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Multicenter comparison between open conversions and semi-conversions for late endoleaks after endovascular aneurysm repair

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Abstract

Objective

The aim of this study is to compare early and follow-up outcomes of late open conversions (LOC, with complete or partial endograft explantation) and semi-conversions (SC, with endograft preservation) after endovascular aneurysm repair in a multicenter experience.

Methods

All LOC and SC performed from 1997 to 2020 in 11 vascular centers were compared. Endograft infections or thrombosis were excluded. Primary endpoints were early mortality and long-term survival estimates. Secondary endpoints were differences in postoperative complication rates and conversion-related complications during follow-up.

Results

In the considered period, 347 patients underwent surgery for endovascular aneurysm repair complications. Among these, 270 were operated on for endoleaks (222 LOC, 48 SC). The two groups were homogeneous in terms of American Society of Anesthesiologists score (LOC, 3.2 ± 0.7; SC, 3 ± 0.5; P = .128) and main endograft characteristics (suprarenal fixation, bifurcated/aorto-uni-iliac configuration). The mean age was 75 ± 8 years for LOC and 79 ± 7 years for SC (P = .009). Reasons for LOC were: 62.2% (138/222) type I endoleak, 21.6% (48/222) type II endoleak, 7.7% (17/222) type III endoleak, and 8.5% (19/222) endotension. Indications for SC were: 64.6% (31/48) type II endoleak, 33.3% (16/48) type I endoleak, and 2.1% (1/48) type III endoleak. Thirty-day mortality was 12.2% (27/222) in the LOC group, and 10.4% (5/48) in the SC group (P = .73). Postoperative complication rate was higher in the LOC group (45.5% vs 29.2%; P = .04). The estimated survival rate after LOC was 80% at 1 year and 64% at 5 years; after SC, it was 72% at 1 year and 37% at 5 years (log-rank P = .01). During the median follow-up of 21.5 months (interquartile range, 2.4-61 months), an endoleak after SC was found in the 38.3% of the cases; sac growth was recorded in the 27.7% of SC patients.

Conclusions

SC has an early benefit over LOC in terms of reduced postoperative complications but has a significantly inferior mid-term survival. The high rates of persistent and/or recurrent endoleaks reduce SC durability.

The great majority of reinterventions after endovascular aneurysm repair (EVAR) for abdominal aortic aneurysms (AAAs) can be successfully performed by endovascular, mini-invasive, procedures.[1, 2, 3] However, over the past few years, reports about surgical management of EVAR complications are increasing in the literature.[4, 5, 6, 7] Furthermore, according to recent experiences, the number of performed late open conversions (LOCs) after EVAR seems to be rising.[8,9] Even though this is likely due to the increasing number of total EVARs performed worldwide, and not to an increasing percentage of failing EVARs, open surgery still plays an important role in AAA treatment.[10]

Open surgery for EVAR complications can be classified into LOCs and semi-conversions (SCs). LOCs consist of endograft explantation (complete or partial), followed by arterial reconstruction. SCs are less invasive treatments for EVAR complications and consist of open or laparoscopic surgery for endoleak correction with complete endograft preservation. Whether SC may have any advantage over LOC in terms of reduced mortality and mid- to long-term efficacy has not been established in the literature so far.

We hereby present a multicenter experience of LOC vs SC, reporting the technical aspects of the two techniques as well as early to long-term results. The aim of this study is to compare these two surgical approaches for EVAR complication repairs to identify relative advantages and drawbacks.

Methods

Patient sample and operative data

Eleven vascular centers retrospectively reviewed medical records about patients who underwent open (or laparoscopic) surgery to repair an endoleak after EVAR. Thus, patients who underwent surgery for endograft infection or endograft thrombosis were excluded. Early open conversions (within 30 days of first EVAR) were also excluded. Thoracic EVAR was excluded as well. We considered all consecutive patients operated on for LOC or SC from 1997 to 2020.

