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RESEARCH ARTICLE

Prevention of Military Stress Fractures using the hadMCS Strategy Approach in Health Resilience Projections in National Defence: Preliminary Research

Arif Rachman[1,2*], Tjahja Nurrobi[3,4], Alfa Januar Krista[4], Nadia Permatasari[5], Muhammad Dimas Reza[6]

[1]Department of Cell Biology and Biomolecular, Faculty of Medicine, Indonesian Defense University, Bogor, Indonesia.
[2]Department of Dental and Oral Medicine, Faculty of Medicine, Indonesian Defense University, Bogor, Indonesia.
[3]Department of Anatomy, Faculty of Medicine, Indonesian Defense University, Bogor, Indonesia., Indonesia.
[4]Department of Orthopedy and Traumatology, Faculty of Medicine, Indonesian Defense University, Bogor, Indonesia.
[5]Department of Microbiology, Faculty of Medicine, Indonesian Defense University, Bogor, Indonesia.
[6]Department of Biochemistry and Biology of Molecular Cells, Faculty of Medicine, Indonesian Defense University, Bogor, Indonesia.

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***Corresponding Author**

arif.rachman@idu.ac.id.

ABSTRACT

Health security in a country is part of national defense, and it requires physical solid strength from TNI soldiers. Physical activity often causes stress fractures during education, training or routine heavy physical activity as people age. Stress fractures are generally classified as fatigue fractures, which occur in the normal bone due to loading with abnormal forces. This risk in military cadets is related to excessive physical activity accompanied by heavy loads, such as clothing and combat equipment, personal weapons, and other necessary equipment. Lower extremity stress fractures are common injuries most often associated with participation in sports involving running, jumping, or repetitive stress. This study aims to analyse the effect of human Adipose-derived Mesenchymal Stem Cell/ hAdMSC intervention in preventing Military Stress Fracture through preliminary research. A Preliminary study was conducted using secondary data from a case study of stress fractures in the military population throughout Indonesia by collecting data at the TNI Kodiklat. There are several components, namely gender, age, type of work, health services, debtors, and diagnoses. The analytical descriptive is used to get a statistical picture of the secondary data components as initial data. Each variable significantly indicates conditions that must be considered, both the performance of student soldiers and the training load that must be taken during the military education period so that it does not result in the severity of the emergence of military stress fractures, both qualitatively and quantitatively. Based on the literature study, it can be concluded that a stress fracture occurred in a 20-year-old male cadet as an official patient at the orthopedic polyclinic and with a diagnosis of a stress fracture, not another class, double stress, as initial data for conducting further research.

INTRODUCTION

Indonesia, as a country that has reliable combat capabilities in all aspects of threats, obstacles, and challenges, must have adequate health security. Health security in a country is part of national defense, and it requires strong physical strength from TNI soldiers. Physical activity often causes stress fractures during education, training or heavy physical activity as people age. Military stress fractures or stress fractures often occur in military cadets during their training period, with an

incidence rate of about 68.3% (Khan *et al.*, 2008). Stress fractures are generally classified as fatigue fractures, which occur in normal bones due to loading with abnormal forces. The risk of stress fracture in military cadets is related to the amount of excessive physical activity accompanied by heavy loads, such as clothing and combat equipment weighing ~ 25 kg, personal weapons, and other necessary equipment (Pihlajamäki *et al.*, 2019). Military cadets who experience stress fractures in basic combat training will be excluded from training and placed in rehabilitation for an average of 62 days. They require hospitalization and are treated conservatively for a week, followed by 4 weeks of sick leave, and thereafter observed for 6-12 weeks, depending on the severity of symptoms. Most military cadets return to their full activity within an averageof 18 weeks (Sarla, 2018). This means that military cadets with stress fractures will lose many of their training hours (Khan *et al.*, 2008).

