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Deep Femoral Vein Reconstruction for Abdominal Aortic Graft Infections is Associated with Low Aneurysm Related Mortality and a High Rate of Permanent Discontinuation of Antimicrobial Treatment☆

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WHAT THIS PAPER ADDS

This paper describes the experience of in situ reconstruction of aortic graft and endograft infections using autologous deep femoral vein and reports overall favourable patient outcomes from the procedure. In particular, the explantation of infected aortic endografts was not associated with increased mortality and morbidity, and freedom for antibiotic therapy after one year was high, indicating a high curative treatment rate. Post-operative renal damage was limited, even in patients in need of suprarenal clamping and permanent renal vein division. Autologous vein graft reconstruction of aortic graft and endograft infections represents a method of choice in these challenging patients.

Objective: Aortic prosthesis infection is a devastating complication of aortic surgery. In situ reconstruction with the neo-aorto-iliac system (NAIS) bypass technique has become increasingly used and is recommended in recent treatment guidelines. The main aim was to evaluate NAIS procedural outcomes when undertaken after previous open or endovascular aortic repair in Sweden.

Methods: In this retrospective study, The National Quality Registry for Vascular Surgery (Swedvasc) was used to identify Swedish centres that offered the NAIS bypass procedure for aortic prosthesis infection between 2008 and 2018. Variables of special interest were procedural details, short and long term survival, renal and other complications, and the durtion of antimicrobial treatment.

Results: Forty patients (36 males, four females [mean age 69 years], 32 open repairs, seven endovascular aortic repairs [EVAR] and one fenestrated EVAR; 21 presented with aorto-enteric fistula) operated on with NAIS bypass were reviewed. The median time from the primary aortic intervention to the NAIS bypass procedure was 32 months (range 0 − 252 months). Mean ± standard deviation operating time was 645 ± 160 minutes, mean blood loss was 6 277 ± 6 525 mL, mean length of intensive care unit stay was 5.3 ± 3.7 days, and mean length of overall hospital stay was 21.2 ± 11.4 days. Thirty-five patients (88%) had a positive microbial culture; the most commonly isolated pathogen was *Candida* spp. The majority of patients survived for 30 days ($n = 35$ [88%]), and 33 (83%) and 32 (80%) patients survived for 90 days and one year, respectively. The number of surviving patients free from antimicrobial treatment at 90 days, six months, and one year was 19 (58%), 29 (88%), and 30 (94%). After a mean long term follow up of 69.9 ± 44.7 months, 20 patients were still alive.

Conclusion: The NAIS bypass procedure offered reasonable survival and functional outcomes, and was associated with a high cure rate, defined as freedom from any antimicrobial treatment.

Keywords: Aortic aneurysm, Aorto-enteric fistulae, Bacterial agent, Deep femoral vein, EVAR, Explantation, FEVAR, Graft infection, NAIS, Open repair
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INTRODUCTION

Aortic graft infection is a devastating complication of both open (surgical) and endovascular aortic repair (EVAR).[1,2] Aortic graft infections may cause sepsis, aortic rupture, and aorto-enteric fistula (AEF), and therefore represent a major threat to the patient's life. Traditionally, abdominal aortic graft infections have been treated by removal of the aortic prosthesis, closure of the aortic stump below the renal arteries, surgical debridement of infected tissue, and extra-anatomic bypass. Five year patency rates for such extra-anatomic reconstructions range from 64% to 75% and have a risk of aortic stump rupture and subsequent life threatening haemorrhage as high as 27%, clearly highlighting the inherent limitations of such treatment strategies.[3] Other possible options in aortic graft infections include conservative approaches with long term antibiotics; however, persisting or recurrent septic complications and rupture remain obvious limitations.[4–6]

Neo-aorto-iliac system (NAIS) bypass for the surgical treatment of abdominal aortic infection was first described by Clagett *et al.*[7,8] During this procedure, the infected prosthesis is removed and replaced with a graft constructed from autologous femoral vein. This technique has been proposed as a more robust surgical alternative, with promising short and long term follow up results.[8–11] The NAIS bypass procedure is also acknowledged as the treatment of choice in the recently published European guidelines for abdominal aortic graft infections.[3]

However, the NAIS bypass procedure has not yet gained full national acceptance as the first line treatment for aortic graft/endograft infections in Sweden. Therefore the aim of this study was to investigate important aspects of the surgical management in patients, including those with an infected endograft offered the NAIS bypass procedure in Sweden, and to determine overall patient outcomes, including long term survival, renal function, and rates of antibiotic treatment discontinuation.

