

# Renal Failure: The Most Important Prognostic Factor for Morbidity and Mortality in Patients Undergoing Open Elective Abdominal Aortic Aneurysm Repair

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## ABSTRACT

**Introduction:** The elective abdominal aortic aneurysm repair leads to a remarkable decrease in the rupture of aneurysm and an increase in the life expectancy among patients.

**Aim:** To study the mortality rate and complications of the open elective abdominal aortic aneurysm repair.

**Materials and Methods:** This descriptive cross-sectional retrospective study was carried out on all patients who had undergone open elective abdominal aortic aneurysm repair in Rasht Hospitals, Iran, from March 2007 to March 2011. The background variables, i.e., preoperative, intraoperative, and postoperative results, as well as relevant variables including mortality and complications were recorded on a checklist. The data collected were analysed using SPSS 21.0 through univariate and multivariate analyses.

**Results:** From the total of 61 patients, 11 (18%) were female

and 50 (82%) of them were male. Nine patients (14.8%) died within 30 days from the surgery, and five patients (8.2%) suffered complications: Acute renal failure (three individuals) and sepsis (two individuals). In the univariate analysis, the Blood Urea Nitrogen (BUN) level of over 25 mg/dL ( $p=0.028$ ) and the serum creatinine level of over 1.2 mg/dL ( $p=0.047$ ) had a significant correlation with postoperative mortality. Additionally, the intensive care unit stay ( $p=0.019$ ) and the duration of the mechanical ventilation ( $p=0.021$ ) were significantly correlated with the postoperative complication occurrence.

**Conclusion:** The BUN level of over 25 mg/dL and the serum creatinine level exceeding 1.2 mg/dL were the predictors of mortality, and the intensive care unit stay and the duration of the mechanical ventilation were the predictors of the postoperative complication occurrence after the open elective abdominal aortic aneurysm repair.

**Keywords:** Abdominal aortic aneurysm complications, Diagnosis, Risk factors

## INTRODUCTION

Arterial aneurysm is one of the most prevalent vascular diseases among the elderly that leads to disabilities and deaths. It occurs 2-6 times more in men than women [1]. Most of the patients die immediately as a result of the rupture of aneurysm, and those who survive and are taken to hospitals have a mortality rate of 30-50% [2].

Taking into account the risk of mortality and long-term morbidity associated with this type of surgery, only experienced surgeons who have relevant information and can precisely select appropriate patients for the surgery can handle it successfully. Therefore, the surgery has turned into a challenge and an opportunity for vascular surgeons [3].

The present study was conducted aimed at examining factors that probably lead to mortality in patients and to use the results in improving the preoperative, intraoperative, and postoperative care of the open elective abdominal aortic aneurysm repair and reduce the mortality and morbidity rate of this type of surgery through identifying high-risk patients and changing the approach to the endovascular surgery.

## MATERIALS AND METHODS

This descriptive cross-sectional retrospective study was carried out on all the patients ( $n=61$ ) who had undergone the open elective abdominal aortic aneurysm repair in Rasht Hospitals from March 2007 to March 2011. The patients' informed consent was obtained individually before enrollment. There were no exclusion criteria apart

from the death of patients. Background variables (age and gender, BUN, and the serum creatinine level), postoperative variables (the duration of the stay in the Intensive Care Unit (ICU) and the duration of the mechanical ventilation), and variables concerning mortality and morbidity were retrieved from the patients' records.

## STATISTICAL ANALYSIS

After the collection of the data required, they were entered into SPSS 21.0. Concerning the quantitative variables, independent t-test and Mann-Whitney U test were used, and Chi-square test and Fisher's-exact tests were utilised to examine the correlation among the qualitative variables. The level of statistical significance was set at  $p<0.05$ . The entire data were retrieved from the patients' records. The patients' names remained confidential, and the results were published in general, in the form of the study group information.

## RESULTS

The mean age of the patients was  $71.7\pm 7.8$  years. Among all the patients, 18% (11 individuals) of them were women and 82% (50 individuals) of them were men. No mortality occurred during the surgeries. The results of examining the hospital mortality status (the first 30 days after surgeries) demonstrated that 14.8% of the patients (nine individuals) died within the maximum period of 30 days after the surgery.

