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Incidence, Predictors, and Outcomes of Colonic Ischaemia in Abdominal Aortic Aneurysm Repair

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WHAT THIS PAPER ADDS

Available real world data evidence is limited regarding the incidence of colonic ischaemia (CI), its predictors, and the possible benefits of endovascular techniques in abdominal aortic aneurysm repair. Although practice patterns have changed significantly since endovascular repair was introduced in the early 1990s, very few studies include patients treated within the last decade. Moreover, available studies are limited to short-term outcomes. This large scale study using contemporary health insurance claims data identified independent predictors for CI, and its link with several major complications and worse long-term survival. Endovascular repair is found to have a protective effect and preventive strategies need evidence based implementation.

Objective/Background: Colonic ischaemia (CI) is a severe complication following abdominal aortic aneurysm (AAA) repair, leading to high morbidity and mortality. The aim of the study was to determine the incidence, predictors, and outcomes of CI following AAA repair.

Methods: National claims from Germany's third largest insurance provider, DAK-Gesundheit, were used to investigate CI after intact (iAAA) and ruptured (rAAA) AAA repairs. Patients undergoing endovascular (EVAR) or open surgical (OSR) repairs between January 2008 and December 2017 were included in the study.

Results: There were 9145 patients (8248 iAAA and 897 rAAA) undergoing EVAR or OSR procedures and the median follow up was 2.28 years. Most patients were male (79.2% iAAA, 79.3% rAAA); the median age was 73.0 years (iAAA group) and 76.0 years (rAAA group). Overall, CI occurred 97 (1.2%) times after iAAA and 95 (10.6%) after rAAA. In univariable analyses CI occurred less often after EVAR than after OSR (0.6% vs. 3.7%; $p < .001$). Acute post-operative renal and respiratory insufficiencies were also related to the occurrence of CI ($p < .001$). CI was associated with greater in hospital mortality (42.2% vs. 2.7% for iAAA, 64.2% vs. 36.3% for rAAA; $p < .001$) and lower long-term survival for iAAA (Kaplan–Meier analysis). In multivariable analyses, rAAA (odds ratio [OR] 5.59), and higher van Walraven comorbidity score (OR 1.09) were independently associated with greater risk of CI occurrence. EVAR use (OR 0.30) was protective. EVAR use remained protective in stratified analyses within iAAA (OR 0.32) and rAAA (OR 0.26).

Conclusion: Post-operative CI after AAA repair is not common but is associated with worse in hospital outcomes and lower long-term survival. EVAR was protective after both rAAA and iAAA repairs. When discussing the treatment of AAA with patients the protective effect of EVAR should be considered. Future studies should validate predictive scores and advance preventive strategies.

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INTRODUCTION

Colonic ischaemia (CI) is a serious and life threatening complication after both endovascular (EVAR) and open surgical (OSR) repair of abdominal aortic aneurysms (AAA).[1] The reported incidence of this major complications varies from 0.5% to 3.6% for elective AAA repairs and from 3.7% to 23.0% for urgent AAA repairs (Supplemental Table 1).[2–17] However, practical guidelines for the management of the diseases of mesenteric arteries and veins do not cover CI after AAA

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repairs. D-dimer remains the only sensitive and highly non-specific biomarker for intestinal ischaemia but is increased in most cases following surgery or intervention, which lowers its diagnostic value.[18] Colonoscopy is the method of choice to diagnose CI,[19,20] and computed tomography angiography can be used to diagnose acute occlusion of the mesenteric arteries. Under specific circumstances, laparotomy is indicated to diagnose CI or to decompress abdominal compartment syndrome as another severe complication associated with the occurrence of CI.[21,22]

There is little evidence concerning the impact of the adoption of new technology in vascular surgery and it is unclear what the other predictors of CI are. Furthermore, the impact of CI on short and long-term mortality is also not well understood. In a systematic review and meta-analysis of 13 studies reporting specific outcomes of CI after elective AAA repair, EVAR was associated with a lower incidence of CI than OSR.[23] Better knowledge of the effect of EVAR on CI in real world settings is much needed and may help make policy recommendations. In addition, understanding other predictors of CI occurrence will help improve care guidelines.