MATERIAL AND METHODS

Study design

The national quality registry in Sweden (Swedvasc) was used to identify eligible centres in Sweden offering the NAIS bypass procedure during the period 2008 – 2018. The Swedvasc registry has full national coverage of all vascular surgical procedures undertaken in Sweden and has established internal and external validation.[12] Centres with an established NAIS service that had performed more than one procedure during the study period were invited to participate. All accepting centres were subsequently contacted, and details of clinical presentation, indications, bacteriology, procedures performed, surgical complications, and outcomes for all NAIS bypass cases were provided by centres based on a predefined variable list and were subsequently extracted by review of the medical charts.

The study was approved by the Regional Ethical Review Board at the University of Gothenburg, Sweden (reference number 1006-15).

Statistical analysis

Descriptive statistics are presented as mean $\pm$ standard deviation or median (interquartile range [IQR]) for continuous data as appropriate, while absolute numbers and percentages are presented for categorical variables. Fisher's exact test was used for survival comparisons between subgroups (explanted endografts *vs.* explanted surgical grafts and supra *vs.* infrarenal clamping), and the Wilcoxon signed ranks test was used to compare renal function parameters from admission to discharge in the overall population and in the subgroups operated on with supra- and infrarenal aortic cross clamping. A Spearman rank correlation test was used to investigate the correlation between AEF and mortality. Statistical analyses were performed with SPSS Statistics software version 23 (IBM, Armonk, NY, USA).

RESULTS

Patient population

Forty patients operated on at five different centres were identified and included in the study. The mean patient age was 69 $\pm$ 6.5 years and the overall median time from primary reconstruction to the NAIS procedure was 2.6 years (range 0 – 252 months). Thirty-two patients had previously been treated with a primary open abdominal aortic repair, seven had undergone a primary EVAR procedure, and one had undergone a primary fenestrated EVAR (two fenestrations). Four patients were treated with a bridge to surgery approach and had a proximal aortic cuff placed as an emergency following admission with AEF, resulting in 12 patients overall with endografts in the aorta that subsequently underwent the NAIS bypass procedure. The four patients who received bridge to surgery management underwent NAIS bypass a mean of 43 days (range 27 – 60 days) after receiving emergency stent grafting. At discharge, 30 patients had a complete recovery and four returned home but required some daily life assistance. Patient characteristics are summarised in Table 1.

Logistical and procedure specific aspects

All but one centre used two surgical teams with simultaneous deep vein harvesting and abdominal dissection, and all centres used a back table for construction of the vein graft. Twenty two of 40 patients were operated on by one surgical team only. There were no significant differences in overall operating times between the one and two surgical team approaches; however, bilateral deep vein harvest was done in 89% of cases with a two team approach *vs.* 45% in the single team approach ($p = .68$). All but one centre used the V patch reconstruction type for the proximal

Table 1. Patient characteristics, peri-operative observations and deep vein reconstruction types in 40 patients treated with neo-aorto-iliac system (NAIS) bypass with deep femoral vein reconstruction for aortic prosthesis infection between 2008 and 2018 in Sweden