Data about demographics, preoperative risk factors, EVAR characteristics (including type of endograft, reasons for surgery, and timing), and patients' medical history (specifically previous attempts to repair the initial EVAR and clinical conditions at presentation such as aneurysm rupture and/or urgent setting) were collected. Frailty index was calculated, and patients were divided into frail (Risk Analysis Index [RAI] $\geq$30) and nonfrail patients (RAI <30).11 Regarding the indication for surgery, we finally reported the endoleak we confirmed during the operation. In case of multiple endoleaks, we reported the endoleak with direct flow into the aneurysm sac (eg, in case of the simultaneous presence of a type I and type II endoleak, this indication was reported as "type I endoleak"), in order to avoid possible inclusion of clinically irrelevant endoleaks. All patients were divided into two groups according to the type of surgical operation (LOC vs SC, namely endograft explantation vs preservation). Intraoperative data included surgical access, aortic clamping site (infra-renal, supra-renal, supra-coeliac, or no aortic clamping), duration of surgery, type of endograft removal (complete/partial/preservation), type of arterial reconstruction (or type of endoleak repair, in case of SC), and intraoperative death rate.

This study was designed after the results of previously published studies by our group, focused solely on LOC.5,9 Our Institutional Ethics Review Board approved the present study. Written informed consent for retrospective medical records search was obtained by all patients except for those who were dead at data collection.

Early outcomes

Early outcomes (30 days) were mortality, length of stay, major postoperative complications (acute renal insufficiency, reinterventions, myocardial infarction, and respiratory complications). Acute renal insufficiency was defined according to the Risk, Injury, Failure, Loss of kidney function, and End-stage kidney disease (RIFLE) criteria.12 Respiratory complications included pneumonia and prolonged invasive ventilation (more than 4 days) during intensive care unit stay.

Follow-up

Follow-up protocols were different among the included centers, but included at least a postoperative and yearly evaluation through clinical examination and abdominal ultrasound. Data about follow-up were collected until December 2020 through medical records search and/or by phone interview with the patient's primary care physician. Collected follow-up data included information about survival, related complications, endoleak persistence, and sac growth.

Endpoints

The two groups were compared in terms of early- and long-term outcomes. The primary endpoints were early mortality and long-term survival. Secondary endpoints were differences in major postoperative complication rates, related long-term complications, endoleak persistence, or continuing sac growth. Sac growth was considered significant if >5 mm when compared with preoperative aneurysm diameter.

Statistical analysis

Data were entered in an .xls database (LibreOffice Calc 7.1.1.2, The Document Foundation, Berlin, Germany), and analyzed with EpiInfo 7.2.4.3 (Centers for Disease Control, Atlanta, GA) and SPSS 16 (IBM, Armonk, NY). Continuous measures were reported as mean ± standard deviation or as median and interquartile range (IQR), in case of normal or skewed distribution, respectively. Differences between the two groups were calculated with the Mann-Whitney U test or analysis of variance, as appropriate. Dichotomic factors were reported with number and percentage, and compared by means of the $\chi 2$ test or the Fisher exact test, as appropriate.
Long-term survival was analysed and compared between the two groups with Kaplan-Meier curves and the log-rank test. Patients were censored at the time of their last clinical examination or imaging. The significance of trend lines was assessed using Pearson correlation analysis. Statistical significance was set at $P < .05$.

Results

Population and indications for surgery

From 1997 to 2020, 13,469 patients underwent EVAR in the 11 participating centers. Among these, LOC or SC was performed in 347 consecutive patients (2.6%). After the exclusion of cases that were operated on for endograft infection or endograft thrombosis, a total of 270 patients were available for analysis. Specifically, 222 patients underwent LOC, and 48 patients underwent SC. The two groups were homogeneous in terms of preoperative risk factors, including American Society of Anesthesiologists (ASA) score, except for age at surgery (79 ± 7 years in the SC group vs 75 ± 8 years in the LOC group; P = .009). The portion of frail patients was similar in the two groups (60% for SC vs 49% for LOC; P = .155). Endograft characteristics (presence of suprarenal fixation, presence of hooks/barbs, bifurcated vs aorto-uni-iliac devices, and presence of complex EVAR such as chimney or fenestrated endografts) were comparable in the two groups. Patients in the SC group underwent more endovascular attempts to repair the failing EVAR before surgery (65% vs 37%; P = .001). These data are summarized in Table I.
The main indication for surgery in the LOC group was a type I endoleak (138/222 patients; 62.2%), whereas the most frequent indication for SC was the presence of a type II endoleak (31/48 patients; 64.6%). Indications for surgery are summarized in Table II.
The number of annually performed SC did not rise significantly over the study period (correlation r = 0.13; P = .61; coefficient of determination $r2 = 0.02$; equation of the trend line $y = 0.066x + 2.228$).