A total of 8.2% of the patients (five individuals) developed postoperative complications. The acute renal failure occurred in 4.9% of the patients (three individuals), the need for haemodialysis arose in 6.6% of the patients (four individuals), and sepsis occurred

in 3.3% of the patients (two individuals). No case of paraplegia, graft infections, or intestinal ischemia was observed.

The results indicated that the duration of the stay in ICU ( $p=0.019$ ) and the duration of the mechanical ventilation ( $p=0.021$ ) had a significant correlation with the development of complications [Table/Fig-1]. In the univariate analysis, the BUN of over 25 mg/dL ( $p=0.028$ ) and the serum creatinine of over 1.2 mg/dL

Variables		Complications		p-value
		No	Yes	
ICU stay duration (day)	Mean	5	19	0.019
	SD	2	15	
	Median	5	14	
	25 <sup>th</sup> percentile	4	11	
	75 <sup>th</sup> percentile	6	30	
	Mean	26	393	
Duration of mechanical ventilation (hour)	SD	19	418	0.021
	Median	21	270	
	25 <sup>th</sup> percentile	15	22	
	75 <sup>th</sup> percentile	41	705	

**[Table/Fig-1]:** The correlation between the variables of the ICU stays duration and the duration of mechanical ventilation in the development of complications in the univariate analysis.

Variable		Mortality			p-value
		No	Yes	Total	
BUN	≤25 (mg/dL)	38 (92.7)	3 (7.3)	41 (100)	0.028
	>25 (mg/dL)	14 (70)	6 (30)	20 (100)	
Serum creatinine	≤1.2(mg/dL)	36 (92.3)	3 (7.7)	39 (100)	0.047
	>1.2 (mg/dL)	16 (72.7)	6 (27.3)	22 (100)	

**[Table/Fig-2]:** The correlation between the variables of BUN and creatinine and the rate of complication in the univariate analysis.

( $p=0.047$ ) had a significant correlation with the development of mortality after the open elective abdominal aortic aneurysm repair [Table/Fig-2].

As [Table/Fig-3] shows, in the multivariate analysis of the prognostic factors based on the multiple logistic regression model, the stay duration in ICU has been considered as a

95% confidence interval, odd's ratio			Odd's ratio	p-value	SD	Regression coefficient
Upper bound	Lower bound					
2.825	1.094	1.758	0.020	0.242	0.564	ICU
		0.001	0.001	1.918	-6.527	Constant

**[Table/Fig-3]:** The regression coefficient and the chance of predicting complications based on the multiple logistic regression models by Backward LR method.

prognostic factor for the complication ( $p=0.02$ ), with the odd's ratio=1.76, 95% CI of OR (1.09-2.83). In other words, for each day of the stay in ICU, the risk of the complication development increases by 1.7 times.

## DISCUSSION

Abdominal aortic aneurysm is one of the most important peripheral vascular diseases, with the most prevalent place for the development of aortic aneurysm being abdominal aorta [2]. In case of failing to diagnose and treat the disease on time, it can lead to fatal complications; moreover, severe bleeding leads to the rupture of aneurysm and death [1,2]. In a report presented by the British Vascular Association in 2012 on the entire elective abdominal aortic

aneurysm repair surgeries conducted in Britain from 2008 to 2010, the rate of mortality was stated to be 4.3% for 3,584 patients [4]. In another study, depending on the patients' conditions and the presence or absence of risk factors, the postoperative mortality varied from 1.9% to 50% [4-11].

Many high-risk patients are in need of endovascular methods to treat their abdominal aortic aneurysm [6,7]. In the early years of the period of the present study, it was not possible to carry out this method in Guilan Province, so a large number of high-risk patients underwent the open elective abdominal aortic aneurysm repair that could lead to an increase in the mortality rate and the development of postoperative complications in the target statistical population. In the present study, 4.9% of the patients (three individuals) developed an acute renal failure after the surgery; this shows a more promising rate compared with the rate 19.4% in the study conducted by Nathan DP et al., [12]. Moreover, no case of paraplegia or intestinal ischaemia was observed in the present study. However, these complications were reported in the study carried out by Nathan DP et al., [12]. In the study conducted by Hicks CW et al., the most frequent postoperative complications were reported to be bleeding requiring blood transfusion >3 units (38.9%) and the acute kidney injury (34.9%) followed by dysrhythmia (26.9%), returning the patient to the operating room (17.9%), and the need for prolonged ventilation (15.7%) [13].

