

Case Study: Post-Orif Joint Stiffness Following a Distal Third Right Tibial Fracture Managed with Infrared Radiation Therapy and Exercise

¹Wita Hana Puspita*, ²Gina Fazrina, ³Nugrahaeni Agustyaningsih, ⁴Faza Izzatul Aziz

¹Sekolah Tinggi Ilmu Kesehatan Cirebon, Indonesia*; email: Wita.tj0408@gmail.com

² Sekolah Tinggi Ilmu Kesehatan Cirebon, Indonesia

³ Sekolah Tinggi Ilmu Kesehatan Cirebon, Indonesia

⁴ Sekolah Tinggi Ilmu Kesehatan Cirebon, Indonesia

*Correspondence

Article Information

Submitted: 09 February 2026

Accepted: 20 February 2026

Publish: 23 February 2026

Keywords: Fracture; Joint Stiffness; OREF; Infrared Radiation (IRR); Exercise;

Copyright holder: Wita Hana Puspita, Gina Fazrina, Nugrahaeni Agustyaningsih, Faza Izzatul Aziz

Year: 2026

This is an open access article under the [CC BY-SA](https://creativecommons.org/licenses/by-sa/4.0/) license.



Abstract

Fractures of the tibia 1/3 distal dextra after Open Reduction External Fixation (OREF) often cause joint stiffness, pain, oedema, muscle atrophy, as well as limitations in joint range of motion (LGS) and functional activity. The administration of physiotherapy with Infrared Radiation (IRR) modalities and exercise therapy is a non-invasive approach to overcome these complications. This study used a case study method, in a 61-year-old female patient, with the provision of interventions in the form of IRR and exercise therapy such as static contractions, free active exercises, active resistance training, and non-weight bearing (NWB) walking exercises using walkers. After 6 sessions of therapy, compressive pain decreased, motion pain decreased, oedema in the maleolus decreased, LGS eversi-inversion increased and LGS plantar-dorsal flexion increased, knee flexor muscle strength, dorsal flexor ankle, plantar flexor ankle, as well as evertor and invertor ankle increases, the circumference of the right thigh muscle increases, and the value of functional ability increases.

Case Study: Post-Orif Joint Stiffness Following a Distal Third Right Tibial Fracture Managed with Infrared Radiation Therapy and Exercise

Introduction

Fracture is a condition when a bone becomes broken, cracked, or ruptured so that it changes the shape of the bone. Fracture *tibia* is one of the most common types of fractures, especially in the lower limb area. These fractures are of particular concern because of their potential to cause long-term health problems, such as hospitalization and afterward health care. Tibia fractures can occur mainly as a result of a motor vehicle accident or a fall from a height. The tibia bone which anatomically is located more *Surface*, thus making it susceptible to open fractures. Globally, the incidence rate of open fractures varies worldwide with a range of 2.6% to 23.5% of all fracture cases. Epidemiological data shows that the incidence of open fractures reaches 30.7 per 100,000 people per year. In the United States, an estimated 3% of fractures are open fractures (Shah et al., 2022). In Indonesia, according to data from Basic Health Research (Riskesdas) in 2018, out of 92,976 people with cases of lower extremity fractures due to accidents, 14,027 people suffered fractures *Cruris*, 3,775 people suffered fractures *tibia*, and 337 people suffered fractures *fibula* (Riskesdas, 2018).

Fracture treatment can be done conservatively or operatively. Conservative methods involve closed repositioning and immobilization using casts or traction to support the bone's natural healing process. Meanwhile, operative approaches such as *Open Reduction External Fixation* (OREF) is performed on complex cases to ensure bone stability through the installation of an external fixation device (Adiguna, 2024). OREF is a surgical method used to treat complex fractures with the installation of an external fixation device. This technique aims to maintain bone stability during the healing process while minimizing the risk of complications such as *Malunion* or *Non-union* (Yuliati et al., 2019).

Complications that often occur after OREF include infection in the pin insertion area, chronic pain, joint stiffness, and decreased muscle strength and range of motion. In addition, systemic complications such as *thromboembolic* can also arise as a result of long-term immobilization (Yuliati et al., 2019). From the various physiotherapy modalities that exist, *Infrared Radiation* (IRR), and exercise therapy was chosen for its effectiveness in pain management and for addressing joint stiffness. The combination of these modalities can provide an analgesic effect, improve circulation, and improve joint range of motion and muscle strength (Johnson, 2007; Tattva, 2021; Utama, 2022).

