REVIEW ARTICLE

Extremely Low Frecuency (ELF) Electromagnetic Radiation Potential to Accelerate Fracture Splicing

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ABSTRACT

The treatment process for healing fractures in the community is still mostly done through traditional methods, which are generally referred to as "sangkal putung". The results obtained 28.2% cannot return to its original form. In the process of denying putung it still takes quite a long time depending on the part of the bone that has broken. This study aims to reveal the potential effect of exposure to the ELF (Extremely Low Frequency) magnetic field on the fracture healing process. This research method uses an article review, with a total of 30 articles from relevant research articles from 2000 to 2022. This aims to examine the effect of effective treatment of the intensity of exposure to the ELF magnetic field on the fracture healing process. The results showed that there were 73.3% of researchers who supported the ELF EM wave was able to accelerate the splicing of fractures. Meanwhile, 26.67% of researchers did not support it. The results of the study reported that exposure to a magnetic field with an intensity of 120μT-200μT was able to increase the proliferation of osteoblast cells so as to heal fractures. The most accurate range of intensity in the process of forming Osteoblam cells is the intensity of 150μT. The results in experimental animals showed that exposure to the ELF magnetic field had an effect on the process of forming osteoblasts completely. The results of clinical research (bone fracture patients) showed that exposure to a magnetic field with an intensity of 150μT was able to form and secrete organic collagen and non-collagen in Osteoblast cells, while ELF Osteoclast cells were able to assist in the reabsorption of existing bone cells. Based on the results of the analysis, it can be concluded that exposure to the 150μT intensity ELF magnetic field has the most optimal ability in the process of forming osteoblasts (osteoclasts and osteosts) in fracture healing.

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Introduction

Fracture or commonly known as a fracture is a condition where the bone breaks, cracks or breaks so that it can change its shape.[1] Fracture itself can be regarded as a complete or partial loss of bone continuity. Fractures can occur because the bone receives pressure or impact whose strength exceeds the strength of the bone.[2] The cause of fractures is accidents, both minor accidents and major accidents. But apart from being affected by accidental fractures caused by pathology and imperfect degenerative processes in the bones.[3] One of them is osteoporosis, where in this condition the bones experience a decrease in minerals and damage to the micro components of the bone and have an impact on increasing the risk of fracture.[4] In general, fractures can be divided into two, namely closed fractures (bone fragments do not penetrate the skin) and open fractures (bone fragments have a relationship with the outside world such as wounds to the skin or soft tissue).[5]

Fracture conditions (broken bones) are one of the major problems that are often experienced by humans. Fracture healing process must be done quickly and precisely.[6] If the fracture healing process is not carried out with the right process, it will have a very dangerous impact on fracture sufferers, and can even cause new diseases that attack the safety of fracture sufferers.[7] The principles in the treatment of fractures include reduction, immobilization, and restoration of normal bone strength function.[8] Healing fractures traditionally "denies putung" is still the prima donna of society. According to [9] 6.23% on average, both rural and urban communities still believe in the denture-putung method in healing fractures. However, this process will not guarantee that the bone will return to its original state and if this treatment is carried out incorrectly, it will have an impact on the growth of new bone diseases. [10]

Magnetic and electric fields are one source of electromagnetic that can help the modern fracture healing process.[11] One of them is that alternating electric current can produce exposure to an ELF (Extremely Low Frequency) magnetic field with a frequency intensity of 0-300 Hz.[12] Radiation exposure to the ELF magnetic field is a type of non-ionizing radiation that cannot perform induction and absorption processes on the media used. The Extremely Low Frequency magnetic field also has non-thermal properties which cannot produce unobstructed heat.[13] So that the magnetic field can penetrate the network or building. The spectrum of electromagnetic wave radiation is very broad and has a variety of frequencies. One of them is in electrical equipment sourced from PLN, the frequency it has on average is 50 Hz.

Many studies have proven that ELF in the field of fracture healing medicine can help the process of forming Osteoblasts and Osteoclasts. Osteoblasts are cells derived from the supporting tissue of stem cells in bone marrow stomata. In this cell has a very important task that is responsible for the formation and development of bones. According to[14] exposure to an ELF (Extremely Low Frequency) magnetic field with an intensity of 120-200 μT is able to assist in fracture healing. With optimum bone conditions, exposure to ELF can help Osteoblast cells.[15] The system used for exposure to the ELF magnetic field is designed with the 30-120 Hz ELF system proven to be able to reduce the Gap Junction Intercellular communication in the bone development phase.[16] However, not all exposure to ELF magnetic fields affects osteoblast differentiation.[17] So this is what makes it clear that exposure to the ELF magnetic field only helps the process of splicing broken bones.