Operative data

Regarding surgical access, in the case of LOC, the great majority of patients underwent a transperitoneal approach (205/222; 92.3%). Access to the aorta was obtained through a midline incision in 195 of 222 patients (87.8%). Other reported incisions were 16 cases of lumbotomy, 1 thoraco-phreno-laparotomy, and 10 bilateral subcostal incisions. On the other hand, in the case of SC, the retroperitoneal approach was used in 22 of 48 cases (45.8%). In addition, the transperitoneal approach was used in 22 cases (45.8%), whereas laparoscopy was adopted in 4 cases (8.3%).
In the case of LOC, the aortic clamping was placed in an infrarenal fashion in 47.3% of the cases (105/222), in a suprarenal fashion in 27.9% (62/222), supra-celiac in 23.4% (52/222), and thoracic in 1.4% (3 cases). In the case of SC, the aorta was not clamped, even though a "safety" clamp was placed as a precaution in about the 30% of the patients (15/48).
Complete removal of the endograft was performed in 143 of 222 (64.4%) LOCs. Partial removal with proximal preservation of the endograft was performed in 42 of 222 (18.9%) cases, whereas distal preservation was maintained in 24 of 222 (10.8%) cases. Both proximal and distal preservation of the endograft was undertaken in 13 of 222 patients (5.9%). Arterial reconstruction was obtained through aorto-bi-iliac (138/222; 62.2%), aorto-aortic (62/222; 27.9%), or aorto-bi-femoral reconstruction (22/222; 9.9%) with Dacron grafts.
Regarding SC, endograft preservation was complete in all cases. Operations for endoleak repair were the following: 23 of 48 patients (47.9%) underwent sacculotomy associated with lumbar and/or inferior mesenteric artery (IMA) ligation; 4 of 48 patients (8.3%) underwent neck banding with Dacron mesh; 12 of 48 patients (25%) underwent sacculotomy associated with proximal or distal neck banding; 5 of 48 patients (10.4%) underwent IMA ligation without sacculotomy; and 4 of 48 patients (8.3%) underwent hypogastric artery ligation. The type III endoleak in the SC group was due to fabric disruption and was treated with direct suture during sacculotomy.
In our series, treatment for complex EVAR, namely chimney EVAR or fenestrated EVAR, was similar to that of standard EVAR. The three patients who underwent SC were treated with sacculotomy and branch ligation. Two of four patients who underwent LOC were managed with infrarenal clamping and partial explantation of the endograft. The two remaining patients underwent complete explantation and renal artery reimplantation.
The median operating time was 240 minutes (IQR, 181-300 minutes) for LOC, and 120 minutes (IQR, 80-150 minutes) for SC ($P < .001$). The median operating time was similar when comparing complete and partial explantations in the LOC group ($P = .829$). The intraoperative death rate was 2.3% (5/222) for LOC and 2.1% (1/48) for SC ($P = .94$). All intraoperative deaths occurred in patients operated on in an urgent setting with a ruptured aneurysm.

Early results

Thirty-day mortality (primary endpoint) was 12.2% (27/222) in the LOC group and 10.4% (5/48) in the SC group ($P = .73$). Within the LOC group, complete and partial explantations experienced a comparable early death rate (14% vs 8.9%; $P = .263$). Complex EVAR was not associated with higher early mortality (28.6% vs 11.4%; $P = .165$). The median length of stay was 10 days (IQR, 8-17 days) after LOC vs 8.5 days (IQR, 7-15 days) after SC ($P = .02$).
Major postoperative complications were higher in the LOC group (101/222 patients; 45.5%) compared with the SC group (14/48; 29.2%; $P = .04$). Acute renal insufficiency rates were higher in the LOC group (26.7% vs 8.5%; $P = .008$), as well as postoperative respiratory complication rates (24.4% vs 8.5%; $P = .02$). On the other hand, myocardial infarction rates (4.2% in the LOC group vs 0% in the SC group; $P = .16$) and reintervention rates were similar (7.2% for LOC vs 9.1% for SC; $P = .75$). Reinterventions were mainly related to gastrointestinal complications such as ischemia or perforation (9 of 16 in the LOC group). Adjunctive reinterventions after LOC were due to bleeding (4 patients), lymph leak (2 patients), or limb thrombosis (1 patient). After SC, we recorded two early reinterventions, due to bleeding, and intestinal ischemia with perforation.

