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Predictive Factors of Amputation for Post-Bypass Surgery on Vascular Trauma Patients

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Abstract

In Indonesia, most vascular trauma is linked to traffic collisions. According to the Statistics Indonesia (Badan Pusat Statistik, BPS), there were 116,411 accidents in 2019. Limb salvages become important in vascular trauma, which is performed through, among others, vascular bypass surgery. However, secondary amputation still occurs after vascular bypass. This study aimed to determine the predictors of secondary amputation after vascular bypass due to vascular trauma. This study used descriptive analysis of medical records and univariate analysis. Medical records of patients with vascular trauma underwent vascular bypass in Dr Soetomo Regional Hospital, Indonesia, from January 2018 to December 2020 were collected. Independent variables were age, MESS, time interval between the incident of trauma to the first incision of bypass surgery, penetrating and blunt injury, injured arterial segment, multiple injuries, and obesity. The dependent variable was secondary amputation. Fisher Exact Test was used to analyze the correlation between dependent and independent variables. Results showed a significant difference between patients with a MESS score of >7 and those with a MESS score of ≤7 (p=0.044), where more patients with a MESS score of >7 experienced secondary amputation. Other variables showed no significant difference (p>0.05). This study concluded that MESS could be used as a predictor of secondary amputation in vascular trauma after vascular bypass. Further studies using multivariate analysis and a larger sample need to be conducted to get further insights on this phenomenon.

Keywords: Bypass surgery, MESS, predictor, traffic accident, vascular trauma, vascular bypass surgery

Introduction

Statistic reports about vehicle accidents in Indonesia increased from 2017 to 2019. The number increased from 104 327,00 in 2017, 109 215,00 in 2018, to 116 411,00 in 2019.[1] The statistics were vital because vehicle accidents are closely related to vascular trauma in Indonesia. Vascular trauma is a lesion in an artery or vein caused by blunt and penetrating mechanisms. Blunt trauma is identified as vehicle accidents or collisions where the patient is the driver, accidents in pedestrians, injuries to motorcycle or bicycle riders, falls, injuries due to explosions, or planned attacks on people. Penetrating trauma happens due to foreign objects penetrating the tissues. The common objects are high-energy weapons (military or hunting rifles), medium-energy weapons (handguns), and low-energy weapons (knives, hand-energized missiles).[2] Vascular trauma is an urgent condition that needs immediate and correct management to keep the tissue viable.[3]

The prognosis of vascular trauma is based on the types and anatomical region. Compression fracture usually has more severe tissue necrosis. A proximal tibia fracture will have a better prognosis if the repair is done quickly. One of the operative management is vascular bypass surgery. Even though the bypass surgery was done, the possibility of amputation is still high in some cases. The number of failed bypasses is higher in blunt trauma cases.[3] Amputation could be a choice if the bypass failed. The common reasons for failed bypass are thrombus, intima hyperplasia, or atherosclerotic plaque.[4] The high

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number of amputations after bypass surgery became a problem that needs to be overcome and predicted. In addition, the study about amputation predictors after bypass surgery is still limited. This study was conducted to find the predictor of amputation after bypass surgery. Thus, observing the prognostic factor could be used for clinical consideration in medical treatment.

Methods

This descriptive-analytic and retrospective study was conducted at Dr. Soetomo General Hospital Surabaya. This study used a total sampling method to collect the data. Only data that met the criteria were included in this research. The inclusion criteria are patients with trauma vascular who underwent vascular bypass surgery, patients with complete medical records, and patients who underwent amputation after vascular bypass surgery in Dr. Soetomo General Hospital from January 1, 2018, until December 31, 2020.

The data were collected from medical records in Dr. Soetomo General Hospital. The medical records were collected from Medical Records Center and the Cardiothoracic and Vascular Surgery Department in Dr. Soetomo General Hospital. This study's independent variables mentioned were age, MESS, the time interval between the incident of trauma to first incision of bypass surgery, penetrating trauma, blunt trauma, injured arterial segment, multiple injuries (multiple injuries described as injuries other than vessels injury, such as nerve injuries, fractures, muscle ruptures), and obesity. The dependent variable is secondary amputation.

The data were analyzed with the Fisher Exact Test using IBM SPSS Statistics 23. The test was a univariate analysis with a significance level of 5%. The Research Health Ethic Committee (protocol number: 0951/110/4/IX/2021) approved the ethical clearance of Dr. Soetomo General Hospital Surabaya.

Results

There were 17 data of medical records included in this study. All the bypass procedure was performed using native GSV. The procedures were done by a cardiothoracic and vascular surgeon as the operator and accompanied by the cardiothoracic and vascular surgeon residents. The mean age (years) of patients with vascular injury was 30.12±14.41, ranging from 3 years old to 58 years. MESS ranged from 3 to 10 with a mean of 7.94±2.22. The mean interval between the trauma incident and bypass surgery (minutes) was 1085.53±1700.69.