	Patients (n = 40)
Baseline patient characteristics	
Age – y	69 ± 6.5
Baseline creatinine – µmol/L	93 ± 37
Male sex	36 (90)
Hypertension	31 (78)
Diabetes	6 (15)
Sepsis at admission	12 (30)
Patients with aorto-enteric fistula	21 (53)
Bridge to surgery	4 (10)
EVAR/FEVAR	8 (20)
ASA class	
1	0 (0)
2	7 (18)
3	24 (60)
4	6 (15)
5	1 (3)
Peri- and post-operative observations	
Operating time – min	626 ± 160
Peri-operative blood loss – mL	6 097 ± 5 864
Discharge creatinine – µmol/L	120 ± 83
Hospital length of stay – d	22.9 ± 20.1
ICU length of stay – d	5.0 ± 3.6
Type of NAIS reconstruction	
Aorto-bi-iliac graft with v-patch	19 (48)
Aorto-uni-iliac graft with v-patch	8 (20)
Aorto-uni-iliac graft with femorofemoral crossover	1 (3)
Aorto-bifemoral graft	2 (5)
Aorto-bifemoral graft with v-patch	1 (2)
Tube graft	2 (5)
Tube graft with proximal and distal v-patch	7 (18)

Data are presented as n (%) or mean ± standard deviation. EVAR = endovascular aortic repair; FEVAR = fenestrated endovascular aortic repair; ASA=American Society of Anesthesiologists; ICU = Intensive Care Unit.

anastomosis (Fig. 1), and one centre used a common main body bi-iliac reconstruction as their primary choice. All centres used non-resorbable monofilament sutures (3-0 for proximal anastomosis, 4-0 for iliac anastomosis, and 5-0 for vein-vein anastomosis).

Details regarding vein graft harvesting

The majority (n = 36/40) of patients underwent ultrasound scanning to determine deep vein status, and to identify vein diameter, vein patency, duplicated vein trunks, and the presence or absence of great saphenous vein. The other four patients were analysed by computed tomography scanning. Only one patient was reconstructed with a simultaneous femorofemoral crossover bypass, in which case a cephalic vein was used. None of the centres used an absolute cutoff level regarding vein diameter, but a deep vein diameter of at least 7 – 8 mm was preferred. The great saphenous vein, as well as the profunda femoris vein, were left intact whenever possible. The superficial femoral vein was exposed via an incision lateral to the sartorius muscle, and the proximal end of the femoral vein was clamped, transected, and sutured flush to the profunda vein, to avoid thrombus formation in the proximal stump. All vein graft vessel branches were sutured with 6-0 or 5-0 monofilament suture. Post-operative lower limb compression therapy was initiated in all patients in the immediate post-operative phase and was recommended for three months by all surgical centres. For post-operative anticoagulation, four of the five centres used low molecular weight heparin (LMWH) for two to four weeks (34 patients) post-operatively and one centre used LMWH or oral anticoagulation for six months (n = 6). Bilateral deep vein harvesting was performed in the majority of patients (n = 26).

Peri-operative details

One patient underwent emergency NAIS bypass repair, 23 patients were operated on in a subacute setting, and 16 underwent an elective procedure (> 2 weeks after diagnosis). Mean operating time was 645 ± 160) minutes, mean blood loss was 6 277 ± 6 525 mL, mean length of intensive care unit stay was 5.3 ± 3.7 days, and mean length of hospital stay was mean 21.2 ± 11.4 days (Table 1). Almost 50% (n = 19) of the patients needed suprarenal clamping during graft explantation for anatomical reasons or owing to a concomitant endograft with suprarenal fixation. Twenty-one patients had an AEF of whom four underwent pyloric exclusion performed by a gastrointestinal surgeon; 15/17 of