Meanwhile, the practice *Range of Motion* (ROM) actively has been shown to significantly increase lower extremity muscle strength and range of motion in the elderly (Detiana et al., 2023). In another study, it was stated that the results *Pre-test* and *Post-test* showed a significant improvement in muscle strength after the exercise intervention. Study by Chao et al. (2021) Conduct a meta-analysis of exercise rehabilitation programs that include strength, flexibility, and aerobic training. The results showed that the exercise provided significant improvements in joint function and reduced pain compared to the control group (Chao et al., 2021). Various complications that occur will eventually affect the patient's daily functional abilities such as walking, doing hobbies, recreation and other activities. This study aims to evaluate the effectiveness of the combination of IRR and Exercise in addressing post-OREF complications of distal dextra-tibia fracture.

Case Study: Post-Orif Joint Stiffness Following a Distal Third Right Tibial Fracture Managed with Infrared Radiation Therapy and Exercise

Methods

The research is carried out by the case study method, which is a type of qualitative research, which conducts in-depth observation and exploration activities on one or more people, especially in case studies in health research, namely by seeking case deepening and its interventions. Observation was carried out during 6 physiotherapy sessions for 6 weeks.

Inspection

The examination carried out is an examination Vital Sign, inspection, palpation, pain examination, joint scope of motion (LGS), examination of muscle strength with Manual Muscle Testing (MMT), anthropometry, and functional activity. The patient came with the help of a wheelchair, there was a 20 cm long 4 pin site on the patient's tibia, edema on the right ankle, atrophy along the muscles around the tibia and femur. The patient walks with pain, antalgic gait pattern, when the transfer bed from the wheelchair the patient immediately lifts the right leg, the patient is seen to be able to move towards knee flexion, knee extension and plantar ankle flexion, but in dorsal ankle flexion dextra with limited movement and pain, unable to eversion & inversion.

Palpation examination (by touching) found that the local temperature in the area was normal. However, there is pressure pain in the ankle dextra (right ankle). No pitting oedema was found, which is a swelling that leaves an indentation after being pressed. The examination of the degree of pain with VAS obtained that the value of silent pain was 0, pressure pain 5.3, and motion pain 3.2. LGS measurements are carried out using a goniometer, to determine LGS in flexion-extension movements for the knee region, plantar-dorsal flexion, and reverse-inversion. The data taken in this measurement is LGS on the knee and ankle dextra. Flexion and extension movements in the sagittal plane, LGS is normally S0-0-135. Plantar-dorsal movement flexion in the sagittal plane, LGS is normally S20-0-35. The eversi-inversion movement in the rotation plane, LGS is normally R30-0-20. The results obtained from the LGS examination using the goniometer measuring device:

Examination of MMT Knee Flexion with a value of (3+), Knee Extension value (4), Dorsal Flexion Ankle value (3-), Plantar Flexion Ankle value (3+), Eversion and Inversion of Ankle value (2-). The results of the anthropometric examination of the length of the limb were obtained that the value of the left leg was 67 cm and the right leg was 66.2 cm. The results of Segment Circumference Measurement with Anthropometry were obtained that on the right ankle Maleolus 22 cm, From Maleolus 5 cm to distal 21.8 cm, From Maleolus 10 cm to distal 19.9 cm, From Maleolus 5 cm to proximal 22 cm, From Maleolus 10 cm to proximal 23.6 cm. The functional activity examination used LEFS with a score of 26, which interpreted that the patient had moderate functional limitations.

The physiotherapy diagnosis obtained is Impairment: the presence of motion pain during dorsi-flexion movements, reversi-inversion and also when walking; decreased muscle strength of the Quadriceps, Hamstring, Gastrocnemius, Soleus, Tibialis Anterior; the presence of muscle atrophy m. quadriceps and m. hamstring; limitation of joint movement in the ankle dextra at the time of dorsi flexion, reverse-inversion; the presence of oedema in the ankle area of the dextra. Functional limitation: limitation of standing from sitting, walking, and doing activities such as toileting. Participation restriction: there are difficulties in participating in congregational prayers and recitations.