Table demonstrates each variable's correlation to secondary amputation using the Fisher exact test. The age was grouped into ≤35 and >35 years old. MESS is grouped into ≤7 and >7. The interval time between the first incision of bypass surgery and the time of trauma (hours). Two groups of trauma mechanisms are blunt and penetrating. The artery segment is grouped as non-end artery and end artery. Multiple traumas are divided into five groups based on the number of associated traumas. At the same time, obesity is grouped as absent or present. The result of the surgery was defined as present and absent of secondary amputation.

Based on the univariate analysis using the Fisher Exact Test, it was found that between two groups of age and secondary amputation has no significant difference with *p*-value=0.338. MESS is the only variable showing a significant difference with a p-value=0.044. It is found that a MESS higher than seven is likely to receive amputation after the bypass surgery. The time interval between trauma and bypass surgery had no significant difference to the result of secondary amputation, with a p-value=0.603. Neither blunt nor penetrating injuries were related to amputation after the bypass surgery, with a p-value=0.228. It was also found that two groups of artery segment and secondary amputation have no significant difference with p-value=0.537. Multiple traumas also did not significantly differ from secondary amputation, with p-value=0.090. Moreover, the last variable, the presence or absence of obesity, had no significant difference to amputation after the bypass surgery, with p-value=0.331.

Discussion

Seventeen out of 32 medical reports met the criteria. The other 15 data could not be used due to lack of comprehensiveness in the medical records and or underwent primary amputation. Along with the small amount of data, it became a limitation for this study.

MESS has been known and used as a scoring system all around the world. Johansen first introduced it in 1990. Four variables included are skeletal or soft tissue injury, signs of limb

Table 1 Univariate Analysis Using the Fisher Exact Test

Variable	Secondary Amputation		p-value
	Present	Absent	
Age (years)			0.338
≤35	6	6	
>35	1	4	
MESS[1*]			0.044
≤7	5	0	
>7	5	7	
The interval time between first incision of bypass surgery and time of trauma (hours)			0.603
≤6	3	1	
>6	7	6	
Trauma mechanism			0.228
Penetrating	4	0	
Blunt	7	6	
Artery segment			0.537
Non-end artery	9	5	
End artery	1	2	
Multiple trauma			0.090
≥3	4	5	
0	2	0	
1	3	0	
2	1	0	
POST-ORIF	0	2	
Obese			0.331
Present	2	0	
Absent	8	7	

ischemia, shocks, and patient age. The higher the scores, the greater the chance of amputation. MESS analysis as trauma prognosis has been widely performed and shows a good correlation between amputation and high scores. A previous study found that the sensitivity and NPV of MESS was 100% which indicates that this scoring system could identify how likely a limb could be saved.[5] Another study also found a poor prognosis in trauma patients with a MESS score of more than 9.[6] The finding in this study indicated that MESS could also predict secondary amputation. It is shown as a significant difference of *P* value less than 0.005. A MESS score of more than 7 is higher in secondary amputation rate than patients with scores of ≤ 7**.**

Age is considered a dire prognosis of limb salvage.[7] Aging is closely related to changes in the human body. Vascular stiffening and vascular changes are part of the normal aging process. Moreover, other diseases such as diabetes and hypertension are higher in the elderly. Thus, older patients are susceptible to injury and acute ischemia.[8] Another study stated the relation between age over 40 and bad clinical outcomes.[6] In addition, other research on the Indonesian population found that age above 35 has a higher prevalence of hypertension than the younger group.[9] According to the research conducted by Maharani, adults aged 40 years and above have a higher risk of cardiovascular disease in the next 10 years of their life.[10] Based on previous research, the age grouping in this article was ≤35 and >35 years old. However, this study found no significant difference between the two age groups (p=0.63). In addition, another study also showed no significant difference between the older and younger age groups.[11] Furthermore, we did not find any comorbidities such as diabetes and hypertension in 17 patients who participated in this study, while age is closely related to such diseases.

