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วารสารสมาคมศัลยแพทย์ทั่วไปแห่งประเทศไทยในพระบรมราชูปถัมภ์

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ORIGINAL ARTICLE

30-days Mortality and Prognostic factors in patients with aortic balloon occlusion and conventional aortic cross clamp in ruptured abdominal aortic aneurysm.

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ABSTRACT

Background: In modern era of endovascular treatment, An Aortic Balloon Occlusion (ABO) is an alternative method to proximal aortic control in ruptured abdominal aortic aneurysm. The aim of this study was to evaluate mortality and prognostic factors of ruptured abdominal aortic aneurysm (rAAA) patients and compare between ABO and conventional aortic cross clamp (CAC) method.

Material and Methods: A retrospective study of patients with rAAA who were performed open abdominal aortic aneurysm (AAA) repair in Nakornping hospital between April 2017 and June 2020. All ruptured cases were reviewed from medical database. Primary outcome was the mortality rate compared between ABO and CAC technique to controlled ongoing bleeding before open AAA repair. Secondary outcome was prognostic factors that effected to mortality rate of open AAA repair procedure in patients with rAAA.

Results: 24 rAAA patients who were performed open AAA repair. Aortic balloon occlusion was performed in 6 patients (25%) and 18 patients (75%) in conventional aortic cross clamping. Mortality rate of CAC was higher than ABO group (16.67 % vs 61.11%, Risk ratio (RR) = 3.6 times, 95% confidence interval (CI) = -0.293 – 0.468, P-value = 0.059). The strong prognostic factors effecting to the mortality of open repair in patients with rAAA was post-operative acute kidney injury (AKI) (RR = 1.46, 95%CI = 0.17 – 0.93, P-value = 0.007). The potential prognostics factors including intra-operative blood loss and patients who need cardio-pulmonary resuscitation (CPR) (P-value = 0.062 and 0.093, respectively). The incidence of acute limb ischemia (ALI) after open AAA repair in patients with rAAA tend to be higher in ABO group (50% vs 5.5%, 95%CI = -0.99 – 0.29, P-value = 0.268).

Conclusions : Mortality rate in patients with open AAA repair to treated rAAA may decreased by alternative ABO technique when compared with CAC. However, most common complication of ABO patients was ALI due to ipsilateral common femoral artery insertion by large profile balloon and non-heparinization. The further study with prospective, large randomization study design should be evaluated.

Keywords: ruptured abdominal aortic aneurysm, aortic balloon occlusion, aortic crossclamp, open aortic repair, aneurysmorrhaphy

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Ruptured abdominal aortic aneurysm (rAAA) was emergency condition that cause high mortality. Perioperative mortality was 30-80 %.[1,2,3] Currently, endovascular aneurysm repair (EVAR) was demonstrated good outcome in rAAA and traumatic aortic injury.[4,5] However, some patients who did not suitable for EVAR still needed to perform open repair of abdominal aortic aneurysm (AAA). Patients treated by open repair AAA required proximal aortic control to prevent severe blood loss. Conventional aortic cross clamping techniques (CAC) was performed after general anesthesia and expeditious midline incision. This technique caused high risk of cardiac arrest. In modern era of endovascular treatment, an aortic balloon occlusion (ABO) is an alternative method to proximal aortic control in open repair of ruptured abdominal aortic aneurysm. Heimbecker et al, first described about the ABO through a brachial approach to proximal aortic control in 1964.[6] An advantage of ABO were ability to perform under local anesthesia and effectiveness in achieving hemodynamic stability. The aim of this study was to evaluate mortality and prognostic factors of rupture abdominal aortic aneurysm (rAAA) patients and compare between ABO and CAC method of open AAA repair procedure in patients with rAAA.

Material and Methods

A retrospective study of patients with rAAA who were performed open abdominal aortic aneurysm (AAA) repair in Nakornping hospital between April 2017 and June 2020. The patient's data were reviewed from medical database. We collected data include patient's characteristics (age, gender, underlying disease and co-morbidities), pre-operative blood pressure, intra-operative conditions (blood loss, operative time). Patients were allocated to two groups according to technique of aortic control including (1) aortic balloon occlusion (ABO) and (2) conventional aortic cross clamping techniques (CAC). After initial fluid evaluation and resuscitation.[7] ABO was performed under local anesthesia in operative theater. Percutaneous femoral approach was done using 2 vascular closure device(Proglide), 17 Fr introducer sheath (AFX) was placed at the level of distal descending thoracic aorta and 32 mm. diameter CODA balloon (Cook Medical) was brought and inflated proximal to aneurysm sac. This procedure was performed under fluoroscopy. Then midline abdominal incision was done. The balloon was kept inflated to avoid hemodynamic variations during anesthesia until aortic control allowed proximal cross-clamping.