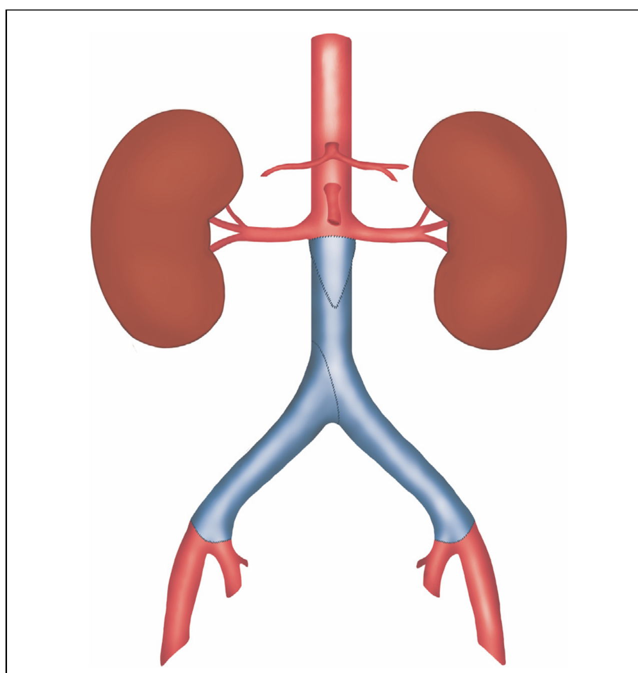

Figure 1. Illustration of the tapered neo-aorto-iliac system (NAIS) bypass V-patch vein graft (blue), representing the most common deep vein reconstruction type in the study of patients treated with NAIS bypass for aortic prothesis infection.

the remaining AEFs were suture repaired by a vascular surgeon. Two main approaches to clamp the aorta were used. In seven patients with an endograft and in two patients with a conventional aortic graft, aortic balloon occlusion via the left axillary artery was used,[13] whereas the remaining 31 patients had standard aortic clamping. Eight patients requiring suprarenal clamping also underwent left renal vein division without re-attachment. The synthetic graft or covered stent graft was explanted in all patients ($n = 40$), but the suprarenal uncovered barbs were partially left in place in two cases due to intimal overgrowth. All patients were reconstructed with autologous deep femoral veins. The most common vein reconstruction was the aorto-bi-iliac vein graft with a tapered proximal vein patch, a reconstruction that was used in 48% of cases (Fig. 1). A summary of all used vein reconstructions is shown in Table 1.

Mortality

The overall mortality rate at 30 days (including in hospital mortality) was 13% ($n = 5$), increasing to 18% ($n = 7$) at 90 days, while the one year mortality rate was 20% ($n = 8$). The majority of deaths occurred in the early post-operative phase, and all but one death during the first post-operative year were aorta related. There were no deaths within 30 days in patients with an explanted endograft ($n = 12$) *vs.* an 18% mortality rate in patients without an endograft ($p = .29$), and no significant difference in 30 day mortality was observed between patients with suprarenal and infrarenal cross clamping (n = 2/19, 10.5% *vs.* 3/21, 14.3%; $p = .99$). The presence of an AEF did not increase the 90 day mortality rate ($p = .27$).

Mean length of follow up was 5.8 years and the observed all cause mortality rate during this period was 50% while the aorta specific mortality rate was 15%.

Renal function and procedural complications

A transient creatinine level increase was observed that was largely independent of clamp site (suprarenal/infrarenal), although a small residual creatinine increase *vs.* creatinine level on admission was observed at discharge in patients who had undergone suprarenal clamping (Table 2). All patients who had left renal vein division were placed in the suprarenal cross clamping group. Two patients needed transient dialysis during the post-operative period, but no patient remained permanently on renal replacement therapy.

Overall, post-operative complications occurred in 52% of patients. The most common surgical complication was bleeding ($n = 10$), whereas the second most common complication was transient moderate swelling of the lower extremities in the early post-operative phase ($n = 8/40$). Only one patient (who after two months underwent ipsilateral major amputation) needed fasciotomy of the lower limbs following the deep vein harvest, and there were no surgical site infections at the deep vein harvest sites. Re-interventions were undertaken in 11 patients and occurred within a median time of 7 days (IQR 1–20) following the NAIS bypass procedure. A summary of surgical and non-surgical complications are shown in Table 3, and the types and indications for all re-interventions are shown in Table 4.

Microbial agents and discontinuation of antibiotic therapy

The most common bacterial agent was a coagulase negative *Staphylococcus* bacterium, followed by *Bacteroides fragilis* and *Enterococcus faecalis*. A complete list of isolated microbial agents is given in Table 5. Interestingly, 25% of patients had a concomitant fungal infection. Thirty-six patients had a positive bacterial culture in either blood, graft tissue, or both (positive culture in blood, $n = 26$; graft/tissue, $n = 22$). Blood cultures were taken pre-operatively and tissue samples peri-operatively.

