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Treatment modalities in failed aortic endografts: comparing outcomes after open versus endovascular repair

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Disclosures

- None

Introduction

- Increased utilization of EVAR has resulted in associated increase in EVAR failure over the past decade, especially with device applications outside of IFU
- Rupture rates between 0.5 to 1.2% per patient per year following EVAR²
- Treatment strategies for failed EVAR: endovascular vs open
- Reintervention rates of 6% at 1 year, 16% at 3 years, and 21% at 5 years with endovascular salvage^{1,4,5}
- Average incidence of EVAR explant of 3.7%³

Study Aims

- Compare outcomes of open versus endovascular salvage of failed EVAR
 - 30-day mortality
 - Residual endoleak and sac growth
 - Need for re-intervention

Methods

- Single institution
- Retrospective analysis of a prospectively collected, institutional aortic database
- 2014 to 2019
- Failed EVAR = type I or III endoleak, sac growth, rupture, infection
- Salvage techniques:
 - Endovascular (EV)
 - Open
 - Hybrid

Methods

- EV: endoanchors, embolization, proximal cuff, cuff + snorkel/chimney, cuff + snorkel/chimney + limb extension, limb extension, relining, FEVAR
- Open: explant
 - Aortobifemoral bypass, axillo-bifemoral bypass, aortic interposition graft, sac exploration, plication, and ligation of lumbar arteries or inferior mesenteric artery
- Hybrid
 - AUI, femoral-femoral bypass
 - EV + exploratory laparotomy
 - EV + carotid-carotid bypass, carotid transposition
 - EV + groin I&D

Results

- 190 patients in aortic database, 24 excluded
 - Exclusion criteria:
 - No previous EVAR
 - Open repair as index operation
 - Failed EVAR but refusing re-intervention
- 139 patients, 166 salvage procedures
 - 105 endovascular (63.25%), 44 open (26.52%), 17 hybrid (10.24%)
- Index operations:
 - 77.71% (n=129) at outside hospital
 - EVAR > FEVAR = TEVAR > AUI

Results

Table 1: Demographics by salvage type

Characteristics	Overall n (%)	Endovascular n (%)	Open n (%)	Hybrid n (%)
# of interventions	166	105 (63.25)	44 (26.51)	17 (10.24)
Males	146 (87.95)	89 (84.76)	41 (93.18)	16 (94.12)
Females	20 (12.05)	16 (15.24)	3 (6.82)	1 (5.88)
Average Age	76.97	78.6	72.5	78.59
Ever smokers	143 (86.14)	90 (85.71)	38 (86.36)	15 (88.24)
White	159 (95.78)	101 (96.19)	41 (93.18)	17 (100)
COPD	46 (27.71)	25 (23.81)	15 (34.09)	6 (35.29)
CAD	94 (56.63)	61 (58.01)	23 (52.57)	10 (58.82)
CVD	35 (21.08)	21 (20)	9 (20.45)	5 (29.41)
CKD without RRT	41 (24.99)	25 (23.81)	11 (25)	5 (29.41)
CKD with RRT	7 (4.21)	6 (5.71)	12 (2.27)	0 (0)
HTN	153 (92.12)	94 (89.52)	43 (97.73)	16 (94.12)
DM	31 (18.67)	17 (16.19)	10 (22.73)	4 (23.53)

