiliac Endarterectomy studies.

Author	Early morbidity				
	Operative morality (%)	Systemic (%)	Local (%)	Failed AIE (%)	5-year patency rate
Aguiar[9]	4.2	–	–	18.3	87.0
Brewster[52]	5.0	–	–	3.7	86.8
Butcher[12]	6.0	24.0	2.0	4.0	72.0
Hsiang[19]	–	–	–	–	82.0
Inahara[20]	5.0	15.0	2.0	2.2	92.0
Melliere[31]	2.8	–	2.8	2.8	92.0
Naylor[34]	0.0	9.0	5.3	3.5	92.0
Oertli[36]	1.2	–	–	2.7	93.5
Oskam[38]	0.0	10.3	2.1	3.2	83.0
Radoux[44]	0.0	4.0	6.1	6.1	78.9
Vitale[50]	0.0	5.3	6.7	0.0	80.4
All studies	2.7	12.5	3.4	3.8	88.3



Interval	0	1	2	3	4	5	6	7	8	9	10
AFB Claudication	4836	4206	3657	3053	2521	1982	1494	1201	958	732	549
AFB Ischaemia	2685	2228	1888	1552	1253	968	717	568	446	335	246
AIE Claudication	1397	1287	1153	1034	911	806	721	639	566	503	439
AIE Ischaemia	574	511	449	393	339	296	259	226	197	172	147
IFB Claudication	416	344	264	217	169	144	118	105	88	78	67
IFB Ischaemia	373	288	212	170	131	109	87	76	64	56	47

Figure 2 Patency rates for patients undergoing Aortofemoral Bypass, Iliofemoral Bypass and Aortoiliac Endarterectomy for intermittent claudication and critical limb ischaemia.

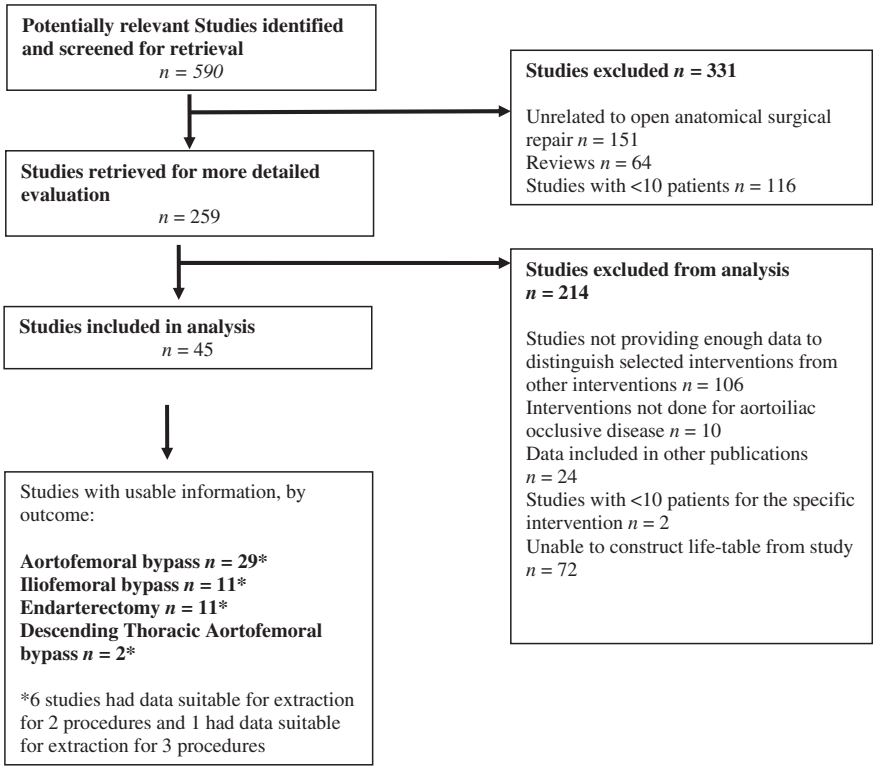


Figure 3 Data selection.

reported primary patency data. Although Johnson *et al.*[23] reported secondary patency in isolation we were able to reconstruct a primary patency life-table from the published data. The 5-year primary patency rates were 86.3%, 85.3% and 88.3% for AFB, IFB and AIE, respectively ($p = 0.12$).

