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"Impact of Kidney Disease on Outcomes Following Endovascular Aneurysm Repair"

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Abstract:

Endovascular aneurysm repair (EVAR) is a prevalent minimally invasive method for treating aortic aneurysms, providing lower perioperative morbidity and mortality rates compared to open surgical repair. Outcomes after EVAR differ markedly among patient populations, especially in those with chronic kidney disease (CKD). Chronic kidney disease (CKD) is linked to diminished physiological reserve, cardiovascular comorbidities, and heightened susceptibility to acute kidney injury (AKI), reliance on dialysis, and perioperative mortality. This study sought to assess the influence of chronic kidney disease (CKD) on outcomes after endovascular aneurysm repair (EVAR), examine the correlation between CKD and postoperative acute kidney injury (AKI), and identify perioperative strategies to alleviate negative effects. Employing a descriptive and quantitative methodology, data were extracted from patient medical records, categorised by CKD stage, and analysed utilising SPSS. The findings demonstrated that advanced chronic kidney disease markedly elevated the occurrence of acute kidney injury, prolonged hospitalisations, and intensified the requirement for dialysis, whereas enhanced perioperative management mitigated these risks. The results emphasise that the severity of CKD is a critical factor influencing both short- and long-term outcomes after EVAR, indicating the necessity for focused perioperative strategies to enhance patient prognosis.

Keywords: Endovascular aneurysm repair, chronic kidney disease, acute kidney injury, perioperative management, vascular surgery.

المستخلص :

يُعد إصلاح تمدد الأوعية الدموية داخل الأوعية (EVAR)طريقة شائعة قليلة التوغل لعلاج تمدد الأوعية الدموية الأبهرية، حيث يُقلل من معدلات الاعتلال والوفيات خلال فترة ما حول الجراحة مقارنةً بالإصلاح الجراحي المفتوح. تختلف النتائج بعد إصلاح تمدد الأوعية الدموية داخل الأوعية بشكل ملحوظ بين فئات المرضى، وخاصةً لدى المصابين بأمراض الكلى المزمنة. يرتبط مرض الكلى المزمن بانخفاض الاحتياطي الفسيولوجي، والأمراض القلبية الوعائية المصاحبة، وزيادة قابلية الإصابة بإصابة الكلى الحادة (AKI)، والاعتماد على غسيل الكلى، والوفيات خلال فترة ما حول الجراحة. سعت هذه الدراسة إلى تقييم تأثير مرض الكلى المزمن على النتائج بعد إصلاح تمدد الأوعية الدموية داخل الأوعية (EVAR)، ودراسة العلاقة بين مرض الكلى المزمن وإصابة الكلى الحادة بعد الجراحة (AKI)، وتحديد استراتيجيات ما حول الجراحة لتخفيف الآثار السلبية. باستخدام منهجية وصفية وكمية، تم استخراج البيانات من السجلات الطبية للمرضى، وتصنيفها حسب مرحلة مرض الكلى المزمن، وتحليلها باستخدام برنامج SPSS. أظهرت النتائج أن مرض الكلى المزمن المتقدم يزيد بشكل ملحوظ من حدوث إصابات الكلى الحادة، وإطالة مدة الاستشفاء، وزيادة الحاجة إلى غسيل الكلى، في حين أن تحسين الإدارة في الفترة المحيطة بالجراحة خفف من هذه المخاطر. تؤكد النتائج أن شدة مرض الكلى المزمن عامل حاسم يؤثر على النتائج قصيرة وطويلة الأجل بعد إصلاح تمدد الأوعية الدموية داخل الأوعية الدموية، مما يشير إلى ضرورة اتباع استراتيجيات مركزة في الفترة المحيطة بالجراحة لتحسين تشخيص المريض.

الكلمات المفتاحية: إصلاح تمدد الأوعية الدموية داخل الأوعية الدموية، مرض الكلى المزمن، إصابة الكلى الحادة، الإدارة في الفترة المحيطة بالجراحة، جراحة الأوعية الدموية.

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Introduction:

Endovascular aneurysm repair (EVAR) is a prevalent minimally invasive method for treating aortic aneurysms, providing lower perioperative morbidity and death rates than open surgical repair. Improvements in device technology and procedural techniques have broadened its application, rendering it the preferred option for numerous patients (Kim et al., 2019). Nonetheless, the results of EVAR might fluctuate markedly across various patient demographics, with individuals suffering from chronic kidney disease (CKD) being especially susceptible to problems.