Follow-up data and long-term results

The median follow-up was 21.5 months (IQR, 2.4-61 months). The estimated survival rate after LOC was 80% at 1 year, and 64% at 5 years, by means of Kaplan-Meier curves (Fig 1). In comparison, the estimated survival rate after SC was 72% after 1 year, and 37% after 5 years. The long-term survival difference was statistically significant (log-rank P = .01, primary endpoint). Within the LOC group, there were no differences in survival for complete and partial explantations (log-rank P = .518).
The estimated aneurysm-related survival was 82.1% at 1 year and 80.4% at 5 years in the LOC group, and 78.7% at 1 year and 59.2% at 5 years in the SC group (log-rank P = .04) (Fig 2).
During follow-up after LOC, we recorded the following related complications: five graft infections, four anastomotic false aneurysm development, three incisional hernias, three limb stenosis or thrombosis, and one aorto-enteric fistula. In two cases of anastomotic false aneurysm development, the patients presented with rupture. Thus, after exclusion of the five patients who died intraoperatively, LOC-related complications occurred in 7.4% (16/217) of the patients.
After SC, we recorded three graft infections (of which 2 directly caused the death of the patient) and one limb stenosis. A persistent or recurrent endoleak was observed in 38.3% of the patients (18/47, after the exclusion of 1 patient who died intraoperatively). Sac growth was detected in 27.7% (13/47) of the patients. Five patients presented with aneurysm rupture and subsequent death during follow-up. All ruptures were associated with persistent or recurrent type I endoleak; four of five were associated with sac growth.
During follow-up, 72.3% (34/47) of the patients in the SC group underwent at least one computed tomography angiography in addition to ultrasound vs 30% (65/217) in the LOC group (P < .001).

Subgroup analysis

We compared early and follow-up results in the two groups of patients stratified by endoleak type (type I and type II). Regarding type I endoleaks, the age at conversion was significantly lower in the LOC group (median, 74.8 years [IQR, 68.5-81.4 years] vs 79 years [IQR, 78-85.2 years]; P = .004). Early mortality was similar (12.5% for SC vs 13.8% for LOC; P = .889). Estimated survival was higher for LOC (78.3% at 1 year and 60.7% at 5 years vs 66.1% at 1 year and 29.4% at 5 years; log-rank P = .044), but was strongly influenced by the younger age at surgery for LOC patients (hazard ratio, 1.085; 95% confidence interval, 1.046-1.126; P < .001).
Regarding the type II endoleak subgroups, patients were homogeneous for age (median, 79.2 years [IQR, 73.4-83.6 years] for SC vs. median, 78.8 years [IQR, 73.7-82 years] for LOC; P = .508), ASA score (median 3 in both groups; P = .386), and early mortality rates (9.7% for SC vs 8.3% for LOC; P = .837). Estimated survival after SC remained significantly lower (80.9% at 1 year and 47.8% at 5 years vs 89.3% at 5 years after LOC; log-rank P = .006) and was not influenced by age (P = .303).

Discussion

The number of LOCs performed worldwide seems to be constantly rising in the literature.[8,9] However, LOC after EVAR is associated with high postoperative morbidity and mortality rates.[4,5] Thus, some authors proposed a less-invasive type of surgical conversion by complete endograft preservation, the so-called SC, which seems to be associated with reduced postoperative complications.[13,14] In this study, we compared these two treatments in terms of intraoperative, early, and mid- to long-term results.

In our multicenter experience, SC and LOC patients were homogenous for all preoperative risk factors, apart from age at surgical conversion, which was higher in the SC group (79 ± 7 vs 75 ± 8 years). Notwithstanding, preoperative anesthesiologist evaluation assessed a comparable operative risk for the two groups, with a mean ASA score around 3. The portion of frail patients was also similar in the two groups. Thus, preoperative risk factors did not seem to influence the choice of the treatment. The two groups were also similar in terms of characteristics of the implanted endograft and complexity of the initial EVAR. Within the LOC group, complete and partial explantations were comparable in terms of operating time, and early and follow-up outcomes, thus they were considered as a single group. Partial explantations may simplify the surgical technique; however, no other advantages were demonstrated in this study.