Outcomes following AFB, IFB and AIE were further sub-analysed according to patient clinical presentation. The 5-year primary patency rates for patients with IC were 89.8%, 86.7% and 90.8% for AFB, IFB and AIE, respectively ($p = 0.07$) and, for patients with CLI, were 79.8%, 74.1% and 81.7% for AFB, IFB and AIE, respectively ($p = 0.06$). There was a significant difference in 5-year patency rates for patients with IC and CLI ($p < 0.0001$) (Tables 1, 8—10 and Figs. 1 and 2).

The pooled results were further analysed according to the decade during which the studies were undertaken. For AFB, the 5-year patency in studies carried out during the 1970s was 88.4% and gradually decreased to 76.1% for studies carried out after the millennium ($p = 0.03$). For IFB, data were only available for studies carried out in the 1980s and 1990s and this also demonstrated a fall in 5-year patency rate from 88.6% to 73.1% ($p = 0.001$). The results were not statistically significant for AIE.

The small number of patients who underwent DTAF precluded reliable statistical comparison with the other three techniques. Operative mortality for DTAF was 4.6%. Systemic and local morbidities were not reported in the published studies but graft-related morbidity was 4.5%. The 5-year primary patency rate for DTAF was 79.6% (Table 11).

Discussion

The present review represents more than 35 years of experience in anatomical open surgical revascularisation for patients with symptomatic AIOD and, to our knowledge, the first comparative analysis of major outcomes following aortofemoral bypass, iliofemoral bypass and aortoiliac endarterectomy.

The principal finding of the present study is that AIE appears to be associated with significantly lower operative mortality (2.7%) and systemic (12.5%) and local complication rates (3.3%) compared with the two bypass procedures. The reason for this finding is not obvious from the data collected and presented but intuitively one would assume that patient selection is important with AIE being utilised predominantly for localised aortoiliac disease and AFB and IFB may be used for more extensive disease.[53] All three techniques were equally effective in terms of 5-year primary patency rates. There was a trend toward improved 5-year patency rates for both IC and CLI following AFB and AIE when compared to IFB.

Several studies have compared prosthetic bypass with endarterectomy for the treatment of AOID with conflicting results. Some authors have reported higher morbidity and lower patency rates for AIE[52,54] while others have demonstrated lower morbidity and comparable long-term outcomes when compared with bypass in appropriately selected patients.[53,55,56] There are no trials directly comparing AFB and IFB, and those observational studies that exist are inconclusive with some reporting comparable outcomes while others report poorer long-term outcomes

Table 11 Patient demographics, risk factors, short- and long-term outcomes of DTAF studies.

Author	Study years	Patients	Limbs	Female (%)	Mean Age (yr)	Claud (%)	Isch (%)	DTAF	Other
Schultz[5]	1972—1985	28	46	29	62	37	63	25	0
Criado[4]	1982—1993	146	146	–	–	–	–	146	0
All DTAF studies		174	192					171	0
Risk factors									
	Smoker (%)	Diabetes (%)	IHD (%)	HTN (%)					
Schultz[5]	89.3	25.0	25.0	42.9					
Criado[4]	–	–	–	–					
Early morbidity									
	Operative Morality (%)	Systemic (%)	Local (%)	Graft related (%)	Unit of Observation	Source of data	Patency reported	5-year patency rate	
Schultz[5]	3.6	33.3	–	6.3	Limbs	Figure	Primary	80.4	
Criado[4]	4.8	–	–	3.4	Patients	Table	Primary	78.7	
All DTAF studies	4.6			4.5				79.6	

Table 12 Study design and reported results of Aortofemoral Bypass studies.