In a combat environment, stress fractures result in limited physical activity and increased costs associated with post-injury care and recovery. The stress fractures caused significant economic losses to the military, with an estimated total cost of $34,000 per soldier in the US. In men, the incidence of stress fractures ranges from 1–5% and 2–21% in women with a mean age of 23 years (range 20–26 years) (Cosman *et al.*, 2013). Incidence is highest during exercise and reaches a maximum at 12 weeks of the training schedule (Sarla, 2018). The location of stress fractures most often occurs in the tibia 72.3%, followed by the tarsus 12.3%, femur 6.1%, metatarsus 6.2% and patella 3.1% (Singh & Banerjee, 2000). As for 64% of stress fractures in the military population starting within the first 7 days of training (W.A. *et al.*, 2002). The prevention of stress fractures has so far been limited to limiting physical activity and training periods (Cosman *et al.*, 2013).

Cell-based strategies using mesenchymal stem cells (MSC) are therapeutic candidates for the prevention of military stress fractures, which are still a challenge in the world of military medicine. The therapeutic potential of MSCs towards tissue repair and wound healing is based on their paracrine effects. MSCs can repair and regenerate bone abnormalities through several mechanisms, namely homing, angiogenesis, differentiation, and response to inflammatory conditions. In in vitro studies, MSCs were able to differentiate into osteoblasts, osteocytes, and chondrocytes, which are required for the bone remodeling process. MSCs have varying abilities to secrete many of the different cytokines, growth factors, and chemokines required to repair bone injury (Kangari *et al.*, 2020)(Chen *et al.*, 2021)(Steens and Klein, 2018)(Han, Li and Li, 2019).

Human Adipose-Derived Mesenchymal Stem Cells/hADMSC, adipocytes, and vascular endothelial cells are contained in fat (adipose) tissue. hADMSC is considered another ideal source of stem cells because of its characteristics. ADMSCs can differentiate into several lineages (adipose cells, fibroblasts, chondrocytes, osteoblasts, nerve cells, endothelial cells, myocytes, and cardiomyocytes). Theyhave also been shown to be immune and genetically stable in long-term cultures. hADMSCs can be easily harvested in large quantities with minimally invasive procedures, and there are no ethical issues as they are medical waste (liposuction waste) (Ciuffi, 2017). The Human Angiogenesis Antibody Array C1000 (RayBiotech, Norcross, GA, USA) demonstrated that hADMSC secretes 43 angiogenic factors (cytokines, growth factors, proteases, and soluble receptors). Of these 43 factors, a group of 11 factors have been reported to be involved in bone regeneration (Linero and Chaparro, 2014).

Lower extremity stress fractures are common injuries most often associated with participation in sports involving running, jumping, or repetitive stress. The initial diagnosis can be made by identifying localized bone pain that increases with weight bearing or repetitive use. Plain film radiographs are frequently unrevealing. Confirmation of a stress fracture is best made using a phase nuclear medicine bone scan or magnetic resonance imaging. Prevention of stress fractures is most effectively accomplished by increasing the level of exercise slowly, adequately warming up and stretching before exercise, and using cushioned insoles and appropriate footwear. Treatment involves the rest of the injured bone, followed by a gradual return to the sport once free of pain. Recent evidence supports the use of air splinting to reduce pain and decrease the time until return to full participation or intensity of exercise (Sanderlin BW et all., 2003).

In this study, we want to analyze the effect of human-derived Mesenchymal Stem Cell (hADMSC) intervention in the prevention of Military Stress Fracture through preliminary research using secondary data.

MATERIALS AND METHODS

A preliminary study was conducted using secondary data from a case study of stress fractures in the military population throughout Indonesia, which was carried out by collecting data at the TNI Kodiklat.

RESULTS

Secondary data revealed several components, namely gender, age, type of work, health services, debtors, and diagnosis. The data were then analyzed using analytical descriptive methods to get a statistical picture of the secondary data components asinitial data.

A. Gender: Gender is an important thing to show in secondary data. Gender can be seen in the following Bar Chart, which shows that the male gender is higher than the female gender (Fig.1).

