Cardiovasc Surg Int 2020;7(2):57-62
http://dx.doi.org/DOI: 10.5606/e-cvsi.2020.814
www.e-cvsi.org

Original Article Open Access

A comparison of renal failure development between endovascular and open aortic aneurysm repair in patients older than 80 years

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Received: May 16, 2020 ***Accepted:*** June 07, 2020 ***Published online:*** June 16, 2020

ABSTRACT

Objectives: In this study, we aimed to compare open surgery and endovascular aneurysm repair in terms of renal failure development in patients over 80 years of age.

Materials and methods: The literature search was carried out in PubMed, Ovid, Web of Science, and Scopus electronic databases without publication date and language restriction. Clinical studies involving the group of patients over 80 years old, comparing open surgery and endovascular aneurysm repair, including post-procedural renal failure rates, were included in the analysis. The results of the studies were evaluated according to the presence of heterogeneity (I^2>25%) by the random or fixed effect model.

Results: A total of 7,845 articles were reached. After reviewing the article titles and abstracts, 10 articles including 9,027 patients were included in the analysis. As a result of the analysis, there was a significant difference between open surgery and endovascular aneurysm repair in terms of renal failure development (odds ratio [OR]: 0.378, 95% confidence interval [CI]: 0.187-0.765 and p=0.007). Studies were observed to be heterogeneous (I^2=83.8%). Possible publication bias results were not significant using the Begg test (tau^2=0.70).

Conclusion: Our study results suggest that aortic aneurysm repair with both techniques carries serious risks for renal failure, and the risk is higher with open surgical technique in patients over the age of 80.

Keywords: Aortic aneurysm, elderly, endovascular repair, open repair.

The most frequent diseases of aorta are atherosclerosis and aneurysms.[1] True aneurysms defined as a permanent localized dilatation of an artery, having at least a 50% increase in diameter compared to the normal diameter".[2] Aortic aneurysms may be located in the abdomen (62.7%), thorax (25.9%), thoracoabdominal region (8.3%), and unspecified (3.0%) sites.[2]

The risk factors for aortic aneurysms include age, male sex, smoking, family history of abdominal aortic aneurysms (AAAs), coronary artery disease, hypertension, peripheral artery disease, and previous myocardial infarction.[3] In particular, age older than 65 years is the main risk factor for aortic aneurysms.

In the interventional treatment of aneurysms, two options can be selected: conventional open surgical repair (OSR) or endovascular aneurysm repair (EVAR). In a recent meta-analysis performed by Powell et al.,[4] early mortality was found to be lower in EVAR compared to OSR. However, five-year survival rates were comparable between the groups.[4] In a more recent analysis for long-term outcomes, there was no significant difference between the EVAR and OSR.[5]

Factors causing renal failure in aortic aneurysm repair are thought to be problems such as atheroembolism, intraoperative hypotension, and renal ischemia.[6] Saratzis et al.[7] reported that 18.8% of acute renal injuries occurred in a cohort study including 149 patients. In another study, Toya et al.[8] observed that a similar rate (19%) of renal failure in their cohort. Previous studies demonstrated that post-procedural

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Citation:
Öztürk S, Kayacıoğlu İ, Öztürk İ. A comparison of renal failure development between endovascular and open aortic aneurysm repair in patients older than 80 years. Cardiovasc Surg Int 2020;7(2):57-62.

acute renal injury increased the aneurysm-related mortality and cardiovascular morbidity rates and prolonged the length of hospital stay.[7,8]

To the best of our knowledge, there is no meta-analysis available in the literature comparing EVAR and OSR for renal failure in patients older than 80 years. We, therefore, aimed to compare OSR and EVAR in terms of renal failure development in this patient population.

MATERIALS AND METHODS

Literature search

We performed database search according to the systematic review and meta-analysis guidelines published in 2015.[9] In the initial stage, we conducted our electronic database search to determine whether postoperative renal failure could differ between EVAR and OSR. Researchers screened the PubMed, Scopus, Web of Science and Ovid electronic databases up until 01.02.2020 without no publication or language restriction. In the search, the following keywords were used: "aortic aneurysm", "thoracic aortic aneurysm", "abdominal aortic aneurysm", "endovascular repair", "open surgical repair", "renal failure", "renal insufficiency", "renal injury", "kidney failure", "kidney insufficiency", and "kidney injury".

Selection criteria

All studies (i.e., retrospective/prospective; randomized/observational) were included without sample size restriction. Inclusion criteria were as follows: *(i)* clinical human study, *(ii)* adult patients, *(iii)* articles in English language. Exclusion criteria were as follows: *(i)* experimental studies and *(ii)* case studies or case series. Studies which were relevant to our subject of study, but were unable to investigate development of postoperative renal failure were not included in the analysis. A meta-analysis was carried out for studies in which comparative data were reported. In addition, articles in which relevant data were presented as figures or graphs were excluded from the analysis.

Data collection

Researchers recorded the related data (including name of the first author, date of publication, sample size, research design, and prevalence of renal failure) independently from each other. Disagreements were resolved by consensus.