Kidney illness correlates with a significant prevalence of cardiovascular comorbidities and a substantial decline in long-term survival, with mortality risk escalating in direct relation to the severity of renal impairment. In the context of EVAR, preoperative renal impairment has been consistently recognised as an independent predictor of negative outcomes, including elevated perioperative mortality, heightened risk of myocardial infarction, prolonged hospital stays, and an increased probability of necessitating postoperative dialysis. In advanced stages of chronic kidney disease (stages 4–5), perioperative mortality may be up to thrice higher than in patients with normal renal function (Timaran & Ramanan, 2024).

The EVAR procedure has particular hazards for patients with renal illness. The necessity for iodinated contrast and catheter intervention in the visceral portion of the aorta may result in acute kidney damage (AKI), a condition closely linked to heightened postoperative mortality. The likelihood of perioperative mortality may escalate by as much as seven times in individuals who experience acute kidney injury following vascular surgery. While certain patients may restore baseline renal function within months, those with pre-existing chronic kidney disease (CKD) have an elevated risk of enduring decline or advancement to end-stage renal disease (ESRD) (Pizano et al., 2023).

Notwithstanding acknowledgement of these problems, there exists a paucity of extensive information evaluating the complete range of renal disease severity and its impact on EVAR outcomes in current clinical practice. Furthermore, discrepancies in the classification of chronic kidney disease (CKD) and variations in research techniques have obstructed the establishment of definitive perioperative guidelines for this high-risk population.

This study examines the correlation between chronic kidney disease (CKD), encompassing end-stage renal disease (ESRD), and postoperative outcomes after endovascular aneurysm repair (EVAR), utilising classifications consistent with the National Kidney Foundation Kidney Disease Outcomes Quality Initiative (KDOQI) recommendations. The study seeks to refine risk assessment, guide perioperative planning, and optimise long-term treatment techniques for patients with kidney disease undergoing EVAR.

Problem Statement:

Endovascular aneurysm repair (EVAR) is a commonly endorsed less invasive technique that presents diminished perioperative risks in comparison to surgical repair. Nevertheless, results differ among patient populations, with chronic kidney disease (CKD) presenting a considerable obstacle. Individuals with chronic kidney disease exhibit elevated rates of cardiovascular comorbidities, diminished physiological reserve, and an augmented danger of postoperative consequences, encompassing mortality, dialysis necessity, and extended hospitalisation. The severity of renal impairment, particularly in advanced chronic kidney disease (CKD) and end-stage renal disease (ESRD), exacerbates prognosis. Moreover, EVAR treatments necessitate the use of iodinated contrast and catheter manipulation, both of which may induce acute kidney damage (AKI), a condition closely associated with heightened death rates.

Notwithstanding these acknowledged hazards, existing information regarding the influence of CKD severity on EVAR outcomes is constrained by limited sample sizes, different classifications of renal disease, and inconsistency in follow-up protocols. The absence of comprehensive, large-scale data obstructs the formulation of definitive perioperative recommendations and precise risk classification

instruments for CKD patients undergoing EVAR. Rectifying this deficiency is crucial for advancing clinical decision-making, refining perioperative treatment, and improving both immediate and prolonged outcomes in this at-risk patient demographic.

Study Objectives:

- To evaluate the impact of chronic kidney disease (CKD) on outcomes following endovascular aneurysm repair (EVAR).
- To determine the association between CKD and the risk of acute kidney injury (AKI) after EVAR.
- To identify perioperative strategies that may reduce the negative impact of CKD on outcomes following EVAR.

Study Significance:

Endovascular aneurysm repair (EVAR) has transformed the treatment of aortic aneurysms by providing reduced perioperative morbidity and mortality in comparison to surgical surgery. Nonetheless, patient results are heterogeneous, and patients with chronic kidney disease (CKD) have markedly elevated risks. Chronic kidney disease (CKD) is a significant worldwide health challenge, closely linked to cardiovascular disease, diminished survival rates, and compromised recovery after major surgical interventions. In the context of EVAR, patients with CKD are at an increased risk of acute kidney damage (AKI), reliance on dialysis, and elevated perioperative and long-term death rates. Comprehending these hazards is crucial due to the global rise in the incidence of CKD, resulting in a more frequent presence of this patient subgroup in vascular practice.

This study is important as it fills an evidence vacuum in assessing how various phases of chronic kidney disease (CKD), including end-stage renal disease (ESRD), influence outcomes after endovascular aneurysm repair (EVAR). While prior research has emphasised the correlation between renal impairment and surgical complications, several studies were constrained by inadequate sample sizes, inconsistent classifications of kidney illness, or insufficient long-term follow-up. This research will utilise standardised CKD definitions and extensive data to deliver a more precise and thorough evaluation of the influence of renal impairment on EVAR outcomes. The results will elucidate whether the severity of CKD directly corresponds with adverse outcomes, so aiding doctors in making better informed decisions regarding surgical time, patient selection, and perioperative treatment.

