

Original Article

The Risk Factors of Patients with Cruris Fracture Nonunion in dr. Mohamad Soewandhie Hospital in 2021-2022: A Case-Control Study

Regina Clarissa¹ , Bimo Sasono² , Ni Njoman Juliasih³ 

¹Faculty of Medicine, Ciputra University, Surabaya, Indonesia

²Orthopedic Department, Dr. Mohamad Soewandhie Hospital, Surabaya, Indonesia

³Department of Medicine, Ciputra University, Surabaya, Indonesia

Correspondence should be addressed to Bimo Sasono, Orthopedic Department, dr. Mohamad Soewandhie Hospital, Villa Kalijudan 9/10 blok K-5 Surabaya 60114, Indonesia. e-mail: bimo.sasono@ciputra.ac.id

ABSTRACT

Background: The crural region is highly susceptible to injury in Indonesia, with fractures being a common occurrence. However, if not properly treated, these fractures can lead to complications such as nonunion. To investigate the risk factors for nonunion cruris fractures, this study was conducted at dr. Mohamad Soewandhie Hospital, examining age, gender, working status, education, trauma mechanism, and previous treatment history.

Methods: This case-control study analyzed patient records from 2021-2022 at Dr. Mohamad Soewandhie Hospital, comparing 12 nonunion and 24 union cruris fracture cases. Data on age, gender, work, education, trauma, and treatment history was collected between August and October 2023. Statistical analysis was performed using the McNemar and Wilcoxon tests, with a significance level of $p < 0.05$.

Results: A study of 149 cruris fractures found 12 nonunions, primarily affecting males aged 26-45 or 46-65. Notably, the highest nonunion rate (41.7%) was in the 12-25 age group ($p = 0.027$). Males were more affected, with 7 nonunion cases (58.3%) ($p = 0.041$). Working class patients had the highest fracture and nonunion rates (83.3%) ($p < 0.001$). High school education was most common among nonunion cases (75%) ($p = 0.374$). High-energy trauma was reported in almost all nonunion cases (91.7%) ($p < 0.001$). All nonunion patients had a history of ORIF ($p = 0.102$).

Conclusions: The study revealed that age, gender, work status, and trauma mechanism significantly influenced nonunion cruris fractures at Dr. Mohamad Soewandhie Hospital in 2021-2022. Patient education and past treatment history, however, had no significant impact.

Keywords: Risk factors; Cruris fracture; Nonunion; Health risk

INTRODUCTION

The crural region, comprised of the medial tibia and lateral fibula bones, is the most commonly injured body part in Indonesia, accounting for 67.9% of all injuries involving the lower extremities.^{1,2} Fractures are one of the potential injuries that can happen to bones, which can be cracks, crushes, or ruptures of the cortex.³ Healthy bones, which are incredibly strong, are able to endure the impact of shocks. However, if the bones lack strength, they can easily break. Fractures are mainly caused by physical trauma, violence, and medical conditions that weaken bones, such as osteoporosis.⁴

Some factors influence bone healing, including patient age, gender, and trauma mechanism. Nonunion occurs when a fracture fails to heal within the expected timeframe and cannot heal without further intervention.⁵ The crural region has one of the highest prevalences of fractures, with nonunion occurring in 14% of these cases.⁶ Nonunion etiology can be attributed to various factors, categorized as host and mechanical factors. Age and gender are considered host factors, while the fixation method is a mechanical factor.⁷

The patient's age is believed to have varying levels of risk for nonunion, depending on the type of bone.⁸ Gender plays a significant role in predicting



nonunion, as men are at a greater risk due to their gender-associated injury patterns and types of physical activities.⁹ The use of a low energy trauma mechanism was found to be highly reliable in predicting fracture union.¹⁰ However, the high-energy trauma mechanism is a strong predictor of fracture nonunion. Conservative treatment has the highest nonunion rate compared to operative treatment. However, there was little difference between external fixation and ORIF regarding their nonunion rates.¹¹ There has been no prior research on the correlation between a patient's education and working status with the risk of nonunion in cruris fractures. Hence, these variables were selected to determine their impact on the occurrence of nonunion in cruris fractures.

This study aims to identify the risk factors that contribute to cruris fracture nonunion among patients at dr. Mohamad Soewandhie Hospital. The findings from this research can serve as a foundation for further comprehensive studies and investigations on other potential risk factors. Notably, this is the first study of its kind conducted at dr. Mohamad Soewandhie Hospital, making it a valuable source of information on the epidemiology of cruris fracture nonunion in 2021-2022.