In the present study, less attention has been paid to the cause of intestinal ischaemia, but more attention has been devoted to the indications of large bowel revascularisation and even the anastomosis of the inferior mesenteric artery to the aortic graft. In the univariate analysis, the BUN of over 25 mg/dL had a significant correlation with the occurrence of hospital mortality after the open elective abdominal aortic aneurysm repair ( $p=0.028$ ). Nevertheless, this variable had no significant correlation with the development of the complications.

In the study conducted by Grima M et al., the urea exceeding 9 Mmol/l (equal to the BUN of 25 mg/dL) in the univariate analysis ( $p=0.031$ ) had a significant correlation with the occurrence of hospital mortality after the surgery. However, it was not significant in the multivariate analysis of the predictive model [5].

In the univariate analysis, serum creatinine exceeding 1.2 mg/dL had a significant correlation with the occurrence of hospital mortality after the open elective abdominal aortic aneurysm repair ( $p=0.047$ ). In the same vein, Hicks CW et al., and Brady A et al., demonstrated that serum creatinine exceeding 120 Mmol/l (equal to 1.4 mg/dL) in both the univariate analysis ( $p=0.005$ ) and the multivariate analysis ( $p=0.006$ ) had a significant correlation with the occurrence of postoperative hospital mortality [13,14]. In the study conducted by Brady A et al., it was reported that a higher level of serum creatinine in the univariate analysis ( $p=0.002$ ) had a significant correlation with the occurrence of postoperative hospital mortality [14]. It should be noted that similar results were reported in the studies carried out by Banke A et al., Davidović L et al., and Halpern VJ et al., [7,15,16].

In the present study, the average stay duration in ICU was reported to be six days, being more than the hospital stay of one day and four days after the endovascular surgery and the open surgery, respectively, as stated by Lederle FA et al., in their study [17]. This difference can be attributed to the absence of the post-ICU ward in the surgery ward, and due to the remarkable difference between the quality of the postoperative care in ICU and the surgery ward, the patient is hospitalised inevitably in ICU for a longer time.

In both the univariate analysis and the multivariate analysis, the stay duration in ICU had no significant correlation with the occurrence of

mortality, but it had a significant correlation with the occurrence of complications ( $p=0.019$ ). Besides, the stay duration in ICU was the only predictor of the complication occurrence after the open elective abdominal aortic aneurysm repair ( $p=0.02$ ) (odd's ratio=1.758) which is due to the prolonged stay in ICU that can lead to the occurrence of the complications.

In the present study, the mean duration of the mechanical ventilation, regardless of exceptional cases was measured to be about 30 hours being remarkably higher than that of the study conducted by Lederle FA et al., where the mean durations of the mechanical ventilation were 3.6 hours and 5 hours after the endovascular surgery and the open surgery, respectively [17]. The difference can be attributed to the anaesthesiologists' protocols at the centres in the present study, according to which after the open elective abdominal aortic aneurysm repair, the patients need to undergo mechanical ventilation at least for 24 hours so that they try less to breathe and consequently experience less cardiac afterloads.

In the univariate analysis and the multivariate analysis, the duration of mechanical ventilation had a significant correlation with the occurrence of complications ( $p=0.021$ ). This correlation can be due to the fact that the patients undergoing complications require more mechanical ventilation. On the other hand, this can be the indication of the weakness of the anaesthetic protocol that during the longer periods of mechanical ventilation that leads to an increased likelihood of complications such as respiratory pneumonia (VAP) and other complications when staying in the ICU, the mortality rate is concurrently increased.

## LIMITATION

The small sample size and exclusion of the endovascular surgery has been considered as the main limitations of the present study.

## CONCLUSION

To conclude it can be stated that understanding the factors leading to mortality and the development of complications after the open elective abdominal aortic aneurysm repair can help improve the preoperative, intraoperative, and postoperative cares. Besides, the mortality and complications of this type of surgery can be reduced through identifying high-risk patients and changing the approach to the endovascular surgery.

As a result, it is recommended that similar studies be conducted with larger samples to enhance the reliability of the results. It is also suggested that the endovascular surgery be used for high-risk patients to treat abdominal aortic aneurysm. Moreover, further investigations need to be made into anaesthesiologists' protocols

of longer mechanical ventilation after the open elective abdominal aortic aneurysm repair.