Complex EVAR, such as fenestrated or chimney endografts, were treated in a similar way in comparison with standard cases. This indicates that selected patients who underwent prior complex EVAR can be treated with "simplified surgical techniques" through SC or partial explantations.

The main difference regarding preoperative variables was the surgical indication. In fact, the majority of the patients in the LOC group presented with a type I endoleak, whereas in the SC group the main indication was represented by type II endoleaks. We think a clear type I endoleak, with possibly a proximal neck dilatation or aneurysmal degeneration, is preferably treated with a complete explantation or with advanced EVAR such as chimney or fenestrated endografts.[15, 16, 17] In these cases, SC may not be technically feasible or may be deemed insecure during preoperative planning (Fig 3). On the other hand, type II endoleaks were often considered for SC, and represented the main indication in this group of patients (64.6%). This higher rate of type II endoleaks is also related to the larger portion of patients in the SC group who underwent endovascular attempts, mostly unsuccessful, to repair the failing EVAR prior to surgery.[18, 19, 20]
In our experience, as well as in the literature, LOC were performed in different ways in terms of surgical access, site of aortic cross-clamping, endograft removal, and arterial reconstructions.[4,21, 22, 23, 24] This is also valid for SC, where surgical techniques strongly depend on the type and location of the endoleak to treat.[14] In fact, for example, a type II endoleak from the IMA can be treated with simple ligation through laparoscopy, whereas a type I or III endoleak may need a more complex approach. These findings suggest LOC and SC are non-standardized procedures, and the choice of a different approach may also be influenced by the surgeon's preference.[4]
Early mortality was similar in the two groups (12.2% in the LOC group vs 10.4% in the SC group). On the other hand, postoperative major complications were significantly higher in the LOC group (45.5% vs 29.2%), and, subsequently, the median length of stay was shorter in the SC group (8.5 days vs 10 days). Especially acute renal insufficiency and respiratory complications were more frequent in the LOC group (26.7% vs 8.5% and 24.4% vs 8.5%, respectively). The first was likely a consequence of suprarenal clamping, which was adopted in more than 50% of LOC patients. The latter was possibly a complication of a prolonged surgical time and subsequent longer invasive intraoperative ventilation (240 minutes vs 120 minutes median operating time).
The initial advantage of SC over LOC is lost during follow-up. In fact, estimated 5-year survival rate was 64% after LOC, and 37% after SC (P = .01). Moreover, during follow-up, an endoleak was still present in a significant portion of SC patients (38.3%). We think there are two reasons for endoleak persistence and/or recurrency. In the first, patients may have had occult endoleaks which were not treated during SC.[18,25,26] This issue is less likely to occur during LOC, with endograft explantation and complete neck and aneurysm sac exploration. Regarding the second reason, because SC leaves the endograft in place, it does not resolve the inherent lower durability of EVAR, which is conversely resolved with LOC.[1, 2, 3,27] Thus, we may speculate that patients are still exposed to the future development of new or recurrent endoleaks.
This endoleak persistence/recurrency led to a sac enlargement in the 27.7% of the patients, which often terminated with rupture. The increased aneurysm mortality in the SC group was mainly

attributable to secondary aneurysm sac rupture (5 ruptures [10.6%] in SC vs 2 ruptures [0.9%] in LOC). Similar rupture rates during follow-up were reported in the EVAR-1 Trial.1 These findings impose an EVAR-like lifelong surveillance in patients who underwent SC.

Major aortic complications occurred similarly in the two groups during follow-up. These included, in the LOC group, infections (5 patients), anastomotic false aneurysms (4 patients), and aorto-enteric fistulae (1 patient), resulting in a total of 4.6% (10/217) major aortic complications. In the SC group, we recorded three EVAR infection developments (6.4%). It is important for patient counseling to specify that the technical complexity of these operations may be reflected also during follow-up.