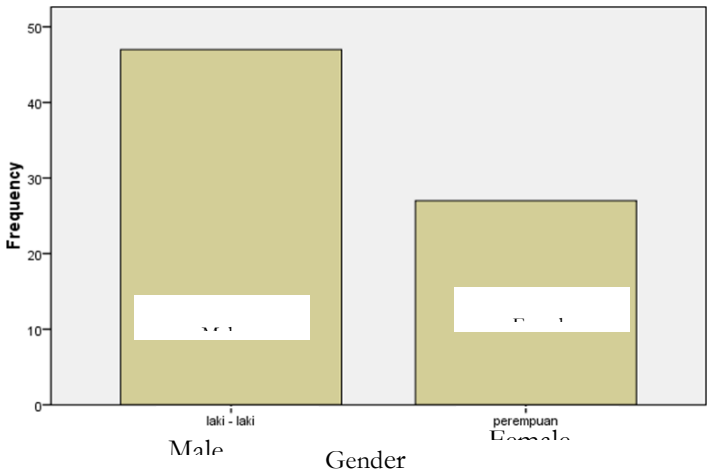

Figure 1: Gender

B. Age: In secondary data, the patient's age is shown at 20, which is higher than the other productive ages; this can be seen in the Bar Chart below (Fig. 2).

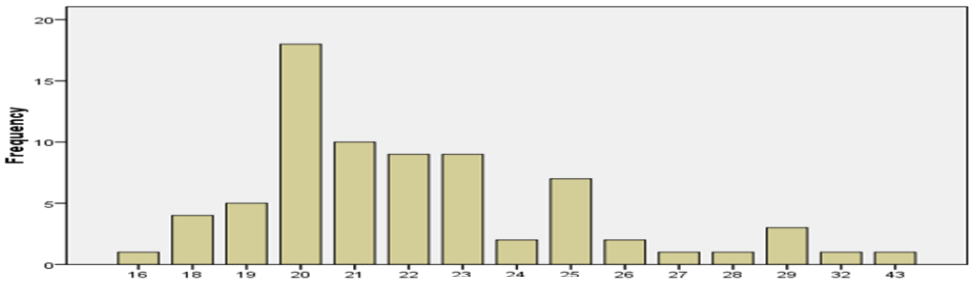

Figure 2: Age

C. Type of work: The type of work shown through the results of statistical data with descriptive analysis, where thetype of work that dominates is Taruna then, followed by Taruni, as shown in Figure 3 in the Bar Chart.

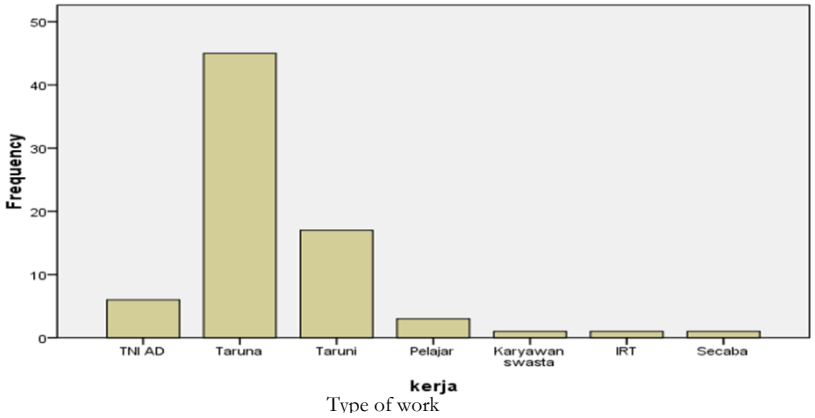

Figure 3: Type of work

D. Health services

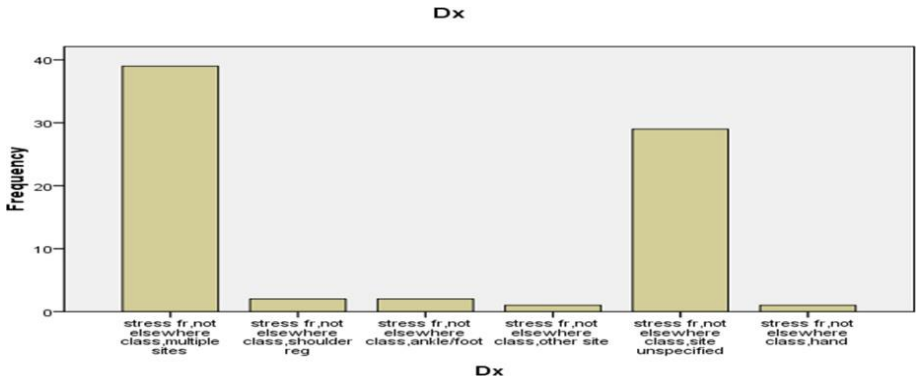

Figure 4: Health services carried out in any institution/polyclinic according to their specialty

The health service referred to here is that the patient gets services at any polyclinic and is carried out by any specialist doctor. The data on health services for orthopedic surgery is higher than for neurosurgery and general surgery. The data can be seen in Figure 4, which shows that health services are carried out in any institution/polyclinic according to their specialty on the Bar chart.