[4] Clinical outcomes including (1) primary outcome was mortality rate between ABO and CAC technique to control ongoing bleeding before open AAA repair and (2) secondary outcome was prognostic factors that effected to mortality rate of open AAA repair procedure in patients with rAAA.

Statistical analysis

Associations between the baseline clinical data, predictive factors, cardiovascular conditions, and all-cause morbidities and mortalities were assessed with a univariate two-sample t-test for continuous data and a chi-squared/Fisher exact test for categorical data, and data were presented as the mean. Correlations between the cardiovascular condition and the overall mortality were also analyzed. P <0.05 was considered significant. The power was 0.80. All the statistical

analyses were performed with STATA/SE 15.1 for Windows (Stata Corp LP, TX, USA).

Results

24 patients of rAAA who were performed open AAA repair included in the study. Aortic balloon occlusion was performed in 6 patients (25%) and 18 patients (75%) in conventional aortic cross clamping. Patient's characteristics were not different between two group (Table 1). We compared outcome of surgery that no statistically significant difference in blood loss, operative time, ICU stay and hospital stay. Mortality rate of CAC was higher than ABO group (61.11% vs 16.67 % Risk ratio (RR) = 3.6 times, 95% confidence interval (CI) = -0.293 – 0.468, P-value = 0.059) as shown in table 1.

Table 1 Comparison of patients' demographic and clinical data between the aortic balloon occlusion and conventional aortic cross clamp groups

	Aortic Balloon occlusion (n =6)	Aortic crossclamp (n = 18)	SUM	P-value
Age (years ± SD)	75.16 +/- 7.02	76.88 +/- 9.63	76.45 +/- 8.93	0.692
Gender				
- **Male (%)**	6 (100)	3 (72.22)	19 (79.17)	0.147
- **Female (%)**	0 (0)	5 (27.78)	5 (20.83)	
Underlying				
COPD (%)	1 (16.67)	4 (22.22)	5 (20.83)	0.772
CAD (%)	1 (16.67)	5 (27.78)	6 (25.00)	0.586
HTN (%)	4 (66.67)	9 (50)	13 (54.17)	0.478
DLD (%)	1 (16.67)	1 (5.56)	2 (8.33)	0.394
Smoking (%)	0 (0)	2 (11.11)	2 (8.33)	0.394
CKD (%)	0 (0)	7 (38.89)	7 (29.17)	0.070
AF (%)	1 (16.67)	0 (0)	1 (4.17)	0.077
Operative detail				
SBP (mmHg ± SD)	83.33+/- 37.2	75 +/- 28.3	77.08 +/- 30.1	0.568
DBP (mmHg ± SD)	60 +/- 26.83	45.16 +/- 16.7	48.87 +/- 20.15	0.120
Blood loss (ml ± SD)	1416.66 +/- 847.1	2733.33 +/- 1883.6	2404.16 +/- 1765.7	0.115
Op time (hours ± SD)	2.44 +/- 0.93	2.03 +/- 0.87	2.13 +/- 0.88	0.344
In-hospital detail				
ICU stay (days ± SD)	11 +/- 7.37	10.11 +/- 12.40	10.33 +/- 11.21	0.870
Hospital stay (days ± SD)	19 +/- 13.43	13.11 +/- 15.36	14.58 +/- 14.84	0.412

Table 1 Comparison of patients' demographic and clinical data between the aortic balloon occlusion and conventional aortic cross clamp groups (cont.)

	Aortic Balloon occlusion (n =6)	Aortic crossclamp (n = 18)	SUM	P-value
Complication				
Post-operative AKI (%)	0 (0)	4 (22.22)	4 (16.67)	0.206
ALI (%)	3 (50)	1 (5.56)	4 (16.67)	0.011
Bowel ischemia (%)	1 (16.67)	0 (0)	1 (4.17)	0.077
CPR (%)	0 (0)	5 (27.78)	5 (20.83)	0.147
DOT (%)	0 (0)	1 (5.56)	1 (4.17)	0.555
Mortality (%)	1 (16.67%)	11 (61.11%)	12 (50%)	0.059

SD, standard deviation; COPD, chronic obstructive pulmonary disease; CAD, coronary artery disease; HTN, hypertension; DLD, dyslipidemia; CKD, chronic kidney disease; AF, atrial fibrillation; SBP, systolic blood pressure, DBP; diastolic blood pressure; ICU, intensive care unit; AKI, Acute kidney injury; ALI, acute limb ischemia; CPR, cardiopulmonary resuscitation; DOT, death on table