The subgroup analyses confirmed the lower durability of SC especially in case of type II endoleaks. On the other hand, the long-term difference in survival for type I endoleaks was influenced by the younger age of LOC patients. We think there are two main reasons for this finding: (1) reduced feasibility of SC in case of a challenging type I endoleak, and (2) in case of a type I endoleak in a young patient, LOC is probably offered as a first choice treatment.

The main limitation of this study is the different endoleak distribution between the two groups. In fact, many more type I endoleaks were included in the LOC group compared with the SC group. Thus, the type of endoleak seems to be the primary driver of operative approach, at least in case of type I endoleaks. Another limitation is its retrospective design. However, all available studies about this subject have a similar design. Another possible limitation is the initial selection bias, related to the multicenter experience. In fact, centers may have adopted different indications for surgery, and the choice between LOC and SC may have been heterogeneous. However, the rates of endovascular attempts to repair the failing EVAR prior to surgery (65% for SC and 37% for LOC) are higher than the average reported in literature.[4] Furthermore, all centers have access to advanced EVAR and reach the minimum annual surgical volume for AAA repair.[3] Regarding the choice between SC and LOC, one of its potential limitations is the fact that SC is not always anatomically or clinically feasible. Apart from complete migrations, the role of SC is also limited for infected endografts. In fact, while the number of LOC demonstrated an increase over the past years, we found the number of SC to be steady over our study period.[8,9] Finally, the complications after LOC may have been underestimated because these patients did not continue to undergo an EVAR-like surveillance protocol. However, these complications were likely less serious than those found after SC, as demonstrated by the higher survival rates. Despite its potential limitations, this is the first study directly comparing LOC and SC to treat endoleaks deemed not amenable to endovascular repair.

Conclusions

Despite the initial advantage of SC over LOC in terms of reduced postoperative complications and shorter length of stay, LOC demonstrated significantly better survival rates over the mid-term follow-up. The reduced durability of SC is related to the high occurrence of persistent and/or recurrent endoleaks and sac enlargement, with subsequent greater aneurysm-related mortality. This is valid in particular for type II endoleaks, because the operative approach for type I endoleaks was likely influenced by the aortic anatomy and the age of the patients.

For these reasons, SC should be considered only in selected cases in high-risk patients, with a clear detectable and treatable endoleak on preoperative imaging not amenable to endovascular repair. After SC, continuing a strict, EVAR-like lifelong surveillance is suggested.

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Tables

Table I. Patients and endograft baseline characteristics of the population

Baseline characteristics	LOC (n = 222)	SC (n = 48)	*P* value
Male sex, n (%)	201 (91)	39 (81)	.060
Age at LOC/SC, years	75 ± 8	79 ± 7	**.009**
EVAR duration, months[a]	52 ± 36	52 ± 41	.992
Risk factors			
Smoking (ongoing)	68 (31)	19 (40)	.209
COPD	93 (42)	21 (43)	.528
Hypertension	191 (86)	44 (92)	.531
Diabetes	28 (13)	7 (15)	.512
Chronic kidney disease	55 (25)	17 (35)	.139
CAD	86 (39)	18 (38)	.393
AF	46 (21)	6 (13)	.092
CHF	20 (9)	4 (8)	.499
Dyslipidemia	112 (51)	31 (65)	.123
ASA classification	3.2 ± 0.7	3 ± 0.5	.128
Frail patients[b]	109 (49)	29 (60)	.155
Endograft characteristics			
Suprarenal fixation	136 (61)	25 (52)	.156
Hooks	125 (56)	32 (67)	.123
Bifurcated	210 (95)	43 (90)	.196
Aorto-uni-iliac	8 (4)	3 (6)	.419
F-EVAR/Ch-EVAR configuration	4 (1.8)	3 (6.3)	.08
Previous endovascular treatment of EL	83 (37)	31 (65)	**.001**
Urgent setting[c]	60 (27)	9 (19)	.276
Rupture	51 (23)	7 (15)	.247

AF, Atrial fibrillation; ASA, American Society of Anesthesiologists; CAD, coronary artery disease; Ch-EVAR, chimney EVAR; CHF, chronic heart failure; COPD, chronic obstructive pulmonary disease; EL, endoleak; EVAR, endovascular aneurysm repair; F-EVAR, fenestrated EVAR; LOC, late open conversion; SC, semiconversion; SD, standard deviation.
Continuous data are presented as mean ± standard deviation and categoric data as number (%).
Boldface P values indicate statistical significance.