At 90 days post-operatively, 19/33 (58%) of the surviving patients had permanently discontinued antimicrobial treatment; this increased to 29 (88%) at six months. Overall, 94% ($n = 30$) of surviving patients were completely free from antimicrobial treatment at one year (Fig. 2).

DISCUSSION

Aorto-enteric graft and endograft infections that are left untreated or are treated conservatively with antibiotic therapy confer a poor patient prognosis.[14–16] In this population based Swedish cohort, curatively aimed treatment with the NAIS bypass procedure resulted in reasonably low short and long term mortality rates. The majority of deaths occurred in the early post-operative phase and a clear majority of surviving patients were permanently cured, as indicated by the high rate of antimicrobial treatment discontinuation during follow up. In terms of lower limb complications, no surgical site infections were identified in

Table 2. Renal function in relationship to aortic cross clamping site in 40 patients treated with neo-aorto-iliac system bypass with deep femoral vein reconstruction for aortic prosthesis infection

Aortic cross clamping site	*n*	Serum creatinine			*p* value, admission *vs.* maximum	*p* value, admission *vs.* discharge
		At admission	At maximum	At discharge		
Suprarenal clamping	19	103 (76–121)	235 (177–328)	118 (80–220)	.001	.047
Infrarenal clamping	21	79 (63–93)	110 (75–133)	81 (58–114)	.001	.96
Total	40	83 (69–114)	144 (91–290)	98 (68–132)	.001	.081

Data are presented as median (interquartile range).

Table 3. Post-operative complications in 40 patients treated with neo-aorto-iliac system (NAIS) bypass with deep femoral vein reconstruction for aortic prosthesis infection between 2008 and 2018 in Sweden

	Patients (n = 40)
Surgical complications	
No surgical complications	19 (48)
Haemorrhage	10 (25)
Bowel ischaemia	3 (8)
Lower extremity ischaemia	2 (5)
Renal artery stenosis	2 (5)
Abscess formation	2 (5)
Iatrogenic renal artery damage	1 (3)
Fasciotomy	1 (3)
Amputation	1 (3)
Other complications	
No other complications	13 (33)
Myocardial infarction	3 (8)
Acute kidney injury, > 50% increase from pre-operative creatinine	7 (18)
Need for intermittent dialysis	2 (5)
Deep vein thrombosis	2 (5)
Moderate swelling of lower extremity	8 (20)
Pulmonary embolism	2 (5)
Severe confusion	1 (3)
Pneumonia or respiratory failure	2 (5)

Data are presented as n (%).

the lower extremities, which has previously been a concern and some authors advocate primary closure of the deep vein extraction site before laparotomy.[9] Despite eight patients with transient swelling of the legs, more severe complications associated with vein harvesting were few, although one patient in the study cohort required fasciotomy and underwent major amputation two months later. Two patients had pulmonary emboli during the post-operative phase (Table 3), which may or may not be attributable to the deep vein harvesting, but only one patient developed venous compartment syndrome. Ali *et al.* reported fasciotomy rates as high as 12% in a large cohort of 187 patients, which contrasts with the present findings.[11] The low number of fasciotomies in the current series may be explained by a more uncertain estimate due to the smaller sample size, but the results may also indicate that deep vein harvesting is well tolerated as long as the profunda vein is spared and adequate compression therapy is initiated directly in the early post-operative phase.

Aortic graft infection is associated with high overall morbidity and mortality.[17–19] This complication occurs not only after open aortic procedures, but also after endovascular aortic repair.[20] There has been increasing interest in *in situ* reconstructions, as conservative treatment and extra-anatomical reconstruction with ligation of the infrarenal aorta have shown poor results, with a residual risk of aortic stump blowout and extra-anatomic graft failure leading to limb amputation.[21,22] Thus, extra-anatomic reconstruction is no longer considered the method of choice (either in primary mycotic aortic pathology or when operating on an infected aortic graft/stent graft reconstruction), and the most recent European treatment guidelines now endorse the NAIS bypass procedure for definitive repair.[3] The role of endovascular repair in aortic graft infections is uncertain, although it may have a role as a bridging procedure in patients presenting with AEF. However, re-infection rates remain high (69% – 83%) if the graft is not subsequently explanted.[13,15,16,23] In this series, all four patients who were treated with an endovascular cuff due to AEF and thereafter underwent NAIS bypass surgery were alive at one year.