The overarching importance of this study is in its capacity to enhance patient care and optimise health system efficiency. The data can guide doctors in developing customised perioperative measures to mitigate problems, including optimising renal function preoperatively, limiting contrast exposure, and implementing improved postoperative monitoring techniques. The study will enhance shared decision-making for patients by offering clearer information regarding the risks and anticipated effects of EVAR in the context of CKD. The research can provide evidence-based recommendations at the policy and guideline level that incorporate kidney disease severity into vascular surgical risk models. This study may prolong survival, decrease postoperative complications, and improve the quality of life for patients with kidney disease receiving EVAR.

Limitations of the study:

- **Retrospective data reliance:** The study may depend on registry or database information, which could introduce selection bias and limit the ability to control for all confounding variables.
- **Variability in CKD classification:** Despite the application of standardised criteria (KDOQI), discrepancies in the initial diagnosis or documentation of CKD between centres may impact accuracy.
- **Heterogeneity of patient population:** Variations in age, comorbidities, and surgical expertise across centers may influence outcomes and make it challenging to isolate the impact of kidney disease.

- **Restricted follow-up duration:** Certain datasets may lack long-term follow-up, thereby limiting conclusions regarding survival, late complications, or the loss of renal function beyond the initial postoperative phase.
- **Unmeasured confounders:** Elements such as preoperative hydration protocols, nephroprotective efforts, or institution-specific practices may not be comprehensively documented, hence affecting outcomes.
- **Generalisability concerns:** Results from a multicenter registry may not be universally relevant to all healthcare systems or patient demographics, particularly in areas with varying clinical practices.

Definition of key terms:

Endovascular Aneurysm Repair (EVAR):

EVAR is a minimally invasive surgical procedure employed to rectify aortic aneurysms, specifically in the abdominal or thoracic areas. Surgeons utilise small incisions in the groin to introduce a stent graft, which is navigated to the aneurysm site by imaging, rather than performing an open abdominal or thoracic procedure. The stent graft fortifies the compromised aortic wall and inhibits rupture (Jacobs et al., 2022). This study analyses EVAR as the primary surgical intervention, focussing on outcome disparities in patients with kidney disease.

Chronic Kidney Disease (CKD):

Denotes a prolonged, gradual decline in renal function over a span of months or years. The classification has five stages determined by the glomerular filtration rate (GFR), extending from modest impairment (stage 1) to severe functional loss or end-stage renal disease (stage 5). Patients with chronic kidney disease (CKD) face an elevated risk of surgical complications due to their kidneys' diminished capacity to filter waste, control electrolytes, and sustain fluid equilibrium (Ammirati, 2020). This study assesses the impact of various stages of CKD on short-term and long-term outcomes after EVAR.

End-Stage Renal Disease (ESRD):

ESRD is the terminal phase of Chronic Kidney Disease (CKD) classified as stage 5, characterised by significantly diminished kidney function (GFR <15 mL/min/1.73 m^2), necessitating renal replacement therapy, including dialysis or kidney transplantation, for survival. Patients with end-stage renal disease encounter markedly elevated perioperative risks and poorer long-term results (Wouk, 2021). This study investigates ESRD as a separate subgroup to ascertain how results following EVAR differ from those in patients with earlier stages of CKD.

Acute Kidney Injury (AKI):

AKI is a rapid deterioration of renal function that may manifest within hours or days, frequently precipitated by surgical stress, contrast exposure, or ischaemia during interventions. Diagnosis typically occurs via elevated serum creatinine levels or diminished urine output. Post-EVAR, acute kidney injury (AKI) is a significant issue as it can deteriorate survival results and elevate the necessity for dialysis. This study examines the correlation between pre-existing chronic kidney disease and the probability of developing acute kidney injury subsequent to endovascular aneurysm repair (Turgut et al., 2023).

Perioperative outcomes:

Perioperative outcomes denote the clinical results noticed during and immediately following surgery, generally within a 30-day period. These factors encompass mortality, complications, duration of hospital stay, necessity for dialysis, and re-interventions. They serve as critical indications of surgical safety and efficacy.

Long-term outcomes:

Encompass the results observed months or years post-EVAR, including survival rates, preservation of renal function, aneurysm-related comorbidities, and quality of life. Given that chronic kidney disease

(CKD) is a progressive ailment influencing overall survival and cardiovascular health, assessing long-term outcomes in this demographic is crucial for comprehending the extensive effects of kidney disease on endovascular aneurysm repair (EVAR) results.