The strong prognostic factors effecting mortality of open AAA repair in patients with rAAA was post-operative acute kidney injury (AKI) (RR = 1.46, 95%CI = 0.17 – 0.93, P-value = 0.007). The potential prognostics factors including intra-operative blood loss and patients who need cardio-pulmonary resuscitation (CPR) (P-value = 0.062 and 0.093, respectively).(Table 2). We focused on post-operative complication include acute renal failure, acute limb ischemia, bowel ischemia. The incidence of acute limb ischemia (ALI) after open AAA repair in patients with rAAA tend to be high in ABO group (50% vs 5.5%, 95%CI = -0.99 – 0.29, P-value = 0.268). (Table 1). Acute renal failure was not significant difference. We found only 1 case of bowel ischemia.

Table 2 Comparison of predictive factor variables between the aortic balloon occlusion and conventional aortic crossclamp groups (multivariate analysis)

	Survival (n =12)	Periop-dead (n = 12)	P-value
Blood loss	1683.33 +/-1401.19	3125 +/- 1849.88	0.062
ICU stay (days ± SD)	15.58 +/- 13.12	5.08 +/- 5.53	0.486
Hospital stay (days ± SD)	24.08 +/- 15.28	5.08 +/- 5.53	0.053
Post-operative AKI (%)	0 (0)	4 (100)	0.007
ALI (%)	4 (100)	0 (0)	0.381
CPR (%)	0 (0)	5 (100)	0.093
Type of proximal control			0.667
- **Aortic balloon occlusion (%)**	5 (83.3)	1 (16.7)	
- **Aortic crossclamp (%)**	7 (38.9)	11 (61.1)	

ICU, intensive care unit; AKI, Acute kidney injury; ALI, acute limb ischemia; CPR, cardiopulmonary resuscitation

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Discussion

Open repair abdominal aortic aneurysm in rAAA has high mortality due to hemodynamic instability, blood loss and post-operative complication. When blood flow in aorta was occluded, it effected hemodynamic alteration. However, technique of aortic balloon occlusion is equivalent to conventional aortic cross clamping in terms of increases in preload and afterload. Greenberg et al. and Malina et al.[8] published early reports of good outcomes following balloon occlusion in the distal descending thoracic aorta for hemorrhage control from ruptured AAA. In this study, the mortality rate of CAC was higher than ABO correlated with Maxime et al[9] study. They found that CAC may be associated with marked reduction of intraoperative mortality and reduced collateral damage, such as surgical injuries, although it did not significantly influence in-hospital mortality . The major advantage of ABO over CAC was the balloon can be positioned under local anesthesia, thus sparing the patient's abdominal muscular tone that can prevent further blood loss. Moreover, anesthetic agents induced decrease in systemic vascular resistance worsens tissue perfusion, thus compromising already altered organ function. ABO allowed a rapid increase of cerebral and coronary perfusion, while decreasing hemorrhage and blood loss due to open repair.[10] But from our study, intraoperative blood loss was not significant between two groups.

We studied prognostic factor effecting mortality that post-operative acute kidney injury was the strong factor. In this study, 22.2 % of patients in CAC had post-operative acute kidney injury. Acute kidney injury developed in 2% to 10% of patients after open abdominal aortic aneurysm repair and was independently associated with mortality and prolonged lengths of stay.[11,12] Hypoperfusion related to aortic cross-clamping, perioperative hemorrhage, and atheroembolism increase the risk of renal failure.

Acute limb ischemia was significant risk factor in aortic balloon occlusion. We only used femoral approach and large long sheath to support aortic balloon. Because of ruptured abdominal aortic aneurysm and risk of ongoing bleeding and hemorrhagic shock, the systemic heparinization was contraindicated. This effected acute limb ischemia occurred more often in ABO. Although a brachial or axillary approaches are feasible, we favored the femoral approach because left brachial approach interferes with the positioning of the C-arm, as a contralateral right side approach carries a risk of cerebral emboli. Large sheath may damage the brachial artery. Another procedure related complication such as aortic ruptured from balloon, we did not have experience.

Limitation

This study was retrospective study with small sample size. The choice of treatment depended on teams experience and available of equipments. In our hospital trend to use more aortic balloon occlusion in rAAA.

Conclusion

ABO of the aorta in rAAA compared with CAC may be associated with reduction of mortality although it did not influence blood loss, operative time, ICU stay, hospital stay. The post-operative AKI was a strong predictor to mortality in rAAA patients who were performed open AAA repair.

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The further study with prospective, large randomization study design should be evaluate

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