Deep femoral vein reconstruction of the aorta is a complex and time consuming procedure, which may have resulted in a certain threshold among vascular surgeons to offer the surgery routinely and perform it, especially given the low centre caseload for the procedure in most countries. The operating times in the current series were long, and the use of a two team approach did not seem to impact substantially on operating times. However, in 89% of cases where bilateral femoral veins were harvested a two team approach was used as opposed to one. This indicated a decreased operating time with the two team approach in cases requiring a more extensive vein harvest. Moreover, it has previously been shown that overcoming the initial NAIS bypass learning curve markedly decreased the overall operating time,[13] emphasising the importance of centre caseload as an important factor in reducing procedure times. Pre-treated vascular grafts, such as rifampicin soaked synthetic grafts, have been proposed in low grade infections, although these are prone to re-infection.[24] Other reconstruction possibilities to simplify the procedure have also recently been suggested as tentative alternatives. Self made biological grafts constructed as xenopericardial tubes may eliminate the need for deep vein harvesting, although long term results are lacking.[25,26] Other possibilities involve

Table 4. Post-operative re-interventions in 40 patients treated with neo-aorto-iliac system bypass with deep femoral vein reconstruction for aortic prothesis infection between 2008 and 2018 in Sweden

	Patients (n = 40)
Type of re-intervention	
No re-interventions	29 (73)
PTA	1 (3)
Patch angioplasty	4 (10)
Stent graft	2 (5)
Colorectal resection	3 (8)
Thrombectomy	1 (3)
Indication for re-intervention	
Vein limb occlusion	1 (3)
Vein limb stenosis	1 (3)
Anastomotic pseudoaneurysm	2 (5)
Duodenal blowout	1 (3)
Bowel ischaemia	3 (8)
Vein rupture	3 (8)

Data are presented as n (%). PTA = percutaneous transluminal angioplasty.

Table 5. The different microbes detected in cultures in 40 patients treated with neo-aorto-iliac system bypass with deep femoral vein reconstruction for aortic prothesis infection between 2008 and 2018 in Sweden

Bacterial culture	Patients (n = 40)
Candida	10 (25)
Coagulase negative *Staphylococcus*	8 (20)
Bacteroides fragilis	6 (15)
Enterococcus faecalis	6 (15)
Staphylococcus aureus	5 (13)
Alpha *Streptococcus*	5 (13)
Escherichia coli	4 (10)
Streptococcus anginosus	3 (8)
Klebsiella	3 (8)
Prevotella	2 (5)
Propionibacteria	2 (5)
Lactobacillus	2 (5)
Proteus vulgaris	1 (3)
Moraxella catarrhalis	1 (3)
Citrobacter	1 (3)
Haemophilus parainfluenzae	1 (3)
Corynebacteria	1 (3)

Data are presented as n (%).

the use of cryopreserved arterial and venous allografts, where especially the latter seems like a viable option, particularly in cases where the deep veins are unsuitable.[27] However, cryopreserved grafts are not readily accessible for most vascular centres and dedicated cryopreservation programmes are currently only available in two Swedish university hospitals.