Results

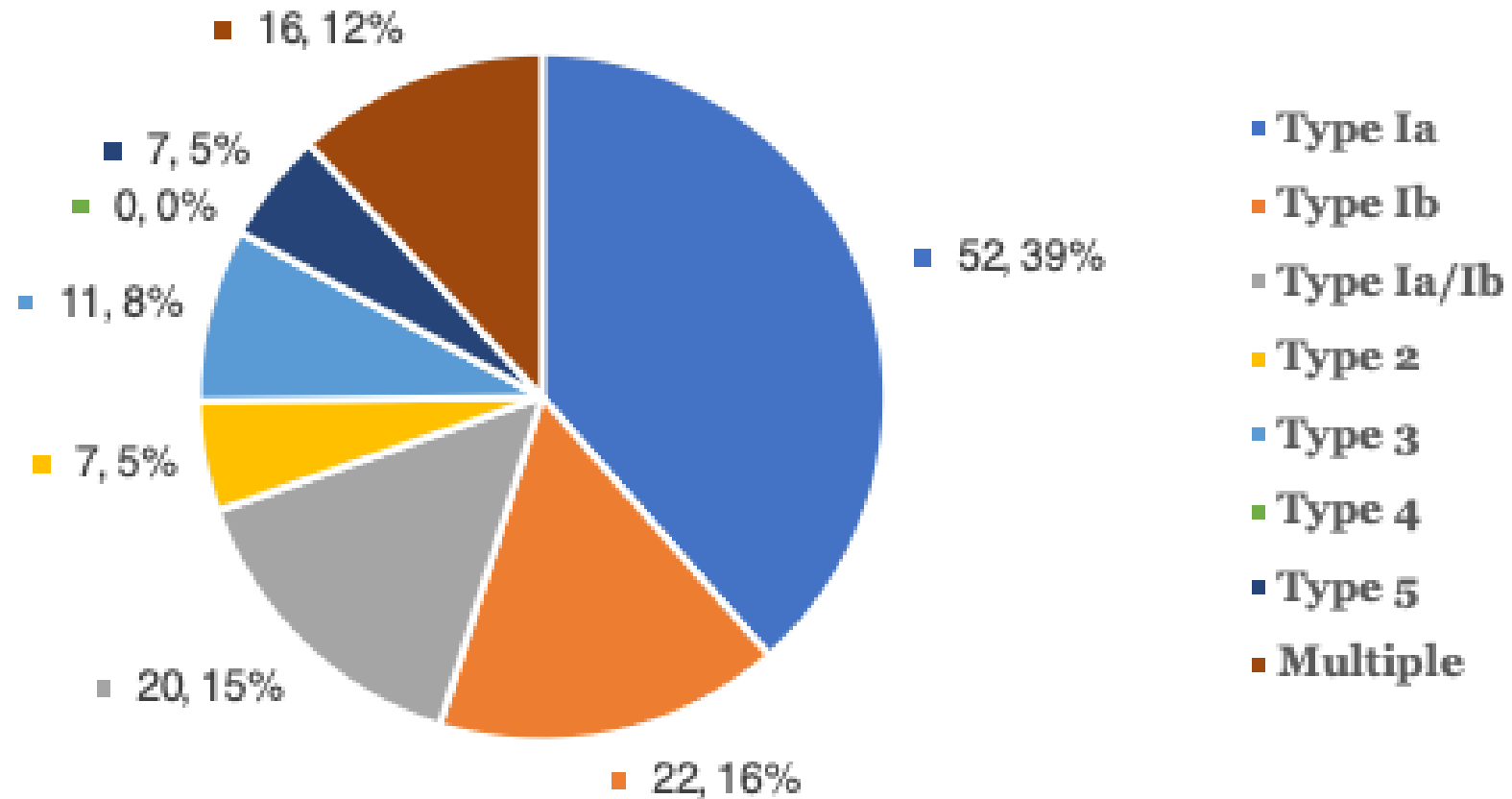
Table 2: Mechanism of failure by salvage type

	Endoleak % (n)	Rupture % (n)	Stenosis/ Occlusion % (n)	Infection % (n)	Other % (n)
Endovascular	93.33 (98)	3.81 (4)	0.95 (1)	0 (0)	1.9% (2)
Open	50 (22)	13.64 (6)	0 (0)	36.36 (16)	0 (0)
Hybrid	88.24 (15)	11.76 (2)	0 (0)	0 (0)	0 (0)

- Indication “other”
 1. Index procedure aborted due to intraoperative instability; limb left floating
 2. Acute type B dissection causing crushed stent
- Average time since index: 70.5 +/- 49.95 months