Literature Review:

- **The impact of chronic kidney disease (CKD) on outcomes following endovascular aneurysm repair (EVAR):**

- **CKD increases perioperative morbidity and mortality**

Patients with pre-existing chronic kidney disease exhibit elevated perioperative complication rates following endovascular aneurysm repair compared to those with normal renal function. The risk level increases with the severity of chronic kidney disease (CKD): those with moderate-to-severe CKD (stages 3b–5) and those reliant on dialysis exhibit much higher perioperative mortality and complication rates. The heightened risk is multifactorial, associated with decreased physiological reserve, concurrent cardiovascular illness, and a reduced capacity to withstand haemodynamic stress during and immediately following the procedure (D'Oria, et al., 2021).

- **CKD markedly raises the risk of acute kidney injury (AKI) after EVAR:**

EVAR entails exposure to iodinated contrast and catheter manipulation in proximity to renal arteries—both significant precursors to AKI. Patients with baseline chronic kidney disease possess a diminished number of functional nephrons and a decreased ability to recuperate from ischaemic or nephrotoxic injuries. Consequently, pre-existing chronic kidney disease is a significant predictor of post-endovascular aneurysm repair acute kidney injury. The incidence of AKI is elevated in complex or fenestrated/branched operations and with the utilisation of bigger amounts of contrast agents.

- **Postoperative AKI strongly worsens short-term and long-term outcomes:**

Acute kidney injury (AKI) during endovascular aneurysm repair (EVAR) is not a trivial, isolated incident; it correlates with prolonged hospitalisations, an elevated requirement for critical care and dialysis, and significantly increased perioperative mortality rates. The severity of acute kidney injury (AKI) is directly proportional to the level of risk; more severe AKI forecasts poorer survival outcomes and increased rates of permanent renal replacement therapy. Consequently, minimising acute kidney injury in chronic kidney disease patients is essential for enhancing endovascular aneurysm repair outcomes (Zarkowsky et al., 2016).

- **CKD predicts worse long-term survival even when EVAR is technically successful:**

Beyond the immediate postoperative phase, chronic kidney disease is independently correlated with poorer medium- and long-term survival following endovascular aneurysm repair. This consequence indicates both advancing renal disease and the significant burden of cardiovascular comorbidities associated with chronic kidney disease (CKD). Research categorising patients by CKD stage reveals a gradual decrease in 1- and 5-year survival rates as renal function deteriorates; reliance on dialysis is associated with a particularly adverse prognosis. Consequently, the technical effectiveness of EVAR does not mitigate the adverse effects of preexisting kidney disease on long-term results.

- **Contrast volume and renal function–adjusted dosing are key modifiable risk factors:**

The overall volume and concentration of iodinated contrast utilised in preoperative imaging and intra-operative angiography are consistently linked to the risk of acute kidney injury (AKI). Patient-specific thresholds, such as contrast volume adjusted to baseline eGFR, more accurately predict AKI than absolute volumes alone. Restricting contrast, employing low-osmolar agents, and customising contrast dosages according to renal function diminishes the incidence of acute kidney injury and enhances renal outcomes in chronic kidney disease patients undergoing endovascular aneurysm repair (Isaka et al., 2018).

- **Complex EVAR (fenestrated/branched) presents higher renal risk but mixed effects on renal recovery:**

F-/B-EVAR procedures necessitate increased catheter manipulation in the visceral and renal regions, typically resulting in heightened contrast exposure, hence elevating the risk of acute kidney injury in patients with chronic kidney disease. Despite the elevated frequency of AKI in complex EVAR, numerous studies indicate that a significant percentage of patients return to baseline creatinine levels within months; nonetheless, individuals with severe CKD continue to face an increased risk of enduring deterioration or the necessity for dialysis. The literature indicates that complex EVAR is viable but necessitates enhanced renal-protective strategies in the presence of CKD (Khoury et al., 2020).

- **CKD complicates post-EVAR surveillance and detection of late complications:**

Post-EVAR monitoring typically depends on contrast-enhanced CT angiography to identify endoleaks and device complications. Repeated contrast imaging presents a cumulative renal risk for people with chronic kidney disease (CKD). This necessitates trade-offs: diminished imaging frequency or the use of alternate modalities (duplex ultrasound or non-contrast MRI) may restrict detection sensitivity, but frequent contrast imaging heightens kidney risk. Thus, chronic kidney disease hampers the implementation of safe, long-term monitoring strategies following endovascular aneurysm repair.

- **Economic, resource, and quality-of-life implications:**

Patients with chronic kidney disease (CKD) who have endovascular aneurysm repair (EVAR) utilise more healthcare resources due to elevated complication rates, extended hospital and intensive care unit (ICU) admissions, increased rehospitalizations, and a higher probability of requiring postoperative dialysis. These causes elevate direct expenses and diminish patient quality of life. From a systems viewpoint, discovering treatments that mitigate AKI and subsequent problems in CKD patients can provide both clinical advantages and cost reductions.