Based on the description above, the use of the ELF (Extremely Low Frequency) magnetic field aims to reveal the intensity of exposure to the ELF magnetic field which is in accordance with the fracture grafting process.[18] The ELF magnetic field is able to help the process of forming Osteoblast cells so that the process of secreting organic collagen and non-collagen in Osteoblast cells can be carried out quickly and precisely.[19] This has been proven by previous studies, where exposure to a magnetic field for 30 minutes with an intensity of 120μT can increase Osteoblam cells which are able to help heal fractures. With the use of the right intensity ELF magnetic field is expected to maximize the fracture healing process. And can be used as an appropriate alternative in the treatment of fracture healing.

Methods

The type of research design used is descriptive research. The research method used is Article Review by reviewing 30 articles originating from international articles and national articles. Literature searches were carried out by accessing Sciencedirect, Pubmed, Google Scholar and have been indexed by SINTA or Scimago. The search terms used were 'Extremely Low Frequency (ELF), Fractures, Electromagnetic Radiation, Bone Comprising Cells'. What is reviewed from the 30

articles is the intensity of exposure to the ELF (Extremely Low Frequency) magnetic field that is suitable and able to help the process of splicing fractures. This study also examines the effect of exposure to the ELF magnetic field on bone formation cells and the effect of exposure to ELF on the human body.

Result

Characteristic of the Studies

The collection of literature data on Sciencedirect, PUBMED, Google Cendikia and indexed by SINTA or Scimago resulted in 30 articles that had a significant relationship to the results of the reviews carried out. The articles used as literature data are international articles originating from various regions, as well as national articles. Twelve journal articles discuss the effect of long exposure to Extremely Low Frequency (ELF) magnetic fields, four journal articles discuss the intensity of exposure to Extremely Low Frequency (ELF) magnetic fields, and 16 Journal Articles discuss fractures and the process of bone formation.

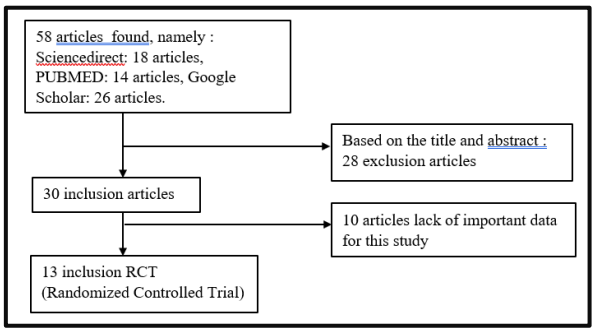

Figure 1. Path Diagram of the Process of Selecting Studies.

Discussion

EM-ELF Exposure Intensity

The results obtained from the source of the review article show that there is a very significant correlation and relationship between the intensity of exposure to Extremely Low Frequency electromagnetic fields and the fracture healing process. However, from these articles there has been no study that explains significantly between the intensity of exposure to Extremely Low Frequency (ELF) magnetic fields for fracture healing.

The results obtained are 6 journals that use therapy with exposure to Extremely Low Frequency (ELF) magnetic fields. Details of the research results are shown in table 1. The results from the 6 journals state different things about the intensity of exposure to ELF magnets. The intensity of exposure to a magnetic field with the right intensity will have a good influence on the formation of bone cells but the intensity given is not right it will have an impact on damage to other body organs. This is in accordance with research from (Agil, M., Ma'arif, B. and Aemi, N. Y., 2019) with the results of research conducted on Balb/C mice with various osteoporosis cases (Akdag, M. Z. *et al., 2010)* giving an intensity of 120 T to Balb/C mice the results were able to increase the proliferation of osteoblast cells so as to heal fractures. In contrast to the research that has been done by (Van Den Heuvel, R. *et al., 2001)* It was found that exposure to an ELF magnetic field with an intensity of 80 mT (50 Hz) showed a reduction in proliferation. According to (Alcaraz, M. *et al.,2014)* Geometric and biomechanical analysis showed that there was a significant decrease in rats exposed to 100 mT-MF compared to rats exposed to sham and 500 mT-MF regarding the value of the cross-sectional area of the femoral shaft (Po0.05). The femoral cortical thickness of mice exposed to MF (100 mT and 500 mT) was also significantly decreased.

Exposure to the Extremely Low Frequency magnetic field has various intensities. The right intensity can help assist in the health sector, but if exposure to EM-ELF is not appropriate, the impact will vary on the human body and other living things. Basically the human body has electric and magnetic fields which have a complex role in controlling the physiological mechanisms of the body. So if there is excessive external exposure, it will cause additional stress to the human body and damage the functions of other organs.

EM-ELF Exposure Time

The results obtained are 4 journals that use Extremely Low Frequency (ELF) as a fracture healing process using a certain length of exposure. The results showed that ELF with an exposure duration of 30 minutes with an intensity of 120μT had a good effect on the formation of osteoblasts in osteoporotic bones. This is in line with research conducted by (Agil, M., Ma'arif, B. and Aemi, N. Y., 2019) which states that intermittent exposure to Extremely Low Frequency magnetic fields 30 minutes, 60 minutes, 90 minutes on the formation of osteoblasts has a different impact, accuracy in bone formation is obtained at intermittent 30 minutes. In contrast to research (Manjhi, J. *et al.,*

2013) Stating that bones with mild osteoporosis can be exposed to an ELF electric field with a duration of exposure of 30 minutes. However, in cases of advanced osteoporosis and fractures, the duration of exposure in the formation of osteoblasts is 90 minutes.