Author	Type of Study	Retrospective/ Prospective	Materials used	Unit of observation	Source of data	Patency reported
Bowes[10]	Observation	Retrospective	Not mentioned	Limb	Figure	Primary
Brewster[52]	Observation	Retrospective	Not mentioned	Limb	Table	Primary
Couch[14]	Observation	Retrospective	Dacron/PTFE	Limb	Figure	Primary
Dunn[15]	Observation	Retrospective	Not mentioned	Patient	Table	Primary
Friedman[16]	Randomised	Prospective	Dacron/PTFE	Limb	Table	Primary
Harris[18]	Observation	Retrospective	Dacron	Limb	Figure	Primary
Jackson[21]	Observation	Retrospective	SFP vein/Dacron	Patient	Table	Primary
Jensen[22]	Observation	Retrospective	Not mentioned	Patient	Table	Primary
Johnson[23]	Observation	Retrospective	Dacron	Patient	Table	Secondary
Lau[26]	Observation	Retrospective	Dacron	Limb	Figure	Primary
Littooy[27]	Observation	Retrospective	Dacron	Limb	Table	Primary
Martinez[28]	Observation	Retrospective	Dacron	Limb	Table	Primary
Mason[29]	Observation	Retrospective	Dacron/PTFE	Limb	Figure	Primary
Meister[30]	Randomised	Prospective	Not mentioned	Patient	Figure	Primary
Melliere[31]	Observation	Prospective	Dacron/PTFE/SFP vein	Patient	Table	Primary
Mingoli[32]	Observation	Retrospective	Not mentioned	Limb	Figure	Primary
Mulcare[33]	Observation	Retrospective	Not mentioned	Patient	Table	Primary
Naylor[34]	Observation	Retrospective	Not mentioned	Both	Figure	Primary
Hsiang[19]	Observation	Retrospective	Not mentioned	Patient	Figure	Primary
Passman[39]	Observation	Retrospective	PTFE	Patient	Table	Primary
Piotrowski[41]	Observation	Retrospective	Not mentioned	Patient	Figure	Primary
Prager[42]	Randomised	Prospective	Dacron/PTFE	Patient	Figure	Primary
Prediville[43]	Observation	Retrospective	Dacron	Limb	Figure	Primary
Schneider[45]	Observation	Retrospective	Dacron/PTFE	Patient	Figure	Primary
Sladen[46]	Observation	Retrospective	Not mentioned	Patient	Table	Primary
Szilagy[47]	Observation	Retrospective	Dacron/others	Patient	Table	Primary
Timaran[48]	Observation	Retrospective	PTFE/polyester	Patient	Figure	Primary
Van der Vliet[49]	Observation	Retrospective	Dacron/PTFE	Patient	Table	Primary
Yamazaki[51]	Observation	Retrospective	PTFE	Patient	Table	Primary

with IFB.[17,25,41,57] However, IFB is consistently reported as being less traumatic and requiring shorter exposure time when compared to AFB.[13,58]

As expected, patients presenting with CLI demonstrated poorer 5-year patency rates when compared with patients with IC irrespective of reconstruction.[7,34,59,60] Unfortunately, there was insufficient breakdown of published data to perform sub-analysis according to patient characteristics, risk factors and operative risks.

Interestingly, when data were compared by decade of publication there was a decrease in patency rates for AFB and IFB over time. Previous studies have shown either no statistical difference or improved patency over time.[7,52,61] When each of the patient characteristics were analysed there were statistical differences over time, but no obvious trend to explain why patency rates fell with time. For AFB, patients were younger, more presented with CLI, systemic morbidity fell, local morbidity increased and operative

Table 13 Study design and reported results of Iliofemoral Bypass studies.