- **The perioperative strategies that may reduce the negative impact of CKD on outcomes following EVAR:**

- **Preoperative assessment and risk stratification:**

Comprehensive preoperative screening and risk stratification of patients with CKD before to EVAR is necessary. This encompasses a comprehensive evaluation of baseline renal function utilising estimated glomerular filtration rate (eGFR), serum creatinine levels, and urinalysis. Classifying patients into risk groups aids in customising perioperative treatment, directing anaesthetic strategies, and predicting potential problems. This measure guarantees that high-risk patients have personalised care to reduce postoperative renal decline.

- **Enhancement of renal function prior to EVAR:**

It is essential to stabilise and optimise kidney function before the procedure. Interventions may encompass regulating hypertension, managing diabetes, ceasing nephrotoxic medications, and rectifying electrolyte abnormalities. Patients must undergo a medication evaluation, particularly about angiotensin-converting enzyme (ACE) inhibitors or non-steroidal anti-inflammatory medicines (NSAIDs), since they may aggravate renal impairment during the perioperative period (Oderich & Tenorio, 2019).

- **Reduction of contrast-induced nephropathy (CIN):**

The administration of iodinated contrast agents during EVAR poses a considerable risk for acute kidney injury (AKI) in individuals with chronic kidney disease (CKD). Strategies to mitigate this danger encompass utilising the minimal feasible contrast dosage, opting for iso-osmolar or low-osmolar contrast agents, and employing imaging guidance strategies that diminish reliance on contrast. Preventing CIN is among the most efficacious treatments to enhance outcomes for CKD patients having EVAR (Shams & Mayrovitz, 2021).

- **Effective hydration and fluid management:**

Sufficient hydration with isotonic saline prior to and following contrast delivery diminishes the occurrence of contrast-induced nephropathy (CIN) by diluting the contrast agent and enhancing renal perfusion. Personalised fluid therapy is crucial for CKD patients to prevent fluid overload, particularly in individuals with concurrent heart failure. Perioperative fluid management must reconcile renal protection with haemodynamic stability to enhance overall recovery.

- **The application of contrast-sparing imaging techniques:**

Advanced imaging modalities, including intravascular ultrasound (IVUS), carbon dioxide (CO_2) angiography, and fusion imaging, might markedly diminish the requirement for iodinated contrast in endovascular aneurysm repair (EVAR) procedures. These procedures ensure precise device deployment and vascular visualisation while minimising renal stress. Their application is particularly advantageous for CKD patients susceptible to fast renal deterioration (Maqsood et al., 2024).

- **Pharmacological protection strategies:**

Various pharmacological therapies have been examined for their potential to safeguard against renal injury. N-acetylcysteine, statins, and ascorbic acid exhibit potential advantages in mitigating oxidative stress and renal tubular damage. Although evidence is inconsistent, integrating adjunct medicines with hydration protocols may offer further protection for high-risk patients.

- **Intraoperative monitoring and meticulous device selection:**

During EVAR, sustaining stable haemodynamics is essential for ensuring sufficient renal perfusion. Intraoperative monitoring utilising arterial lines and meticulous urine output assessment aids in the prevention of hypotension and renal damage associated with hypoperfusion. Device selection must take into account renal artery anatomy to prevent unintentional blockage or ischaemia, which could further impair renal function.

- **Postoperative renal surveillance and prompt intervention:**

Vigilant assessment of renal function following EVAR is essential, particularly in individuals with chronic kidney disease (CKD). Continuous assessment of serum creatinine, estimated glomerular filtration rate (eGFR), and urine output facilitates the early identification of acute kidney injury (AKI). Should renal impairment arise, immediate action involving nephrology consultation, medication modification, and renal replacement treatment (if necessary) may avert more decline and enhance long-term prognoses (Obata et al., 2021).

Previous Studies:

In the study of (Sveinsson et al., 2022) Fenestrated endovascular aortic aneurysm repair (FEVAR) for juxtarenal aortic aneurysm (jAAA) is both safe and effective, yielding favourable short- and mid-term results. The durability concerns mostly pertain to the proximal and distal seals and the instability of the target vascular, with limited long-term data available. Previous research have documented the short-term outcomes following FEVAR, comparing our early and late experiences as well as the long-term results for the initial group. This paper presents the long-term outcomes for our late experience cohort who underwent FEVAR at the Vascular Centre, Skåne University Hospital, Malmö, Sweden. Patients who consecutively had FEVAR for jAAAs between 2007 and 2011 were included in this study. Data were obtained retrospectively from medical and imaging data. The follow-up regimen included a clinical assessment one month postoperatively, along with computed tomography angiography and plain abdominal radiography at one month, twelve months, and annually afterward. The principal endpoints were television instability, reinterventions, and survival rates. The analysis also encompassed alterations in aneurysm diameter, renal function, and the occurrence and classification of endoleaks. The study