The time of tissue ischemia, often called the golden period, is no more than 6 hours. A study

on 35 patients with grade III C fractures showed an association. The delay in revascularization intervention significantly indicates a higher incidence of secondary amputation.[12] The maximum time limit for limb ischemia to be salvaged with a good prognosis is 6 hours.[13] Hunter conducted a study on 108 patients undergoing infrainguinal bypass surgery, where the time interval between trauma and surgery did not significantly differ in the outcome.[6] This study used the time interval between the trauma incidence and the bypass surgical treatment. The results are the same as the research conducted by Hunter in that a time interval of more than 6 hours does not indicate a significantly poor prognosis. However, this result is different from the existing textbooks. Previous studies regarding the prognosis of amputation after tissue ischemia of more than 12 hours were strongly associated with the presence of collateral circulation. More collateral vascularization can help maintain tissue viability even after arterial trauma beyond the golden period. However, sensory and motor function in prolonged ischemia is poor.[14] Data from medical records showed that one patient underwent secondary amputation even though the time interval between the incidence of trauma and bypass surgery is less than 6 hours. However, despite the time being still in the golden period, the MESS is 10, which might explain the presence of secondary amputation. Other seven patients with a time interval of more than 6 hours without secondary amputation have a MESS of less than 10. Other findings from medical records are that two patients with the same MESS (MESS=9) and the same time interval of more than 6 hours have different outcomes, amputated and salvaged. After observing the medical records, they have different artery and trauma lesions. The patient with a secondary amputation had a tibial shaft fracture and, an open distal femur fracture with anterior and posterior tibial artery lesions. In comparison, the patient without amputation had ⅓ distal of the posterior tibial artery and ⅓ distal of the tibia-fibula open fracture, open lesion on a knee, and knee dislocation. This finding could be explained by a previous study that found distal femur or knee fracture has a high risk of bad prognosis for the distal limb affected. Moreover, an open fracture accompanied by a lesion of the anterior and posterior tibial artery in the trifurcation level led to the worst prognosis of limb salvage.[15]

Identifying trauma mechanisms could predict vascular trauma. Gunshot injury is more likely to result in more complex vascular trauma and a higher amputation rate than stabbed injury. In addition, blunt trauma usually causes vascular injury.[1316] Nevertheless, another study stated that blunt trauma does not directly cause vascular trauma. The limb salvage could not be reached due to failed revascularization, injury to soft tissue, and osteomyelitis.[17] Based on a univariate study conducted by Hunter, blunt trauma significantly predicts worse outcomes such as death, primary amputation, secondary amputation, and failed bypass surgery.[6] In contrast to previous studies, this univariate study results in no significant difference between blunt trauma and the incidence of secondary amputation. This study has the same result as a previous study about amputation in injury to the popliteal artery, in which blunt and penetrating trauma did not significantly differ from the worst outcome of amputation.[18]

In addition to the above variables, this study examined whether trauma affects specific arterial segments and risk factors for secondary amputation. Trauma to the arterial segment did not have a significant difference that could be used to predict the presence of secondary amputation. Three non-end artery injuries that underwent secondary amputation had a MESS score of 10, and the other had a MESS score of 9. One of the patients with a MESS score of 9 had compartment syndrome. The presence of amputation secondary to an injured artery that may still have collateral circulation may result from a high MESS score.

The reason obesity could be considered as a predictive factor is because it is closely related to dyslipidemia. Atherosclerotic plaque formation and the emergence of cardiovascular disease are often found in patients with obesity.[19] Obesity was found in two patients and both of them achieved limb salvage. As in these cases, the first obese patient who underwent bypass had an ischemic time under 6 hours (still in the golden period) and already received emergency treatment in RSUD Jombang before being admitted to Dr. Soetomo General Hospital. Along with that, as stated in the primary survey, the patient arrived at Dr. Soetomo with GCS 456 and CRT in less than 2 seconds. Another obese patient who achieved limb salvage also came after receiving emergency aid in Babat Hospital and as in the primary survey, this patient came with CRT in less than 2 seconds. However, the finding in this study is no significant differences between the two groups. A prior study observed the relationship between obesity and amputation-free survival conducted by Sabbagh and found no association among

those variables.[20]

This study describes fractures, muscle ruptures, and nerve injuries as multiple injuries. No significant differences were found after Fisher's exact test of 0, 1, 2, and ≥3 associated injuries or post-ORIF. Another study by Song stated that there is a correlation between associated injuries to failed limb salvage.[1211] Like the previous study, multiple injuries could not be an amputation predictor post-bypass surgery.

The significant difference in MESS is 0.044 ($p<0.05$), so high MESS could be an independent predictor for amputation after bypass surgery. Furthermore, it is crucial to consider the proper treatment, further prevention, and precaution for secondary amputation because each treatment would affect the patient's quality of life.

This study concluded that in the Indonesian population, specifically, patients admitted to Dr. Soetomo General Hospital, MESS >7 is an independent predictor of secondary amputation in patients with vascular trauma who underwent vascular bypass surgery. The higher MESS showed a lousy prognosis for secondary amputation. Age, the time interval between trauma and bypass surgery, penetrating trauma, blunt trauma, injured arterial segment, multiple injuries, and obesity are not predictors of secondary amputation in this study. However, the limited sample of this study needs to be considered.

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