MATERIAL AND METHODS

Study Design and Sampling

This study employs a case-control design with an analytical and observational approach. Data was collected from the medical records of the patients who met the inclusion criteria. The subjects were patients who met the inclusion criteria, namely experiencing a cruris fracture at dr. Mohamad Soewandhie Hospital in 2021 – 2022 and having complete medical record data. The exclusion criteria for research subjects were patients with bone fracture complications other than nonunion. Ethical approval for this study was obtained from Health Research Ethics Commission, Faculty of Medicine of Ciputra University (No. 065/EC/KEPK-FKUC/ VII/2023 and Health Research Ethics Commission, dr. Mohamad Soewandhie Hospital (No. 019/KE/KEPK/2023).

Data Collections

The collected data includes the age, gender, working status, education, trauma mechanism, and previous treatment history of the patients. The data was collected from August to October 2023 using a total sampling technique. The study compared 12 cases of nonunion cruris fracture and 24 cases of union cruris fracture in a 1:2 ratio.

Statistical Analysis

The McNemar and Wilcoxon tests were used in the analysis for this comparative study, with a significance of $p < 0.05$. The McNemar test was conducted on independent variables with two categories, such as gender, working status, and trauma mechanism, while the Wilcoxon test is used for independent variables with more than two categories, including age, education, and previous treatment history. The data analysis was performed using SPSS 26.0 software (IBM SPSS Statistics, New York, USA).

RESULTS

Out of the 149 cruris fracture cases identified, 12 were nonunion cases that met the inclusion criteria. As the study employed a 1:2 ratio, 24 cases of cruris fracture union that also fulfilled the inclusion criteria were included. The data in Table 1 displays the frequency distribution of risk factors for nonunion cruris fractures among patients at dr. Mohamad Soewandhie Hospital from 2021 to 2022. Based on the analysis results, the age groups with the most cruris fracture patients are 26–45 years old and 46–65 years old. However, the age group with the highest proportion of nonunion patients was 12–25 years old, with five patients (41.7%). This suggests that age plays a significant role in the nonunion of cruris fractures, with a p-value of 0.027. Based on the distribution of genders, it is evident that majority of cruris fracture and cruris fracture nonunion patients are male. Among the nonunion patients, seven individuals (58.3%) were male. The gender factor was found to be statistically significant with



Table 1. The frequency distribution of risk factors data for patients with nonunion cruris fractures in dr. Mohamad Soewandhie Hospital from 2021 to 2022

	Patients with nonunion (n=12)		Patients with union (n=24)		p-value
	n	%	n	%	
Age					
>65 years old	0	0	3	12.5	0.027
46 – 65 years old	3	25	9	37.5	
26 – 45 years old	4	33.3	8	33.3	
12 – 25 years old	5	41.7	3	12.5	
6 – 11 years old	0	0	1	4.2	
Gender					
Male	7	58.3	15	62.5	0,041
Female	5	41.7	9	37.5	
Working Status					
Working	10	83.3	18	75	<0.001
Non-Working	2	16.7	6	25	
Education					
Elementary School	1	8.3	3	12.5	0.374
Middle School	1	8.3	5	20.8	
High School	9	75	14	58.3	
Bachelor's Degree	1	8.3	2	8.3	
Trauma Mechanism					
High Energy	11	91.7	21	87.5	<0.001
Low Energy	1	8.3	3	12.5	
Previous Treatment History					
Conservative	0	0	1	4.2	0.102
External Fixation	0	0	2	8.3	
ORIF	12	100	21	87.5	

a p-value of 0.041. The working class has the highest number of patients with both cruris fracture and nonunion cruris fracture, with a significant proportion of ten (83.3%) being nonunion. The working status showed a highly significant value ($p < 0.001$).

The majority of patients with cruris and nonunion cruris fractures had a high school education, with nine nonunion cases (75%). The education level did not show significant differences ($p = 0.374$). Out of all patients, the majority have encountered high-energy trauma, with 11 patients (91.7%) developing nonunion. Furthermore, the trauma mechanism holds significant importance with a p-value of $p < 0.001$. All patients (100%) with nonunion cruris fracture had a prior history of undergoing ORIF. This treatment was the most commonly used

among patients. The significance value of previous treatment history was calculated to be $p = 0.102$.

DISCUSSION

In this study, the cruris fracture nonunion cases were the main focus, with the cruris fracture union cases used as a control. The results showed a significance value of $p < 0.05$ for age, gender, working status, and trauma mechanism, indicating their influence on the nonunion outcome in patients at dr. Mohamad Soewandhie Hospital. However, education and previous treatment history, with a significance value of $p > 0.05$, were found to have no impact.