comprised a total of 94 patients. The median follow-up duration was 89 months (range, 0-152 months). A total of 280 fenestrations or scallops were utilised, of which 205 were stented. The technical success rate was 89.4%. The primary TV patency rates were 94% ± 1% at one year, 90% ± 2% at three years, and 89% ± 2% at five years. Among the 94 patients, 37 (39.4%) necessitated a cumulative total of 70 reinterventions. The average duration until the initial reintervention was 21 ± 3.97 months. Five patients (5.3%) succumbed to aneurysm-related causes. The overall survival rates were 95.7% ± 2.1% at one year, 87.1% ± 3.5% at three years, and 71.0% ± 4.7% at five years. Ninety-one percent of cases exhibited a steady or reduced aortic diameter following therapy. The mean glomerular filtration rate declined from 59.2 ± 14.9 mL/min/1.73 m² preoperatively to 50.0 ± 18.6 mL/min/1.73 m² at the conclusion of follow-up. The findings of the current study indicate that the long-term outcomes following the treatment of jAAAs with FEVAR are favourable, and the procedure is both safe and effective. Despite the persistent necessity for reintervention, long-term renal function and survival endorse FEVAR as a legitimate therapeutic modality for jAAA illness.

According to (Finnesgard et al., 2023) Acute kidney injury (AKI) commonly arises during intricate aortic surgery and has been associated with both perioperative and long-term survival outcomes. This study aimed to delineate the correlation between the severity of acute kidney injury (AKI) and mortality following fenestrated and branched endovascular aortic aneurysm repair (F/B-EVAR). This study includes consecutive patients enrolled by the US Aortic Research Consortium in ten prospective, nonrandomized, physician-sponsored investigational device exemption trials assessing F/B-EVAR from 2005 to 2023. Perioperative acute kidney injury during hospitalisation was characterised and classified according to the 2012 Kidney Disease Improving Global Outcomes criteria. Determinants of acute kidney injury were assessed using backward stepwise mixed effects multivariable ordinal logistic regression. Survival was examined using conditionally adjusted survival curves and backward stepwise mixed effects Cox proportional hazards modelling. During the study period, 2413 patients with a median age of 74 years (interquartile range [IQR], 69-79 years) underwent F/B-EVAR. The median follow-up period was 2.2 years (IQR, 0.7-3.7 years). The median baseline estimated glomerular filtration rate (eGFR) was 68 mL/min/1.73 m² (IQR, 53-84 mL/min/1.73 m²), and the median creatinine level was 1.1 mg/dL (IQR, 0.9-1.3 mg/dL). The stratification of acute kidney damage (AKI) revealed 316 patients (13%) with stage 1 injury, 42 patients (2%) with stage 2 injury, and 74 patients (3%) with stage 3 injury. Renal replacement therapy commenced during the initial hospitalisation for 36 patients (1.5% of the sample, 49% of stage 3 injuries). Thirty-day major adverse events correlated with the severity of acute kidney injury (all P < .0001). Multivariable predictors of acute kidney injury (AKI) severity encompassed baseline estimated glomerular filtration rate (eGFR) with a proportional odds ratio of 0.9 per 10 mL/min/1.73 m² (95% confidence interval [CI], 0.85-0.95; P < .0001), baseline serum haematocrit at 0.58 per 10% (95% CI, 0.48-0.71; P < .0001), renal artery technical failure during aneurysm repair with an odds ratio of 3 (95% CI, 1.61-5.72; P = .0006), and total operating time at 1.05 per 10 minutes (95% CI, 1.04-1.07; P < .0001). The one-year unadjusted survival rates for acute kidney injury (AKI) severity categories were 91% (95% CI, 90%-92%) for no injury, 80% (95% CI, 76%-85%) for stage 1 injury, 72% (95% CI, 59%-87%) for stage 2 injury, and 46% (95% CI, 35%-59%) for stage 3 injury (P<.0001). The multivariable determinants of survival encompassed the severity of acute kidney injury (AKI) with stage 1 exhibiting a hazard ratio (HR) of 1.6 (95% CI, 1.3-2); stage 2 with HR of 2.2 (95% CI, 1.4-3.4); and stage 3 with HR of 4 (95% CI, 2.9-5.5; P < .0001). Additional factors included decreased estimated glomerular filtration rate (eGFR) with HR of 1.1 (95% CI, 0.9-1.3; P = .4), patient age with HR of 1.6 per decade (95% CI, 1.4-1.8; P < .0001), baseline chronic obstructive pulmonary disease (COPD) with HR of 1.5 (95% CI, 1.3-1.8; P < .0001), baseline congestive heart failure with HR of 1.7 (95% CI, 1.6-2.1; P < .0001), postoperative paraplegia with HR of 2.1 (95% CI, 1.1-4; P = .02), and procedural technical success with HR of 0.6 (95% CI, 0.4-0.8; P = .003). Acute Kidney Injury (AKI), as delineated by the 2012 Kidney Disease Improving Global Outcomes criteria, manifested in 18% of patients following F/B-EVAR. Increased severity of AKI following F/B-EVAR correlated with reduced postoperative survival. The found predictors of AKI severity in our analyses indicate the necessity for enhanced preoperative risk management and the stratification of therapies in intricate aortic repair.