Several studies of the outcomes of the NAIS bypass procedure in aortic graft infection confirm a high procedural feasibility and low re-infection rates, as well as favourable patency and acceptable morbidity and mortality rates.[28,29] One year survival data in the present study were closely comparable to data from the study by Heinola *et al.*,[29] as were the observed 30 day and in hospital mortality rates (13% *vs.* 9% and 15% *vs.* 13 %, respectively). These more recent results have thus largely replicated the promising and durable results initially reported by Clagett *et al.*[7,8] The fact that the surgical results have been possible to replicate by several centres lends further support to the applicability and durability of the procedure. The operating technique remains similar to when it was introduced, although endovascular bridging procedures have been added to the overall management.[13,29,30] In the present series the clinical course and survival following endograft explantation were at least as good as for grafts inserted with an open technique, which strengthens the usability of endovascular bridging procedures in acute bleeding situations due to AEF. This is important information as other authors have suggested that explantation of an infected EVAR would be associated with a particularly poor outcome.[14,31] By contrast, no 30 day mortality was seen in patients with an explanted endograft, whereas patients who had conventional aortic grafts explanted had a 30 day mortality rate of 18%. These findings may be explained by the fact that some of the endograft explantation patients were managed with bridge to surgery endograft insertion (i.e., converting the need for an emergency procedure to a semi-elective situation). Whenever possible, endografts with suprarenal fixation in bridge to surgery procedures should be avoided, in order to facilitate a subsequent stent graft explantation, but in the authors' experience, and in light of the current study, the existence of suprarenally fixated or even fenestrated aortic stent grafts is not a contraindication for attempting the explantation procedure. Although 50% of the patients in the present study needed suprarenal clamping, renal function was practically normalised during the in hospital stay, indicating that the clinical implication of suprarenal clamping is marginal.

As expected, the most common bacterial agent was coagulase negative *Staphylococcus*, whereas other agents with known foreign body affinity such as *B. fragilis* and *E. faecalis* were also quite common. Interestingly, the most common cultured microbiological agent was the fungus *Candida*, suggesting that this pathogen should be treated

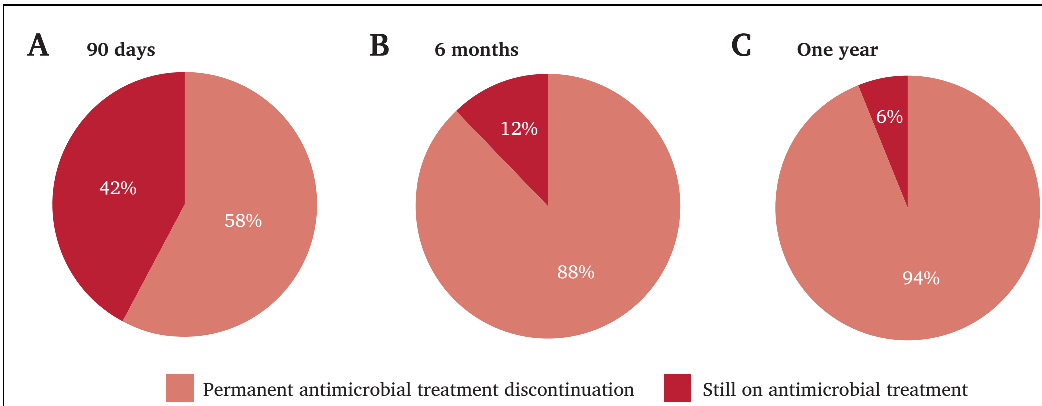

Figure 2. Rates of antimicrobial treatment discontinuation (A) 90 days, (B) six months, and (C) one year after the neo-aorto-iliac system bypass procedure with deep femoral vein reconstruction for aortic prothesis infection between 2008 and 2018 in Sweden.

empirically in the pre-operative phase in order to minimise the risk of graft dehiscence due to invasive *Candida* infection.

This study has limitations that are mainly due to inherent caveats within its retrospective design, and also arise as a result of the relatively small patient population and lack of a control group. However, the study sample was population based and multiple centres contributed data, which strengthens the generalisability of the results and may therefore reflect the everyday outcomes of the NAIS bypass procedure in the treatment of aortic graft/endograft infections. Further improvement of overall surgical management, operating time, blood loss, and procedural outcomes may be possible with increased centralisation in order for dedicated centres and vascular surgery teams to gain more experience about the risks and pitfalls associated with the NAIS procedure when undertaken for aortic prosthesis infections.

Conclusion

The mortality and morbidity rates after the NAIS bypass procedure for aortic graft/endograft infection are acceptable given the underlying severity of the disease if left surgically untreated. Although suprarenal clamping may influence renal function to some degree, the clinical implication seems low. The curative rate of the NAIS bypass procedure is high as almost all surviving patients had permanently discontinued antimicrobial treatment after one year. Antimicrobial treatment addressing the *Candida* infection in the pre-operative setting is advisable.

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CONFLICT OF INTERESTS

None.

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