Case Study: Post-Orif Joint Stiffness Following a Distal Third Right Tibial Fracture Managed with Infrared Radiation Therapy and Exercise

Results and Discussion

Patients were given interventions in the form of IRR for 15 minutes and exercise therapy in the form of static contractions, free active exercises, and active resistance exercises with an intensity of 10 repetitions with 10 seconds of hold, as well as walking exercises *Non-weight bearing* (NWB) using *Walker*. Pain evaluation results using *Visual Analogue Scale* Explained in the table:

Table 1
Final Evaluation Results of Pain with VAS

Types of Pain	Value					
	T1 (06-01-2025)	T2 (13-01-2025)	T3 (20-01-2025)	Q4 (03-02-2025)	Q5 (07-02-2025)	T6 (22-02-2025)
Pain Pressure	3.2	3.2	3	3	2.8	2.5
Motion Pain	5.3	5.3	4.8	4.8	4.5	4.2
Silent Pain	0	0	0	0	0	0

The results of the LGS evaluation using the goonometer are described in the table:

Table 2
Final Evaluation Results of LGS with Goneometer

Movement	ROM						ROM Normal
	T1 (06-01-2025)	T2 (13-01-2025)	T3 (20-01-2025)	Q4 (03-02-2025)	Q5 (07-02-2025)	T6 (22-02-2025)	
<i>Knee Flexion</i> <i>Extensions</i>	S0-0-135	S0-0-135	S0-0-135	S0-0-135	S0-0-135	S0-0-135	S0-0-135
<i>Plantar-dorsal flexion</i> <i>ankle</i>	S20-0-15	S20-0-18	S20-0-20	S20-0-22	S20-0-28	S20-0-35	S20-0-35
<i>Eversi-Inversion</i>	R12-0-8	R17-0-14	R19-0-15	R22-0-16	R25-0-18	R30-0-20	R30-0-20

Table 3
Results of Evaluation of Muscle Strength with MMT

Muscle Group	Value					
	T1 (06-01-2025)	T2 (13-01-2025)	T3 (20-01-2025)	Q4 (03-02-2025)	Q5 (07-02-2025)	T6 (22-02-2025)
<i>Fleksor Knee</i>	3+	3+	3+	4	4	4
<i>Stretcher Knee</i>	4	4	4	4	4	4
<i>Dorsal Flexor Ankle</i>	3-	3-	3-	3	3	3
<i>Plantar Flexor Ankle</i>	3+	3+	3+	4	4	4
<i>Ankle Inverter</i>	2-	2-	2-	2	2	2
<i>Evertor Ankle</i>	2-	2-	2-	2	2	2

Case Study: Post-Orif Joint Stiffness Following a Distal Third Right Tibial Fracture Managed with Infrared Radiation Therapy and Exercise

The results of the evaluation of oedema through anthropometry are described in the table:

Table 4
Results of Evaluation of Oedema Measurement

Measurement	Results						Differences
	T1 (06-01-2025)	T2 (13-01-2025)	T3 (20-01-2025)	Q4 (03-02-2025)	Q5 (07-02-2025)	T6 (22-02-2025)	
<i>Maleolus</i>	19.6 cm	0					
From <i>Maleolus</i> 5 cm to <i>distal</i>	20.1 cm	0					
Left ankle From <i>Maleolus</i> 10 cm to <i>distal</i>	17.5 cm	0					
From <i>Maleolus</i> 5 cm to <i>proximal</i>	15.6 cm	0					
From <i>Maleolus</i> 10 cm to <i>proximal</i>	15.8 cm	0					
<i>Maleolus</i>	22 cm	21 cm	20.5 cm	20 cm	20 cm	19.6 cm	2.4 cm
From <i>Maleolus</i> 5 cm to <i>distal</i>	21.8 cm	21 cm	20.4 cm	20.4 cm	20.4 cm	20.1 cm	1.7 cm
Right ankle From <i>Maleolus</i> 10 cm to <i>distal</i>	19.9 cm	19 cm	18.5 cm	18.3 cm	18.3 cm	17.5 cm	2.4 cm
From <i>Maleolus</i> 5 cm to <i>proximal</i>	22 cm	21.5 cm	20.9 cm	20.2 cm	20.2 cm	15.6 cm	6.3 cm
From <i>Maleolus</i> 10 cm to <i>proximal</i>	23.6 cm	22.8 cm	22.1 cm	21.3 cm	21.3 cm	15.8 cm	7.8 cm

The results of the evaluation of functional activities using LEFS are shown in the table:

Table 5
Results of Functional Activities Using LEFS

No	Activities	Results					
		T1 (06-01-2025)	T2 (13-01-2025)	T3 (20-01-2025)	Q4 (03-02-2025)	Q5 (07-02-2025)	T6 (22-02-2025)
1	Usual work, housework, or school activities	1	1	2	2	3	3
2	Hobbies, recreation, or sports activities that you usually do	0	0	1	1	2	2
	Getting in or out of the bathtub	1	1	2	2	3	3
4	Walk between rooms	1	2	2	3	3	4
5	Walking outdoors on a flat surface	1	1	2	2	3	3
6	Up and down the stairs	0	1	1	2	2	3
7	Stand for 1 hour	1	1	2	2	3	3
8	Sit for 1 hour	3	3	4	4	4	4
9	Crouching	0	1	1	2	2	3
10	Lifting heavy objects	0	0	1	1	2	2
11	Lifting light objects	2	2	3	3	4	4
12	Getting on and off the vehicle	1	1	2	2	3	3
13	Lying in bed	3	3	4	4	4	4
14	Walk for 2 kilometers	0	0	1	1	2	2
15	Walk 500 meters	1	1	2	2	3	3
16	Running on a flat surface	0	0	0	1	1	2
17	Running on uneven surfaces	0	0	0	0	1	1
18	Sharp turns when running fast	0	0	0	0	1	1
19	Jump with one leg	0	0	0	0	1	1
20	Rolling over in bed	2	2	3	3	4	4
TOTAL SCORE		17	20	27	32	42	50

Case Study: Post-Orif Joint Stiffness Following a Distal Third Right Tibial Fracture Managed with Infrared Radiation Therapy and Exercise

The results of this study show that the use of additional therapy in the form of Infrared Radiation (IRR), has the potential to reduce pain and improve blood flow in the condition Musculoskeletal. Pain measurement using VAS as shown in table 1 obtained a T1 pressure pain value of 3.2 at T6 to 2.5 (a decrease of 7%), a T1 motion pain value of 5.3 at T6 4.2 (a decrease of 11%). This is in accordance with Tsagkaris et al. (2022) which found that the application of IRR was able to reduce pain scores, for example in measurements Visual Analog Scale (VAS), as well as improving tissue quality by stimulating blood circulation and reducing inflammation. Lenasari and Imron. (2025) also explains that Far Infrared Radiation (FIR) is able to relieve pain through several mechanisms, including increased blood circulation and tissue oxygenation that accelerates healing and reduces inflammation, decreased levels of pro-inflammatory cytokines such as IL-6 and TNF- α that play a role in chronic pain, increased local temperature that makes muscles more relaxed and reduces spasms, and modulation of the nervous system by decreasing the transmission of pain signals to the brain so that pain perception is reduced (Lenasari & Imron, 2025). Thus, the use of IRR in patients as applied in the case Post-fracture It has a strong scientific basis in helping to reduce pain, promote muscle relaxation, and support the tissue healing process(Lenasari & Imron, 2025; Son, 2013; Tsagkaris et al., 2022; Usman et al., 2019).

The results of this study also show that a combination of exercises in the form of static contractions, free active exercises, and resistance training is effectively able to increase the range of joint movement as seen in table 2 in the reverse-inversion movement of T1 12° to 30° at T6 which is a normal value (100% increase), increasing muscle strength as in table 3 especially in some muscle groups getting a value of 4 from the normal value of 5, reduce atrophy, and improve the ability of functional activities as shown in table 5 on T1 score of 17 and T6 score of 50 from severe to moderate limitation.

Static contraction exercises work by activating the muscular motor units without causing joint movement, so it is safe to do in the early stages of post-fracture rehabilitation when dynamic movement is still restricted to prevent excessive stress on the healing bones. Isometric exercises such as static contractions quadriceps It has a mechanism of activation of muscle fibers so that it is able to increase muscle protein synthesis and has been proven to be effective in minimizing atrophy muscles during immobilization and accelerates recovery of muscle strength during rehabilitation (Stevens et al., 2004). Static contraction exercises also support the restoration of joint function by improving neuromuscular stability and coordination through the activation of joint support muscles, such as the quadriceps and ankle muscles, stimulating proprioceptors, thereby improving joint position awareness and movement coordination (Lewis et al., 2024).