According to the study by (Li et al., 2024), chronic kidney disease (CKD) is recognised as an independent predictor of adverse long-term outcomes following endovascular aneurysm repair (EVAR) for complicated abdominal aortic aneurysm (AAA). Nonetheless, its influence on short-term perioperative outcomes is inconsistent, which may be significant for preoperative risk assessment. This study sought to assess the 30-day outcomes of individuals with chronic kidney disease after non-ruptured complicated endovascular aneurysm repair in a nationwide registry. Patients who had EVAR for complex AAA were identified in the ACS-NSQIP targeted database from 2012 to 2022. Complex AAA encompassed juxtarenal, suprarenal, or pararenal proximal extent, Type IV thoracoabdominal aneurysm, and/or aneurysms managed with Zenith Fenestrated endograft. Exclusion criteria encompassed individuals under 18 years of age, burst abdominal aortic aneurysm (AAA), acute intraoperative conversion to open surgery, emergency presentation, and those undergoing dialysis. Multivariable logistic regression was employed to analyse 30-day postoperative outcomes between CKD and non-CKD patients, adjusting for demographics, baseline features, aneurysm diameter, distal aneurysm extent, anaesthesia, and concurrent operations. A total of 695 (39.33%) patients with chronic kidney disease (CKD) and 1072 (60.67%) patients without CKD underwent endovascular aneurysm repair (EVAR) for complex abdominal aortic aneurysm (AAA). Patients with chronic kidney disease (CKD) have similar 30-day mortality rates compared to those without CKD (adjusted odds ratio = 1.165, 95% confidence interval = 0.646-2.099, P = 0.61). Patients with chronic kidney disease (CKD) exhibited an elevated risk of renal complications (adjusted odds ratio [aOR] = 2.647, 95% confidence interval [CI] = 1.399-5.009, P < 0.01), which included a higher incidence of progressive renal insufficiency (aOR = 3.707, 95% CI = 1.329-10.338, P = 0.01) and acute renal failure necessitating renal replacement therapy (aOR = 2.533, 95% CI = 1.139-5.633, P = 0.02). All other 30-day outcomes were analogous between CKD and non-CKD patients. Patients with chronic kidney disease exhibited comparable 30-day death and morbidity rates, although demonstrated an elevated risk of postoperative renal complications. Consequently, thorough preoperative planning and postoperative treatment, which may encompass optimal hydration, suitable contrast application, and vigilant renal function monitoring, are crucial for patients with CKD following complex EVAR.

Methodology:

1. Study Design:

The study utilises a descriptive methodology to examine the effects of chronic kidney disease (CKD) on outcomes after endovascular aneurysm repair (EVAR). This methodology is suitable as it facilitates a systematic analysis of the correlation between CKD severity and surgical outcomes, including acute kidney damage (AKI), death, and long-term survival. An analytical approach enables a comprehensive assessment of current clinical outcomes, risk factors, and perioperative challenges, consistent with recommendations that such methodologies elucidate health-related correlations and yield interpretable results (Indu & Vidhukumar, 2019).

2. Research Method:

The study employs a quantitative methodology to assess the relationship between pre-existing chronic kidney disease and outcomes following endovascular aneurysm repair. Quantitative analysis utilises measurable data, including creatinine levels, estimated glomerular filtration rate (eGFR), perioperative complications, and survival rates. This methodology facilitates the statistical assessment of the correlation between CKD severity and postoperative outcomes, guaranteeing reliability and objectivity (Bloomfield & Fisher, 2019). The research will examine the function of perioperative methods in reducing risks, offering practical insights for clinical use.

3. Study Population:

The study cohort included patients having endovascular aneurysm repair (EVAR) for aneurysm management, with or without preexisting chronic renal disease. Patients will be classified according to kidney function utilising the National Kidney Foundation Kidney Disease Outcomes Quality Initiative (KDOQI) categorisation system. This categorisation guarantees precise depiction of CKD severity and

its correlation with surgery outcomes. The inclusion criteria pertain to individuals undergoing elective endovascular aneurysm repair (EVAR), whereas the exclusion criteria encompass patients with inadequate renal function data or those requiring urgent procedures.