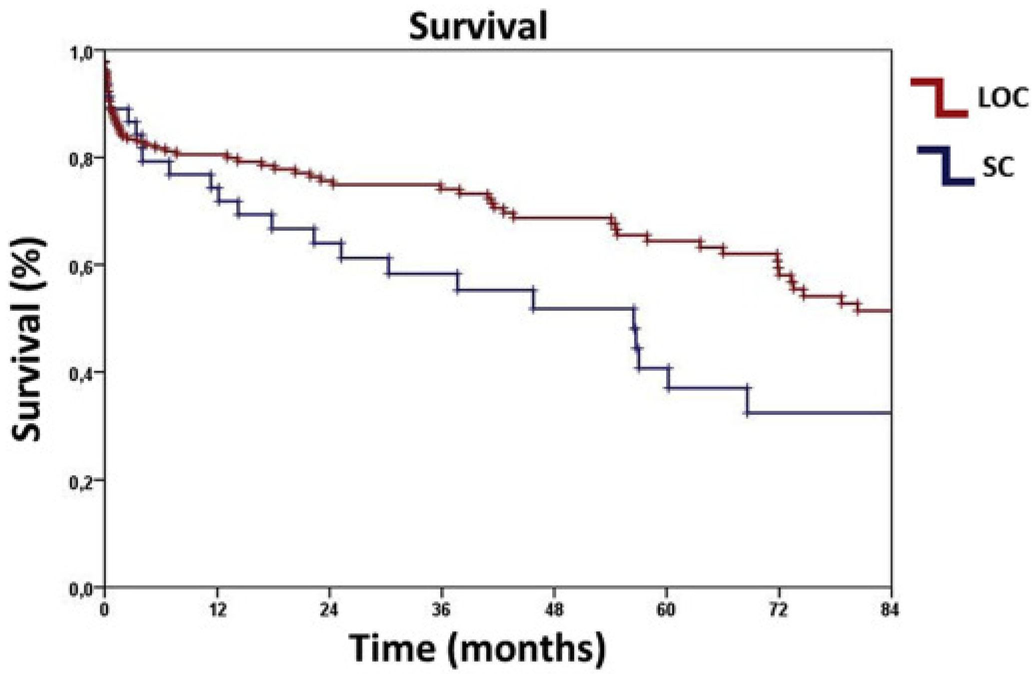
a EVAR duration considers the time from initial EVAR to LOC/SC.
b Divided according to Risk Analysis Index: frail patients if ≥30, nonfrail if <30.
c Urgent setting included ruptured aneurysms and symptomatic patients.

Table II. Indications for surgery for the two groups

Groups			
Indication for surgery	**LOC (n, %)**	**SC (n, %)**	***P* value**
Type I EL	138 (62.2)	16 (33.3)	<.001
Type II EL	48 (21.6)	31 (64.6)	<.001
Type III EL	17 (7.7)	1 (2.1)	.160
Endotension	19 (8.5)	0 (0)	.036
Total	222	48	