Statistical analysis

Data were analyzed using the Jamovi® version 1.2 (The jamovi project; 2020) and Open MetaAnalyst® for Windows 8 version (Brown University, Rhode Island, USA) software. The results were presented in odds ratio (OR) and 95% confidence interval (CI). Heterogeneity was evaluated using the I^2 statistics. No heterogeneity: $I^2<25\%$, low heterogeneity: $50\%<I^2>25\%$, moderate heterogeneity: $75\%<I^2>50\%$, and high heterogeneity: $I^2>75\%$. When there was a significant heterogeneity, analysis of moderators was evaluated for the cause of heterogeneity. The meta-analysis was carried out using fixed or random models and results were presented with forest plot. In the presence of heterogeneity ($I^2>25\%$), the random effects model was used; otherwise for ($I^2<25\%$), the fixed effect model was used. Publication bias was evaluated using the Begg's test.

RESULTS

After the screening of databases, we obtained a total of 7,845 articles. After removing the duplications and unrelated articles, a total of 10 articles were included in the analysis.[10-19] The database search flow diagram is shown in Figure 1.

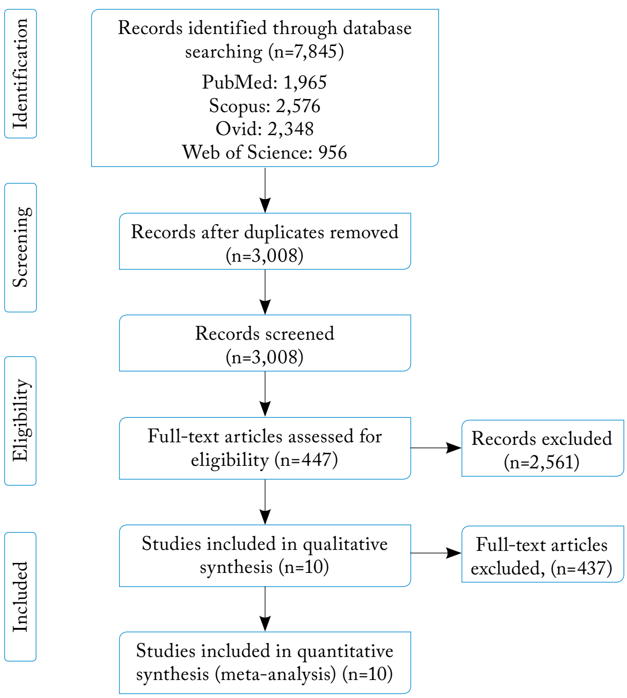

Figure 1. Database search flow diagram.

Table 1
Relevant features of studies included in the analysis

Study	Year	Country	Period	EVAR (n)	OSR (n)	Trial design	Weight on results
Morisaki et al.[10]	2016	Japan	2007-2011	117	90	R	5.83
Sicard et al.[17]	2001	USA	1997-2000	52	38	P	3.79
De Donato et al.[16]	2007	Italy	2004-2007	32	12	P	3.71
Raval et al.[15]	2012	USA	2005-2008	1634	391	R	14.76
Tan et al.[19]	2017	USA	2005-2014	450	598	R	17.62
Martelli et al.[11]	2017	Italy	2006-2010	42	55	R	8.96
Law et al.[13]	2018	China	1999-2013	11	23	P	9.49
Locham et al.[12]	2018	USA	2006-2015	242	306	R	13.80
Karimi et al.[14]	2016	USA	2006-2013	41	54	R	3.79
Hicks et al.[18]	2016	USA	2003-2014	4074	765	R	18.21

R: Retrospective; P: Prospective.

Relevant features of the studies included in the analysis are summarized in Table 1. As a result of the analysis, heterogeneity was observed (Q: 55.56, df,[9] p<0.001, I^2: 84%). The random effect model was used for the final analysis due to the heterogeneity, indicating that the difference between two techniques for the development of renal failure was statistically significant (OR: 0.378, 95% CI: 0.187-0.765; p=0.007). According to this result, possibility of renal failure development was higher in ORS than EVAR (Table 2).

When we analyzed heterogeneity among the studies, the main reason of heterogeneity was the retrospective design of the studies (I^2: 88.79%). The results on the heterogeneity analysis are summarized in Table 2.

Model fitting weights were between 3.71% (De Donato et al.[16]) and 18.21% (Hicks et al.[18]). Four of the studies[12,15,18,19] included in the analysis had 64.3% effect on the results.

Possible publication bias results were not significant according to the Begg's test (tau 2=0.7). Fail-safe number (possible articles overlooked or inaccessible during the literature search) according to file drawer analysis was calculated as 10 using the Orwin approach.

DISCUSSION

In this analysis, we included 10 articles to determine the possibility of renal failure risk between EVAR and OSR in elderly patients older than 80 years. The results demonstrated that there was a significant difference for the development of renal failure. The heterogeneity among the studies was very high, but the possibility of publication bias was not statistically significant. The main reason for the presence of heterogeneity was the retrospective design of the studies.