Exposure to Extremely Low Frequency magnetic fields has clinical implications. According to the World Health Organization (WHO), the threshold for exposure to magnetic fields has a clinical impact if the duration of exposure is not in accordance with the condition of the human body.[1] Inappropriate length of exposure has a negative impact on the body, so this threshold still cannot guarantee the biological effect and further research is needed for research to ensure the correct effect of the threshold.[15] Exposure to EM-ELF has nonlinear properties depending on the intensity of exposure and duration of exposure to EM- ELF and the treatment given. So that exposure

To ELF can have a negative or positive impact on its users.[20]

Table 1. Details of Research Results on the Effect of ELF Magnetic Field Exposure

Author	Year	Method	Sample	Intervention	Results
Van Den Heuvel, R. *et al.*	2001	Testing	Male mice and female mice	Male and female mice were grouped by sex and randomly assigned and treated with Extremely Low Frequency magnetic field exposure with an intensity of 80μT (50Hz).	Exposure of murine bone marrow cells, from male and female mice, to an 80 mT (50 Hz) magnetic field showed reduced proliferation. Results on the effect of the ELF field on stem cell proliferation are somewhat equivocal at present. The results from female mice showed a decrease, while those from male mice did not experience a decrease.
Akdag, M. Z. *et al.*	2010	Testing	Mice	Mice were divided into three groups: two experimental and one sham control. The first and second experimental groups (n 10) were given 100 mT and 500 mT-MF for 10 months, 2 ha days, respectively, and the third group (n 10) was treated like the experimental group except for ELF.	Geometric and biomechanical analysis showed a significant decrease in mice exposed to 100 mT-MF compared to mice exposed to sham and 500 mT-MF about the value of the cross-sectional area of the femoral trunk (Po0.05). The maximum load was increased in mice exposed to 100 mT-MF and 500 mT-MF when compared to sham mice (Po0.05). The femoral cortical thickness of the MF-exposed mice (100 mT and 500 mT) was significantly decreased compared to the sham group mice (Po0.05 and Po0.001).
Manjhi, J. *et al.*	2013	Control trial	Adult Male Wistar Rat	Adult male Wistar rats (n = 24) were equally divided into sham, SCI, and SCI+MF groups. Then exposed to EM-ELF (2 hours/day × 8 weeks) (17.96 micro-Tesla, 50 Hz)	This study demonstrated that SCI-induced osteoporosis in rats could be limited by chronic (2 h/day × 8 wk) exposure to ELF-MF (17.96 T, 50 Hz) as expressed by BBB scores, BMC, BMD, mineral elements. content, and biochemical parameters related to sublesional bone.
KiTaek, L. *et al.*	2013	Testing	Eligible patients	Patients who met the trial requirements were divided	ELF-PEMFs can increase cell proliferation and accelerate osteogenesis. In conclusion, these findings may suggest that ELF-

				into 3 groups and then treated with predetermined variables.	PEMFs at appropriate intensities enhance bone formation by promoting stem cell differentiation and maturation.
Alcaraz, M. *et al.*	2014	Control trial, random	Patients were divided into 3 trial groups.	Patients were randomly selected and divided into 3 treatment groups. The treatment that became the control was the group with 50 Hz EM-ELF exposure.	The results showed that 50 Hz ELM-MF increased MNPCE in rat bone marrow, expressing a genotoxic capacity. Administration of antioxidants with genoprotective capacity against damage caused by ionizing radiation acting through free radical scavenging did not reduce the chromosomal damage caused by this ELM-MF.
Agil, M., Ma'arif, B. and Aemi, N. Y.	2019	Trial, Random	Balb/C mice	Balb/C mice were grouped with an intensity of 120μT, and 150μT with an exposure time of 30', 60', and 90'.	The results showed that exposure to a magnetic field with an intensity of 120μT-200μT was able to increase the proliferation of osteoblasts so that they could heal fractures. The most accurate intensity range in the process of forming osteoblasts is the intensity of 150μT.

CONCLUSION

Based on the analysis that has been done on 30 articles, both national and international articles, it was concluded that exposure to the Extremely Low Frequency magnetic field with an intensity of 120μT to 200μT was found that accurate results in helping the process of splicing fractures were by exposure to an ELF magnetic field of 150μT intensity and duration of exposure. 30' has an effect on the process of forming and secreting organic collagen and non-collagen in Osteoblast cells. However, exposure to Extremely Low Frequency (ELF) Electromagnetic Fields still has a negative impact on health if the intensity of exposure is not in accordance with its use.

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Conflicts of Interest

There are no conflicts of interest declared by the author

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