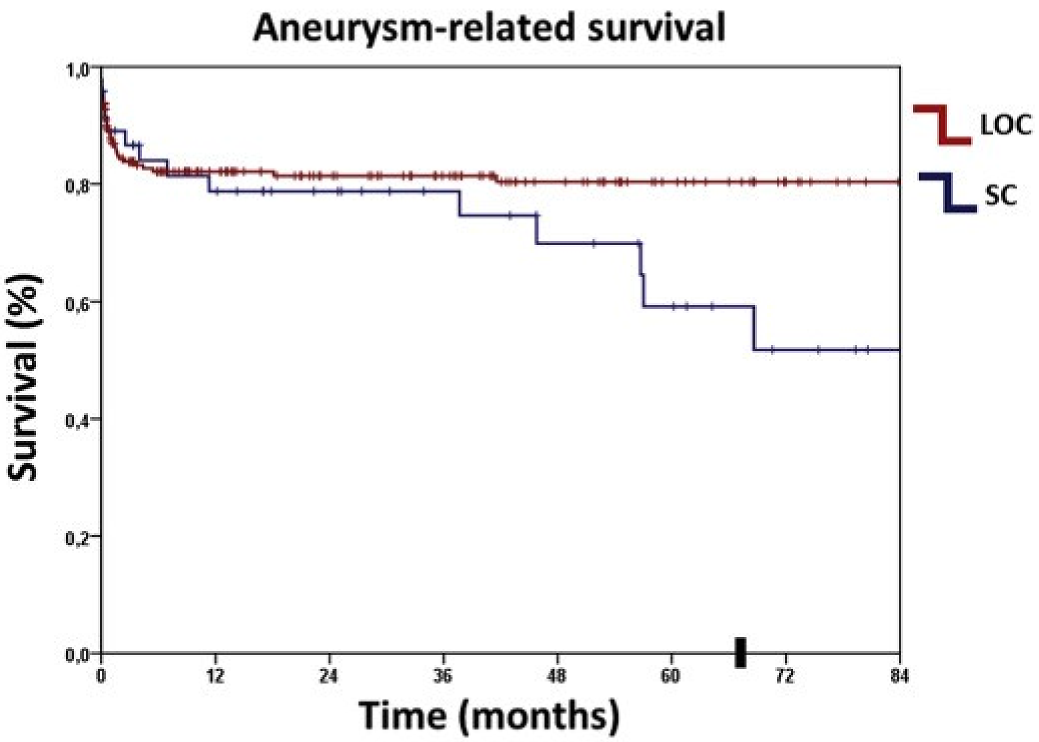
EL, Endoleak; *LOC,* late open conversion; *SC,* semi conversion.

Figures



LOC	n. at risk	222	124	103	90	72	57	44	37
	SE	.010	.028	.032	.033	.037	.041	.045	.049
SC	n. at risk	48	30	24	19	15	11	7	3
	SE	.021	.067	.075	.079	.082	.086	.087	.087

Figure 1. Cumulative Kaplan-Meier estimate of 7-year survival after late open conversion (LOC) or semiconversion (SC) after endovascular repair of aortic aneurysms (EVAR) (log-rank P = .01).



		0	12	24	36	48	60	72	84
LOC	n. at risk	222	124	103	90	72	57	44	37
	SE	.010	.024	.028	.028	.029	.029	.029	.029
SC	n. at risk	48	30	24	19	15	11	6	3
	SE	.021	.063	.063	.063	.082	.098	.110	.110

Figure 2. Cumulative Kaplan-Meier estimate of aneurysm-related 7-year survival after late open conversion (LOC) or semiconversion (SC) after endovascular repair of aortic aneurysms (EVAR) (log-rank P = .04). The black marker depicts where the standard error exceeds 10%.

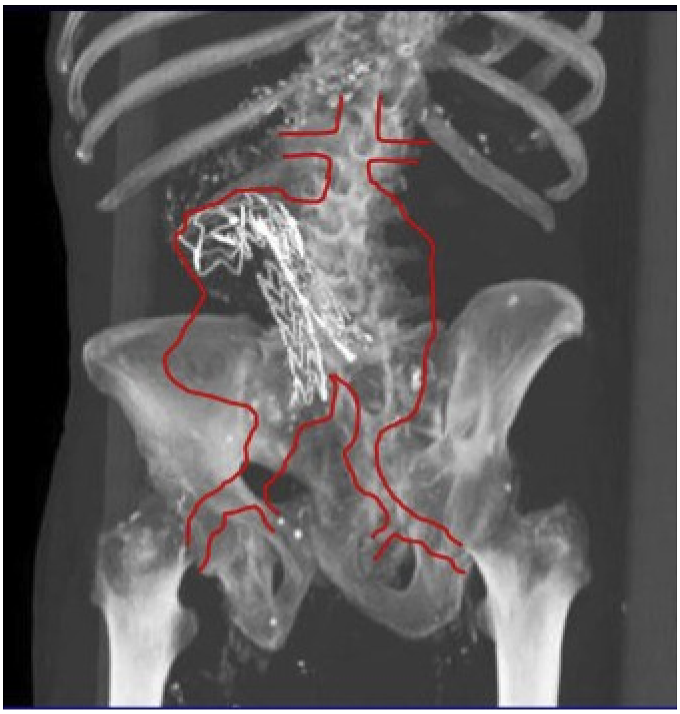


Figure 3. An instance of complete endograft migration with sac enlargement, not suitable for semi-conversion