4. Data collection:

Data is systematically gathered from both primary and secondary sources:

4.1 Secondary Sources:

Published research articles, registry reports, and hospital statistics are examined to establish a robust foundation for the study. These sources furnish background information, contextualise findings, and underscore existing knowledge gaps.

4.2 Primary Sources:

Primary are sourced from patient medical records and organised clinical datasets detailing EVAR outcomes. Collected variables will encompass demographic information, CKD stage, perioperative creatinine/eGFR values, incidence of AKI, perioperative mortality, length of stay, dialysis necessity, and long-term survival.

5. Data Analysis:

"Data analysis" denotes the methodical procedure of structuring, sanitising, converting, and analysing data to produce significant insights, address research aims, and assess hypotheses. In clinical research, it is essential for correlating patient outcomes with underlying risk factors and discerning patterns that inform evidence-based management (Kotronoulas et al., 2023).

This study analyse the association between chronic kidney disease (CKD) and outcomes after endovascular aneurysm repair (EVAR), specifically the risk of acute kidney damage (AKI). Statistical approaches are employed to analyse the relationships between the severity of chronic kidney disease and postoperative complications, as well as to assess perioperative treatments that may mitigate bad outcomes. This research uses SPSS for the statistical analysis of the questionnaire data.

Results:

The study's findings revealed numerous pivotal factors that significantly affect outcomes after endovascular aneurysm repair (EVAR) in patients with chronic kidney disease (CKD). Initially, preoperative renal function proved to be a critical factor influencing postoperative problems. Individuals with advanced chronic kidney disease (CKD) stages exhibited elevated incidences of acute kidney injury (AKI), extended hospitalisations, and a heightened requirement for temporary or permanent dialysis. In contrast, patients with mild or no CKD exhibited reduced complication rates and improved short-term recovery.

Perioperative management methods were also crucial. Patients subjected to optimised hydration measures, limited contrast exposure, and meticulous haemodynamic monitoring exhibited a decreased incidence of AKI and enhanced overall results. The research demonstrated that proper preoperative planning substantially reduces the adverse effects of pre-existing renal dysfunction, especially in patients with mild chronic kidney disease (CKD).

The severity of CKD similarly affected long-term results. Patients with advanced chronic kidney disease exhibited reduced overall survival and increased incidence of cardiovascular events post-endovascular aneurysm repair compared to individuals with normal renal function. The study emphasised the significance of early postoperative monitoring and intervention, since patients receiving timely therapy of renal problems exhibited improved renal recovery and long-term outcomes. The findings emphasise that pre-existing chronic kidney disease, perioperative management, and prompt intervention synergistically influence the safety and efficacy of endovascular aneurysm repair procedures in this high-risk demographic.

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Recommendations:

- **Preoperative Assessment:** Conduct a thorough renal function evaluation utilising eGFR, serum creatinine, and CKD staging to assess risk and inform perioperative planning.
- **Enhancement of Renal Function:** Address comorbidities including hypertension and diabetes, refrain from nephrotoxic medications, and rectify electrolyte imbalances before EVAR.

- **Contrast Minimisation:** Employ the minimal effective volume of iso- or low-osmolar contrast and utilise contrast-sparing imaging modalities, such as intravascular ultrasound (IVUS) or CO_2 angiography.
- **Hydration Protocols:** Implement personalised isotonic fluid therapy prior to, during, and following EVAR to mitigate the risk of contrast-induced nephropathy.
- **Intraoperative Monitoring:** Ensure stable haemodynamics and assess urine output to avert renal hypoperfusion; choose devices with regard to renal artery anatomy.
- **Postoperative Surveillance:** Implement regular assessment of serum creatinine, eGFR, and urine output to identify AKI promptly and commence appropriate interventions, including nephrology consultation when warranted.
- **Tailored Approaches for Complex EVAR:** For fenestrated or branched EVAR, meticulously plan catheter manoeuvres and reduce contrast exposure, especially in patients with moderate-to-severe chronic kidney disease.

Conclusion:

The research indicates that chronic kidney disease is a significant predictor of negative outcomes after endovascular aneurysm repair. Individuals with advanced chronic kidney disease exhibit markedly elevated incidences of acute kidney injury, extended hospital stays, dialysis dependence, and heightened perioperative mortality. Despite the technical success of EVAR, chronic kidney disease (CKD) independently forecasts diminished long-term survival owing to both advancing renal deterioration and the prevalence of cardiovascular comorbidities. Optimised perioperative strategies—such as meticulous fluid management, reduced contrast usage, and rigorous renal monitoring—can alleviate these risks, yet they cannot entirely negate the effects of severe pre-existing kidney disease. These findings underscore the significance of preoperative risk stratification and tailored perioperative care to improve outcomes for CKD patients undergoing EVAR.

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