E. Diagnosis

The diagnosis can be seen on the Bar Chart figure. 5, which shows the diagnosis of a patient with a stress fracture, not elsewhere class, multiple stress is higher than the case of a patient with another diagnosis and followed by a case of a patient with a diagnosis of a stress fracture, not elsewhere class, site unspecified.

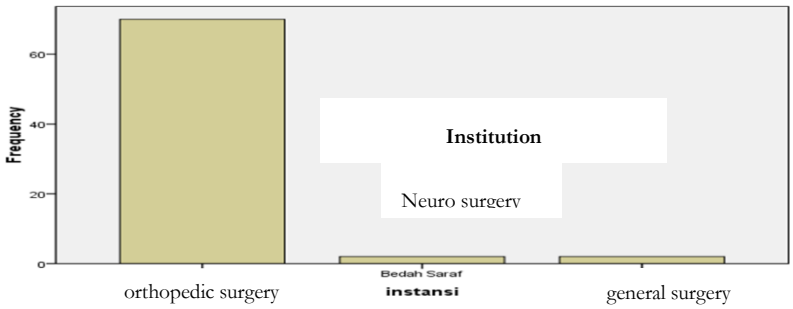

Figure 5: The patients' diagnosis

Based on the research data's results, it is possible to discuss each data analyzedstatistically through descriptive analytics. This discussion is research from a literature study as a first stepto finding

initial data to get the information needed for further research. Initial information is the data needed as the urgency of the next research following the roadmap that has been determined previously.

Research with literature studies can help further research as a novelty step, which is needed so that research has meaning and meaning in military medicine. This can improve prevention as early as possible in stress fracture cases.

DISCUSSION

A. Gender: In the results of the study, which were analyzed statistically through descriptive analytics, it can be seen that the male sex has a greater potential for experiencing stress fractures than women. The potential for stress fractures in men can be caused by the individual burden or the exercise performed by the patientis greater than that of women.

B. Age: Data from research results with age data can be explained that the age that dominates 20 years is age data from cadets and cadets of the Military Academy in Magelang with individual burdens or heavy training in carrying out military education at the Military Academy. At the age of 20 years, there is no bone growth, so the bone regeneration process does not run well when cadets and cadets experience stress fractures while carrying out military education at the Military Academy.

C. Type of work: The research results with job data show that cadets tend to stress fractures compared to cadets or other types of work groups. It can be explained that the training portion of cadets is likely to receive more individual workload treatment or training, and the time given is greater than that of cadets or other types of work groups.

D. Health services: The research results with the health care group explain that patients are more inclined to health services at the orthopedic clinic than the neurosurgery and general surgery poly. Appropriate treatment has been given by referring to the specialists needed in the health services provided.

E. Diagnosis: In the results of the study with the diagnosis group Stress fracture, not elsewhere class, multiple stress has a high potential for occurrence compared to other stress fracture diagnoses. Stress fracture, not elsewhere class, multiple stress caused by individual burden or excessive exercise can be a trigger for stress fracture with this diagnosis. It is hoped that by knowing the diagnosis of the stress fracture, not other classes, multiple stress can be prevented by handling multi-disciplinary disciplines and policies from stakeholders within the Military Academy, Magelang.

Bone stress injuries occur when forces applied to a bone for an extended period exceed the ability of the bone to remodel adequately. These injuries, which range from stress reactions to nondisplaced and even displaced fractures, most often affect people who experience high levels of repetitive stress and loading in the lower extremity or changes in physical activity level (DeFroda *et al.*, 2017).