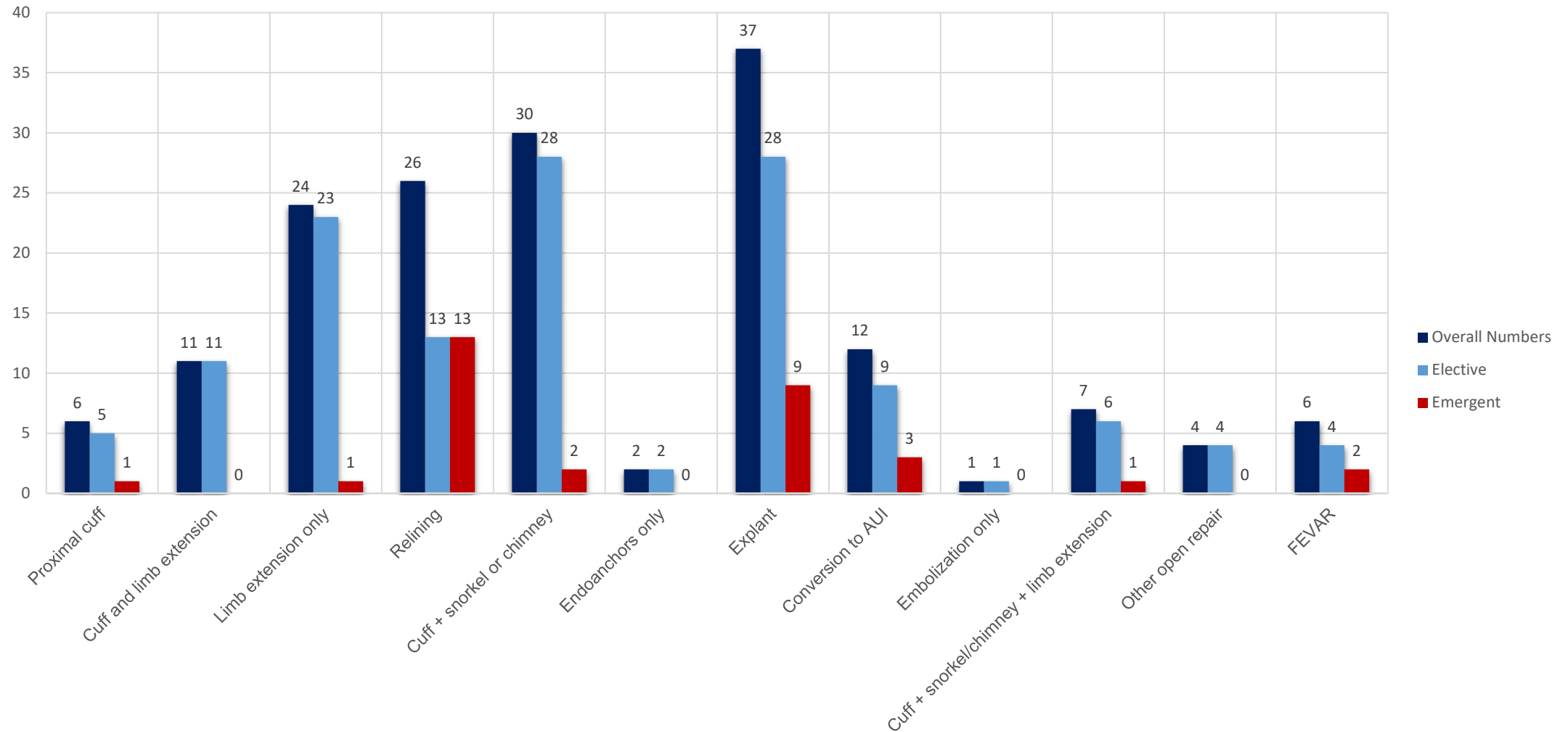
Results

Types of Endoleaks



Results

Method of EVAR Salvage



Results

- “Other open repair,” n = 4
 1. Type 2 endoleak from paired right renal arteries → renal artery ligation x 2, hepato-renal bypass
 2. Contained rupture → sac exploration, repair of material of distal L iliac limb
 3. Persistent type 1b and 2 endoleaks → sac exploration, ligation of lumbar arteries and IMA, repair of left iliac limb, plication of aneurysm sac
 4. Contained rupture with known type 2 endoleak → plication of proximal neck and aneurysm sac, removal of thrombus, lumbar arteries oversewn

Results

Urgency of Revision

- Emergent: n = 32 (19.28%)
 - EV salvage: n = 20 (62.5%)
 - Open: n = 9 (28.13%)
 - Hybrid: n = 3 (9.38%)
 - Most common: reline (n = 13, 40.63%), explant (n = 9, 28.13%), conversion to AUI (n = 3, 9.38%)
- Elective: n = 134 (80.72%)
 - EV: n = 93 (69.40%)
 - Open: n = 32 (23.88%)
 - Hybrid: n = 9 (6.72%)
 - Most common: cuff with snorkel/chimney (n = 28, 20.9%), explant (n=27, 20.15%), limb extension (n = 23, 17.16%)