In their study, Bagia et al.[20] showed that elective AAA repair caused higher treatment costs in patients over 80 years of age. However, the opposite result

Table 2
Results of analysis

	OD	95% CI	*p*	Q	df	*p*	I^2 (%)	Publication bias
Retrospective studies	0.370	0.16-0.82	0.014	53.52	6	<0.001	88.79	0.75
Prospective studies	0.50	0.13-1.87	0.669	1.39	2	0.499	0	0.0
Overall	0.378	0.187-0.765	0.007	55.56	9	<0.001	83.8	0.7

OD: Odds ratio; CI: Confidence interval.

was obtained in the emergency surgery setting. Nevertheless, as a result of analyzing the ratio of treatment cost to survival, emergency AAA repair caused an eight-fold increase over 80 years.

In a recent meta-analysis of 15,580 patients and 13 studies, patients who underwent thoracic aortic aneurysm repair were examined.[21] In this study, OSR was applied to younger patients and EVAR was chosen for mostly elderly. According to this meta-analysis, the rate of renal failure development was higher in the OSR (p=0.01). On the other hand, the age difference between the groups appeared to be an important issue in this analysis. However, Scheer et al.[22] concluded that the development of renal insufficiency did not show a significant difference between the octogenarian and younger patients.

In another study, Grant et al.[23] examined the risk factors of renal failure in patients undergoing elective OSR with a logistic regression model. As a result, age >75 years, symptomatic AAAs, respiratory disease, hypertension, juxta-/supra-renal AAAs, and a serum creatinine level of >150 µmol/L were found to be risk factors. According to the data obtained from this study, for the renal insufficiency in the scoring system, the age of >75 years was 1.5 and serum creatinine >150 µmol/L was 2.5, while the other factors were evaluated with 2 points.

Geriatric patients and renal failure are two important issues for aortic aneurysm repair. Egorova et al.[24] evaluated 66,943 patients who underwent EVAR and recommended a scoring system for 30-day mortality risk. In this scoring system, age and renal failure were the factors which increased the risk. For age between 75 and 79 years one point, 80 and 84 years two points, and ≥85 years four points were determined. On the other hand, the highest risk factor was renal failure (7 points) requiring dialysis. A recent study by Saratzis et al.[7] investigated the development of renal insufficiency due to EVAR in 146 patients, and demonstrated that the rate of renal insufficiency was significant (18.8%) and was associated with mortality. Wald et al.[25] also compared EVAR and OSR in terms of renal failure in their retrospective study including 6,516 patients. Renal failure developed in 6.7% of the patients. However, the authors observed that EVAR had a lower probability (OR: 0.42, 95% CI: 0.33-0.53). In addition, EVAR was more advantageous, as it reduced renal failure requiring dialysis (OR: 0.30, 95% CI: 0.15-0.63). Our analysis and results were an update of a previous meta-analysis performed with only three studies.[26] This current meta-analysis applied with 10 versus three studies in 9,027 versus 2,159 patients. According to these results, retrospective studies have more weight. The total weight of prospective studies was 16.99%.[13,16,17] The weight of four studies with a high sample size was 64.39%.[12,15,18,19] Also, these were retrospective studies. Among the studies we included in the quantitative analysis, there was no study with a randomized-controlled design.

In their research, Hagiwara et al.[27] retrospectively examined 350 patients and 25.7% had chronic renal failure. After 30 months of follow-up, the rate of chronic renal failure increased to 33.4%. On the other hand, 27.5% of them had acute renal failure postoperatively. In this study, the authors concluded that being over 65 years of age was a risk factor for chronic renal failure development, but not for acute renal failure. In another study, Patel et al.[28] examined the effect of renal failure on clinical outcomes in 8,701 patients with chronic renal failure. They analyzed the patients by classifying them as mild, moderate, and severe renal insufficiency and EVAR or OSR. When the groups with mild and severe renal insufficiency were compared, a significant relationship was observed between renal failure severity and 30-day mortality, prolongation of ventilation, and acute renal failure in both EVAR and OSR groups. However, an increased amount of blood transfusion and cardiac arrest differed only in the EVAR group. The development of renal insufficiency in the aneurysm repair may increase the risk for morbidity, leading to an increase in the cost of treatment and mortality due to secondary causes.

There are some limitations to the present research. The lack of randomized-controlled trials which fulfilled the inclusion criteria are the main limitation. On the other hand, although many studies included patients over 80 years of age, the fact that the age variable for renal failure development was not examined by age subgroups reduced the number of studies we analyzed.

In conclusion, our study results suggest that repair of aortic aneurysms with both techniques carries a risk for renal failure development, and the risk is higher with open surgical technique in patients over the age of 80 years. However, further large-scale, randomized-controlled studies are needed to confirm these results.

Declaration of conflicting interests

The authors declared no conflicts of interest with respect to the authorship and/or publication of this article.

Funding

The authors received no financial support for the research and/or authorship of this article.

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