Author	Type of Study	Retrospective/ Prospective	Materials used	Unit of observation	Source of data	Patency reported
Cham[13]	Observation	Retrospective	Dacron/PTFE	Limb	Figure	Primary
Harrington[17]	Observation	Retrospective	Dacron/PTFE	Patient	Table	Primary
Jorgensen[24]	Observation	Retrospective	Not mentioned	Limb	Figure	Primary
Kalman[25]	Observation	Retrospective	Not mentioned	Patient	Figure	Primary
Mason[29]	Observation	Retrospective	Dacron/PTFE	Limb	Figure	Primary
Melliere[55]	Observation	Prospective	Dacron/PTFE/SFP vein	Patient	Table	Primary
Ng[35]	Observation	Retrospective	Not mentioned	Patient	Figure	Primary
Oliveira[37]	Observation	Retrospective	Not mentioned	Patient	Figure	Primary
Perler[40]	Observation	Retrospective	Dacron/PTFE	Patient	Figure	Primary
Piotrowski[41]	Observation	Retrospective	Not mentioned	Patient	Figure	Primary
Van der Vliet[49]	Observation	Retrospective	Dacron/PTFE	Patient	Table	Primary

Table 14 Study design and reported results of Aortoiliac Endarterectomy studies.

Author	Type of Study	Retrospective/Prospective	Unit of Observation	Source of data	Patency reported
Aguiar[9]	Observation	Prospective	Patient	Figure	Primary
Brewster[52]	Observation	Retrospective	Limb	Table	Primary
Butcher[12]	Observation	Retrospective	Patient	Table	Primary
Hsiang[19]	Observation	Retrospective	Patient	Figure	Primary
Inahara[20]	Observation	Prospective	Limb	Table	Primary
Melliere[31]	Observation	Retrospective	Patient	Table	Primary
Naylor[34]	Observation	Retrospective	Limb	Figure	Primary
Oertli[36]	Observation	Retrospective	Limb	Figure	Primary
Oskam[38]	Observation	Retrospective	Limb	Figure	Primary
Radoux[44]	Observation	Retrospective	Limb	Table	Primary
Vitale[50]	Observation	Retrospective	Limb	Table	Priamry

mortality remained unchanged. These results are similar to those observed by de Vries and colleagues with the exception that we did not reveal a statistically significant change in mortality rate.[7] As for IFB, patients were similar in age, less likely to have CLI, systemic morbidity rose, and minor morbidity and mortality remained unchanged. A factor to consider when analysing these results is that there may be overlaps between decades when the operations were carried out. We aggregated our results depending on when the studies were published.

The majority of these studies are retrospective observational studies with the exception of two prospective observational studies[9,31]and 3 randomised trials.[16,30,42] As none of the patients nor surgeons involved in any of the studies were blinded, these data may be biased. Although it is difficult to minimise problems such as selection, performance and detection bias as patients selected into the studies involved were determined by the authors of the studies, we attempted to minimise the effect by selecting studies with larger groups (i.e. studies involving more than 10 patients). We further attempted to minimise analysis bias by carrying out our statistical analysis by an external statistician with no prior knowledge in any of the techniques or preferences of the other authors.

Nearly half of the studies did not mention the types of grafts used in their studies. The majority of the remainder used a combination of Dacron and PTFE, while others used only Dacron, PTFE or superficial femoral vein. Amongst the studies that use a combination of graft materials, only 3 studies provided sufficient data to allow different types of grafts used to be separately analysed (Tables 12—14).[16,42,48] Thus further analysis on how different types of grafts affect patency were not carried out.

Only two studies reporting results for DTAF were identified as suitable for data extraction.[4,5] As one might expect, these data suggest that DTAF is associated with higher operative mortality and graft-related complication rates and lower 5-year patency rate than the other three techniques. However, as DTAF was not included in the statistical analysis it is difficult to draw robust conclusions.

In conclusion, the present review demonstrates that AIE is associated with significantly lower morbidity and mortality rates and equivalent patency rates to AFB and IFB. In appropriately selected patients AIE remains an acceptable, relatively low-risk and robust reconstruction. In patients who do not have a pattern of disease amenable to endarterectomy, AFB or IFB can provide equally effective long-term outcomes albeit with higher peri-operative risk. These data provide an important benchmark with which to compare the short- and long-term results of emerging endovascular interventions.

Conflict of Interest

None.

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