Common male stress-fracture sites were the metatarsals (66%), calcaneus (20%), and lower leg (13%). Common female stress-fracture sites were the calcaneus (39%), metatarsals (31%), and lower leg (27%). Female soldiers suffered more than twice the number of bilateral stress fractures than men. The week of onset of stress fractures during basic training varied directly with the sex of the soldier. Modifications in the physical training program aimed at eliminating continuous, high-impact activities during high-risk weeks resulted in a 12.73% drop in stress-fracture incidence (decreases of 7.32% in women and 16.19% in men) (Astur *et al.*, 2016)(Jacobs, Cameron and Bojescul, 2014).

Approximately 5% of all military recruits incur stress fracture injuries during intense physical training, predominately in the lower extremities. Acute weight loss combined with regular daily physical training among young military recruits may be a significant contributing risk factor for stress fracture injuries in young military men and women (Armstrong *et al.*, 2004).

Musculoskeletal injuries are prevalent among military trainees and certain occupations. Fitness and body mass index (BMI) have been associated with musculoskeletal conditions, including stress fractures. increased risk of musculoskeletal injuries, including stress fractures, among unfit recruits and anincreased risk of non-stress fracture musculoskeletal injuries among recruits who exceeded body fat limits. Once injured, female recruits who were weight qualified but unfit and those who were fit but exceeded body fat limits had increased health care utilization. These findings may have implications for military accession and training policies as the downsizing of military services will make it more important than ever to optimize the health and performance of individual service members (Krauss *et al.*, 2017)(Jain *et al.*, 2018).

Stress fractures are commonplace in military populations, especially endurance trainees. Acetabular stress fractures are rare and therefore unrecognized but do occur and may be a cause of activity-related hip pain in a small percentage of military endurance athletes and recruits (Williams *et al.*, 2002)(Bhatnagar *et al.*, 2015).

These fractures can be partial or complete fractures of bone that result from repetitive microtrauma. Bone remodeling occurs typically as a balance of osteoclastic resorption and osteoblastic production in response to physiologic stress and mechanical loads. As osteoblastic activation lags behind resorption, there is a time when fracture risk increases because of weakened bone.7–9 Many individuals who sustain stress fractures can identify a sudden increase in workout intensity or duration as a precipitating factor for injury, and it is thought that gradual progressions in both exercise intensity and duration may reduce the risk of fracture (Jacobs, Cameron and Bojescul, 2014).

Bone stress injuries are challenging to diagnose with radiographs alone. Making the correct diagnosismay require a combination of physical examination, advanced imaging, and an index of suspicion. Differences in injury location account for variations in risk for nonunion, displacement, and other complications. For low-risk injuries, treatment typically consists of reduced weight-bearing for several weeks with a gradual return to activity. Higher-risk injuries need to be closely monitored for progression and may require operative intervention. Even after surgery, some types of stress fractures may take
several months to achieve radiographic union. In addition, underlying nutritional or metabolic deficiencies may need to be treated to prevent future injuries. In this article, we review the diagnosis, management, and prevention of bone stress injuries with a focus on more serious manifestations, such as stress fracture (DeFroda *et al.*, 2017).

Military stress fractures using secondary data research, obtained each variable data that significantly shows the conditions that must be considered in the implementation of military education, both the performance of student soldiers and the training load that must be undertaken during the military education period, so that it does not result in severe fractures resulting from military pressure both qualitatively and quantitatively. This data provides an overview of stakeholders and subsequent research as a basis for providing input for preventing military stress fractures that occur in soldiers or prospective soldiers during education, training, and other heavy routine physical activities according to age level. Prevention and treatment are carried out by further research with a strategic approach to using hADMSCs as a form of health security for national defense projections

CONCLUSION

Based on the literature study, it can be concluded that a stress fracture occurred in a 20-year-old male cadet as an official patient at the orthopedic polyclinic and with a diagnosis of a stress fracture, not another class, double stress, as initial data for conducting further research.

Authors' contributions

Each author has contributed to the research and writing of this article as follows Arif Rachman: Conceptualization, Methodology, Software, Data curation, Writing- Original draft preparation,

Visualization, and Investigation. Tjahja Nurrobi, Alfa Januar Krista, Nadia Permatasari, Muhammad Dimas Reza : Supervision, Software, Validation, Writing- Reviewing and Editing, and Funding Acquisition.

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