This finding is consistent with the study conducted by Tian et al. which demonstrated the significant impact of age, gender, trauma mechanism, and previous treatment history.¹¹ However, it contrasts with the findings of Alam et al., where age was not found to be significant with a p-value of > 0.05 .¹² According to a study conducted by Ali et al., gender was found to have a significance value of $p < 0.05$.¹³ Similarly, Rante et al. found that trauma mechanism also had a significance value of $p < 0.05$.¹⁴ Further research by Zura et al. revealed that previous treatment history also held a significance value of $p < 0.05$.¹⁵

This study found that the results are consistent with previous research regarding the correlation between gender and trauma mechanism, but contradicting findings on age and previous treatment history. However, there is a lack of research on the effects of education and working status on nonunion fractures, particularly cruris fractures. These results can provide valuable insights for physicians in predicting the likelihood of nonunion in patients with cruris fractures, allowing them to prepare for effective treatment methods.

CONCLUSION

Based on the conducted research, it was determined that patient education and prior treatment history did not significantly impact nonunion cruris fractures at dr. Mohamad Soewandhie Hospital between 2021 and 2022. However, age, gender, working status, and trauma mechanism were found to have a significant influence on the occurrence of nonunion cruris fractures. This suggests that these factors play a role in the development of this condition. Future research could investigate the potential influence of other factors, such as nutrition and medical history, on nonunion cruris fractures. This would provide a more comprehensive understanding of the various factors contributing to this condition.

ACKNOWLEDGMENTS

We are thankful to God for His grace that enabled us to complete this research. Our gratitude also goes to all the lecturers who provided guidance and assistance throughout the research. We would also like to express our appreciation to dr. Mohamad Soewandhie Hospital for their invaluable assistance in collecting the research data.

FUNDING

This research received no specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

REFERENCES

1. Saladin KS. *Anatomy & physiology: the unity of form and function*. 5th ed. New York: McGraw-Hill; 2010.
2. Kementerian Kesehatan Republik Indonesia. Hasil Utama Riskesdas [The main outcome of basic health research] 2018. Jakarta: Badan Penelitian dan Pengembangan Kesehatan; 2018.
3. Apley AG, Solomon L. *System of orthopaedics and trauma*. 10th ed. Boca Raton: CRC Press; 2018.
4. Lieh W. Bone fracture: diagnosis and treatment. *J Trauma Acute Care* 2021;6(S5):e002.
5. Rockwood CA, Green DP. *Rockwood and green's fractures in adults*. 8th ed. Philadelphia: Wolters Kluwer; 2015.
6. Wu AM, Bisignano C, James SL, Abady GG, Abedi A, Abu-Gharbieh E, et al. Global, regional, and national burden of bone fractures in 204 countries and territories, 1990–2019: a systematic analysis from the global burden of disease study 2019. *Lancet Healthy Longev* 2021;2(9):E580-92.
7. Stewart SK. Fracture Nonunion: A review of clinical challenges and future research needs. *Malays Orthop J* 2019;13(2):1–10.
8. Zura R, Mehta S, Rocca GJD, Steen RG. Biological risk factors for nonunion of bone fracture. *J Bone Jt Surg Rev* 2016;4(1):e5.
9. Thomas JD, Kehoe JL. Bone Nonunion. [Updated 2023 Mar 6]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK554385/>
10. O'Halloran K, Coale M, Costales T, Zerhusen T Jr, Castillo RC, Nascone JW, et al. Will



- my tibial fracture heal? Predicting nonunion at the time of definitive fixation based on commonly available variables. *Clin Orthop Relat Res* 2016;474(6):1385-95.
11. Tian R, Zheng F, Zhao W, Zhang Y, Yuan J, Zhang B, et al. Prevalence and influencing factors of nonunion in patients with tibial fracture: systematic review and meta-analysis. *J Orthop Surg Res* 2020;15(1):1-16.
 12. Alam MA, Shirazi AF, Alaradi H. Association of fracture location and pattern with nonunion or malunion in tibia fractures managed with intramedullary nailing: A retrospective study. *Cureus* 2023;15(11):e49156.
 13. Ali SA, Dar UZ, Ali M, Batool S, Siddique F, Siddique F. Characteristics of patients suffering tibial nonunion: A descriptive study carried out in a tertiary care hospital, Lahore, Pakistan. *Pak J Med Health Sci.* 2018;12(4):1330-2.
 14. Rante SDT, Koamesah SMJ, Pakan P, Folamauk CLH. Determinants of fracture patients in nonunion or delayed union. *Bali Med J* 2023;12(2):1769-1773.
 15. Zura R, Watson JT, Einhorn T, Mehta S, Rocca GJD, Xiong Z, et al. An inception cohort analysis to predict nonunion in tibia and 17 other fracture locations. *Injury* 2017;48:1194-1203.