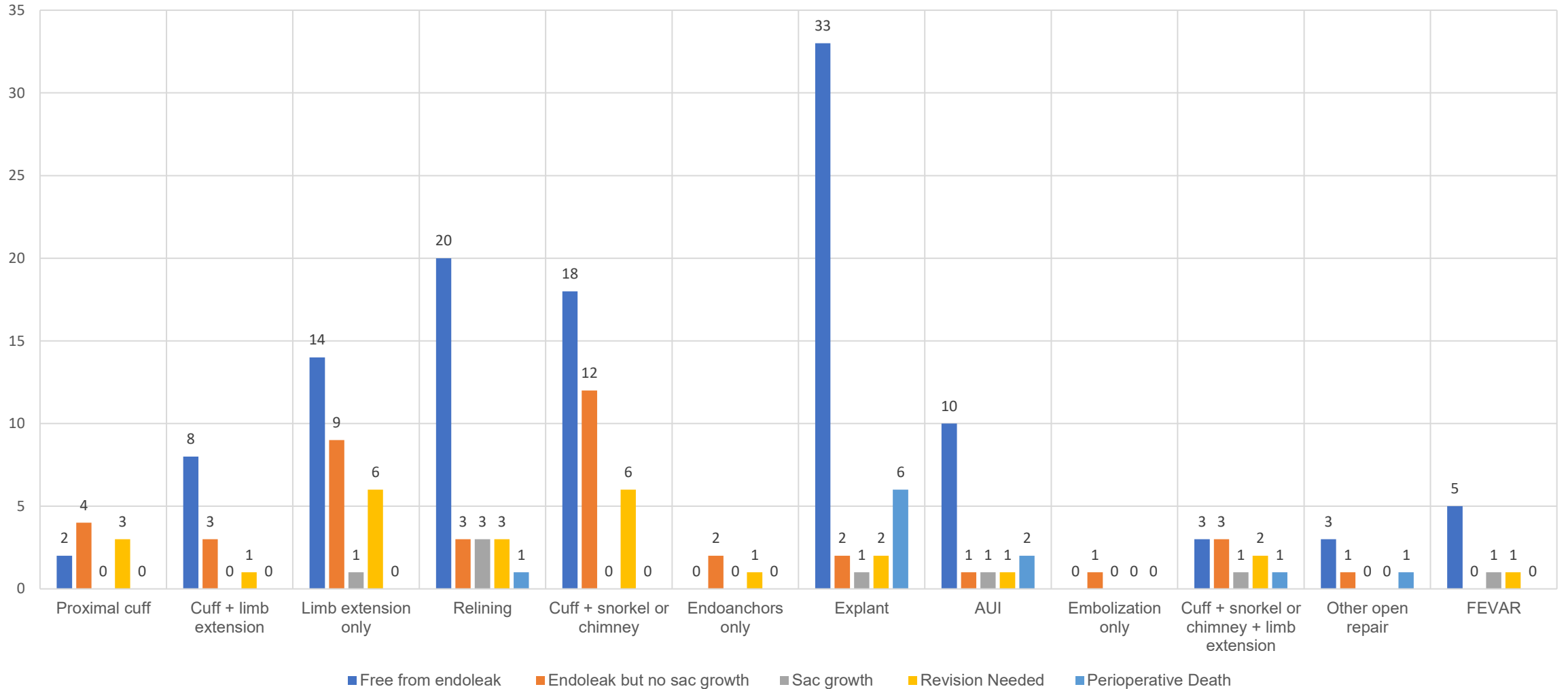
Results

Table 3: Outcomes by salvage type

Repair	No endoleak (n = 116)	Endoleak, no sac growth (n = 41)	Sac growth (n = 8)	30-day mortality, elective (n = 5)	30-day mortality, emergent (n = 6)	Further reintervention (n = 26)
Cuff (n = 6)	2 (33.33)	4 (66.67)	0 (0)	0 (0)	0 (0)	3 (50)
Cuff + limb extension (n = 11)	8 (72.73)	3 (27.27)	0 (0)	0 (0)	0 (0)	1 (9.09)
Limb extension (n = 24)	14 (58.33)	9 (37.5)	1 (4.17)	0 (0)	0 (0)	6 (25)
Cuff + snorkel or chimney (n = 30)	18 (60)	12 (40)	0 (0)	0 (0)	0 (0)	6 (20)
Cuff + snorkel or chimney + limb extension (n = 7)	3 (42.86)	3 (42.86)	1 (14.29)	1 (14.29)	0 (0)	2 (28.57)
Endoanchors (n = 2)	0 (0)	2 (100)	0 (0)	0 (0)	0 (0)	1 (50)
Embolization (n = 1)	0 (0)	1 (100)	0 (0)	0 (0)	0 (0)	0 (0)
AUI (n = 12)	10 (83.33)	1 (8.33)	1 (8.33)	1 (8.33)	1 (8.33)	1 (8.33)
FEVAR (n = 6)	5 (83.33)	0 (0)	1 (16.67)	0 (0)	0 (0)	1 (16.67)
Relining (n = 26)	20 (76.92)	3 (11.54)	3 (11.54)	0 (0)	1 (3.85)	3 (11.54)
Explant (n = 37)	33 (89.19)	2 (5.4)	1 (2.7)	2 (5.41)	4 (10.81)	2 (5.41)
Other open repair (n = 4)	3 (75)	1 (25)	0 (0)	1 (25)	0 (0)	0 (0)

Results

Outcomes According to Salvage Technique



Results

- Average follow up time: 341.13 +/- 500.55 days
- Perioperative mortality (<= 30 days)
 - 11 deaths (6.63%)
 - 6 open (4 emergent); 3.6%
 - 2 hybrid; 1.2%
 - Both conversions to AUI (1 emergent)
 - 3 endovascular; 1.8%
 - 1 relining (emergent; death intra-operative)
 - 1 cuff + snorkel/chimney + limb extension
 - 1 other open repair

Discussion

- EVAR has become the preferred treatment modality in aortic aneurysm repair with more than 70% of elective AAA repairs in the US performed with EVAR⁵
- With increased utilization comes increased EVAR failure, with a reintervention rate of 6% at 1 year¹ and an average incidence of EVAR explant of 3.7%³
- In our experience, endovascular salvage was attempted more often than open, even in emergent cases (relining > explant > conversion to AUI)
 - Emergent cases included type 3 endoleaks with rapid sac expansion, symptomatic limb kinking – not in extremis?
 - Aortic center with providers very skilled at complex endovascular – faster than open?

Discussion

- Re-intervention following endovascular salvage was 21.9% (6% 1-year re-intervention in prior studies)⁴