## REFERENCES

- [1] Bergqvist D. Historical aspects on aneurysmal disease. *Scandinavian Journal of Surgery*. 2008;97(2):90-99.
- [2] Schermerhorn M. Should usual criteria for intervention in abdominal aortic aneurysms be "downsized," considering reported risk reduction with endovascular repair? *Annals of the New York Academy of Sciences*. 2006;1085(1):47-58.
- [3] Cronenwett JL, Johnston KW, eds. *Rutherford's Vascular Surgery*. 8<sup>th</sup> ed. Philadelphia: Elsevier Health Sciences; 2014:654-672. American Thoracic Society.
- [4] Waton S, Johal A, Groene O, Cromwell D, Mitchell D, Loftus I. Outcomes after elective repair of infra-renal abdominal aortic aneurysm. London: The Royal College of Surgeons of England, November 2013. link-<https://www.vsqip.org.uk/content/uploads/2017/06/Outcomes-after-Elective-Repair-of-Infra-renal-Abdominal-Aortic-Aneurysm.pdf>
- [5] Grima M, Karthikesalingam A, Holt P, Vidal-Diez A, Thompson M, Wanhaien A, et al. Comparative analysis of the outcomes of elective abdominal aortic aneurysm repair in England and Sweden: Context for contemporary practice. *European Journal of Vascular and Endovascular Surgery*. 2017;54(5):667.
- [6] Beck AW, Goodney PP, Nolan BW, Likosky DS, Eldrup-Jorgensen J, Cronenwett JL. Predicting 1-year mortality after elective abdominal aortic aneurysm repair. *Journal of Vascular Surgery*. 2009;49(4):838-44.
- [7] Banke A, Andersen JS, Heslet L, Johansson P, Shahidi S. Mortality and morbidity in surgery for abdominal aortic aneurysm. *Ugeskrift for Laeger*. 2008;170(43):3430-34.
- [8] Chong T, Nguyen L, Owens CD, Conte MS, Belkin M. Suprarenal aortic cross-clamp position: a reappraisal of its effects on outcomes for open abdominal aortic aneurysm repair. *Journal of Vascular Surgery*. 2009;49(4):873-80.
- [9] Landry G, Lau I, Liem T, Mitchell E, Moneta G. Open abdominal aortic aneurysm repair in the endovascular era: effect of clamp site on outcomes. *Archives of Surgery*. 2009;144(9):811-16.
- [10] Nobili P, Annolfi B, Codemo R, Confalonieri F. Surgical treatment of abdominal aortic aneurysm. Factors affecting mortality and morbidity. *Il Giornale di Chirurgia*. 2001;22(5):177-80.
- [11] Richards J, Nimmo A, Moores C, Hansen P, Murie J, Chalmers R. Contemporary results for open repair of suprarenal and type IV thoracoabdominal aortic aneurysms. *British Journal of Surgery*. 2010;97(1):45-49.
- [12] Nathan DP, Brinster CJ, Jackson BM, Wang GJ, Carpenter JP, Fairman RM, et al. Predictors of decreased short-and long-term survival following open abdominal aortic aneurysm repair. *Journal of Vascular Surgery*. 2011;54(5):1237-43.
- [13] Hicks CW, O'Kelly A, Obeid T, Locham S, Malas MB. Predicting failure to rescue after abdominal aortic aneurysm repair in elderly patients. *Journal of Surgical Research*. 2017;217:265-70.
- [14] Brady A, Fowkes F, Greenhalgh R, Powell J, Ruckley C, Thompson S. Risk factors for postoperative death following elective surgical repair of abdominal aortic aneurysm: results from the UK Small Aneurysm Trial. *British Journal of Surgery*. 2000;87(6):742-49.
- [15] Davidović L, Marković M, Kostić D, Činara I, Marković D, Maksimović Ž, et al. Ruptured abdominal aortic aneurysms: factors influencing early survival. *Annals of Vascular Surgery*. 2005;19(1):29-34.
- [16] Halpern VJ, Kline RG, D'angelo AJ, Cohen JR. Factors that affect the survival rate of patients with ruptured abdominal aortic aneurysms. *Journal of Vascular Surgery*. 1997;26(6):939-48.
- [17] Lederle FA, Freischlag JA, Kyriakides TC, Padberg FT, Matsumura JS, Kohler TR, et al. Outcomes following endovascular vs open repair of abdominal aortic aneurysm: a randomized trial. *JAMA*. 2009;302(14):1535-42.

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