Accordingly, the aim of this study was to determine the occurrence, predictors, and consequences of this devastating complication following AAA repair using real world evidence.

METHODS

The health insurance claims data of Germany's third largest insurance provider, DAK-Gesundheit (DAK-G), includes the outpatient and in hospital medical care provided to approximately 6.5 million German citizens (8% of Germany's population). In contrast to most registry based data on AAA from Germany, the DAK-G database is not restricted to vascular surgeons but includes all medical specialties treating the insured cohort for AAA (e.g., cardiac surgeons, cardiologists, angiologists, interventional radiologists, and general surgeons). The DAK-G cohort includes nationally generalisable data with comparable sex and age distribution (40.4% female and 29.1% over 65 years of age) and has been validated before.[24]

For this study, the DAK-G database was used to determine in hospital treatments for AAA using the International Classification of Diseases (ICD-10) coding I71.4 (intact [iAAA]) or I71.3 (ruptured [rAAA]) and Operations and Procedures Codes (OPS) coding for OSR (OPS code 5—384*) or EVAR (OPS code 5-38a*, 8—842*) repair of infrarenal AAA. The cohort included procedures conducted between 1 January 2008 and 31 December 2017. The German OPS code is adapted to the International Classification of Procedures in Medicine. For the identified cases that matched the abovementioned basic search criteria, data were collected on the occurrence of colonic ischaemia (OPS K55.0, K55.9), coding of a colonoscopy (OPS 1—65*), occurrence of abdominal compartment syndrome (ICD R19.*), demographics, procedures done while in hospital (OPS codes), coded comorbidities (World Health Organisation [WHO] ICD-10 codes at the time of discharge), and reason for discharge. For the long-term survival analyses, patients whose insurance contract expired within the follow up period were censored. Baseline differences in demographics, comorbidities, and primary and secondary end points were assessed. The first AAA repair procedure was included as the primary case (no re-intervention cases during the study period were included).

Regarding comorbidities, the Elixhauser coding was used to summarise all comorbidities present in 30 categories via WHO ICD-10 code.[25,26] After coding, the linear van Walraven score ranged from −19 to +89 and was used to adjust for comorbidities with a single metric covariate.[27]

Statistical analysis

Mean and SD or median and interquartile range are reported for continuous variables. Proportions and 95% confidence interval are reported for categorical variables. Tests of normality were conducted using Kolmogorov—Smirnov test. Student *t*-test was used for normally distributed data and Mann—Whitney *U* test and Kruskal—Wallis *H* test were used for non-normally distributed data. Rates and univariate differences were compared using Pearson's chi-square test and Fisher's exact test. The multivariable regression models were used for the entire cohort and the model included age, sex, operative procedure (endovascular repair, open repair), rupture, and van Walraven comorbidity score. Predictive models were developed for the entire cohort. Two additional models were developed for subgroups stratified for rupture status (iAAA vs. rAAA).

Kaplan—Meier survival curves were used to study survival by occurrence of CI over time. Patients with unknown mortality were censored. Sensitivity analysis using the landmark approach for all patients who survived at least 30 days after procedure was performed. To address multiple testing in univariate analyses (Tables 1 and 2), the Holm-Bonferroni method was used and a p value of $< .01$ was considered statistically significant. All statistical analyses were performed with software R version 3.3.2 (The R Foundation for Statistical Computing, Vienna, Austria).

Ethical considerations

For a retrospective analysis of anonymised health insurance claims data, no local ethics committee approval was required (exempt), and no patient informed consent was obtained for the study.

RESULTS

A total of 9145 patients underwent invasive treatment for AAA during the study period. Of these patients, 8248 were diagnosed with an iAAA and 897 patients with a rAAA. Of the iAAA repair patients, 97 (1.2%) developed CI (0.56% after EVAR, 1.97% after OSR; $p < .001$). Among rAAA repair patients, 95 (10.6%) developed CI (3.7% after EVAR, 12.8% after OSR; $p = .001$). Median follow up was 2.28 years (range 0—9.78 years) and loss of follow up owing to the end of insurance contract was similar in both groups following both iAAA and rAAA repairs. Baseline demographics,

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