 - Higher technical difficulty at tertiary referral center with use of FEVAR and chimney/snorkels increasing risk of gutter leaks?
- Open and hybrid repairs had lower incidences of revision (4.55% and 5.9%, respectively)
- Limb extension as well as cuff + chimney were associated with highest reintervention despite being associated with sac growth in only 1 case each (associated with EL without sac growth in 9 and 3 cases, respectively)
 - Likely repaired before sac growth could be appreciated on grounds of type I endoleak

Discussion

- Similar to prior studies, endoleak was the most common indication for revision in both open and endovascular salvage; most common = type I (especially Ia)
- Cases of graft infection were solely treated with explant
- Explant had the highest freedom from endoleak, as expected, followed by relining. Relining, however, also demonstrated the highest incidence of post-operative sac growth
 - N for sac growth very low, and relining one of the most common techniques performed?

Discussion

- 30 day mortality was highest in explant in both emergent and elective cases.
- Perioperative mortality of 3.6% in open repair is lower than early studies quoting up to 24% and more contemporary studies quoting up to 5%
 - Low numbers
 - Only 9 emergent compared to 28 elective

Discussion

- Weaknesses
 - Retrospective
 - Only the year of the index operation was recorded, making a more accurate calculation of time to reintervention difficult
 - No record of graft type used in index operation
 - Tertiary care center – receives patients who have exhausted most if not all endovascular salvage options; explant numbers high in elective cases
 - Many patients lost to follow up – further revisions performed at an outside institution?

Conclusions

- Endovascular techniques of failed EVAR salvage are associated with lower mortality than graft explant but with higher rates of residual or recurrent endoleak requiring more re-intervention procedures and closer follow up
- Graft explant is associated with a higher mortality rate than endovascular, though at only 5% in contemporary studies and 3.6% in our study, it certainly does not preclude explant for failed EVAR
- Failed EVAR salvage should be tailored to the individual patient, etiology of device failure, and skill set of the provider

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