The free active exercise performed after cast removal significantly increased the ROM compared to the control group that received only standard instructions. The process involves active movements without weight, such as flexi-knee extensions or dorsiflexi-plantarflexi ankle, which is performed in the position Non-Weight-Bearing (for example, while sitting or lying down) to prevent excessive stress on the healing bones. These movements stimulate the activation of proprioceptors, increase joint position awareness, and prevent contractures, which ultimately improves joint mobility. This study showed that patients who did free active exercise reached normal ROM faster, with an increase in eversi-inversion after 4 weeks of rehabilitation. (Moseley et al., 2015; Shim et al., 2017). Free active exercise also improves joint function by strengthening neuromuscular

Case Study: Post-Orif Joint Stiffness Following a Distal Third Right Tibial Fracture Managed with Infrared Radiation Therapy and Exercise

coordination and joint stability, which is important for functional activities such as walking or going up and down stairs.

Further, Keene et al. (2019) explains that free active exercise that begins immediately after immobilization release improves joint stability and function by improving natural movement patterns (Keene et al., 2014). The process involves repetitive movements performed in a controlled environment (e.g., Palmer-dorsal ankle flexion with the guidance of a physiotherapist) to ensure the joints move within a safe range. These exercises stimulate the activation of synergistic and antagonistic muscles, which improve joint coordination and stability, thereby reducing the risk of re-injury. This study showed that patients who did free active exercise had improved gait and balance, which supported the recovery of daily activities.

Meanwhile, active resistance training works by stimulating muscle hypertrophy and increasing neuromuscular activation through progressive muscle contractions against loads. This exercise stimulates muscle protein synthesis, increases muscle fiber volume, and minimizes atrophy muscles that occur during immobilization (STEVENS et al., 2004). Other studies have also shown that resistance training is active in the thigh muscles, such as quadriceps, helps minimize the degradation of muscle proteins post-immobilization (Yamauchi et al., 2017).

Walking exercises with the NWB method walker also improve stability and reduce the risk of falls, which is a major problem in post-fracture patients due to muscle weakness and balance disorders. Walking exercises with the NWB method walker in post-hip fracture patients improve stability and walkability without increasing the risk of re-injury. The process involves training the patient to use a walker with a three-point gait technique. Walker was moved first, followed by a healthy foot, while the injured leg remained unloaded. This technique minimizes pressure on the injured limb while working the muscles of the arms and torso to support balance. Walking exercises with the NWB method walker can be modified to support the transition to partial weight bearing gradually, which improves functional ability without jeopardizing fracture healing.

Conclusion

In this case study study, it was concluded that the combination of Infra-Red Radiation (IRR), exercise therapy such as Static Contraction, Free Active Exercise, Active Resisted Exercise, and walking exercises using walkers with Non-Weight Bearing is an effective physiotherapy modality to reduce pain, increase muscle strength in the knee flexors, dorsal flexor ankle, plantar flexor ankle, evertor ankle, and ankle inverter, improve the range of motion of the ankle joint (eversi-inversion and plantar-dorsal flexion), reduce edema and improve the circumference of the quadriceps muscle, as well as improving the patient's functional ability in daily activities such as in worship activities and in social activities such as recitation although it is still in moderate limitations due to the installation of external fixation devices.

Further research is recommended with observation with a longer time and also research using experimental research designs with larger sample numbers to improve the validity and generalization of the research results. In addition, it is necessary to have a control group or comparator to determine the effectiveness of each modality more specifically.

Reference

- Adiguna, R. (2024). *Fracture Surgery and Healing Procedure*. Bunda Hospital Group.
- Chao, J., Jing, Z., Xuehua, B., Peilei, Y., & Qi, G. (2021). [Effect of systematic exercise rehabilitation on patients with knee osteoarthritis: a randomized controlled trial](#). *Cartilage*, *13*(1_suppl), 1734S-1740S. <https://doi.org/10.1177/1947603520903443>
- Detiana, D. ... Lusiana, L. (2023). [Latihan Range of Motion \(ROM\) Aktif Meningkatkan Kekuatan Otot Ekstremitas Bawah dan Rentang Gerak Sendi Lansia](#). *Journal of Telenursing (JOTING)*, *5*(2), 3834–3843. <https://doi.org/10.31539/joting.v5i2.8329>
- Johnson, M. (2007). Transcutaneous Electrical Nerve Stimulation: Mechanisms, Clinical Application and Evidence. *Reviews in Pain*, *1*(1), 7–11. <https://doi.org/10.1177/204946370700100103>
- Keene, D. J. ... Lamb, S. E. (2014). Early ankle movement versus immobilization in the postoperative management of ankle fracture in adults: a systematic review and meta-analysis. *The Journal of Orthopaedic and Sports Physical Therapy*, *44*(9), 690–701, C1-7. <https://doi.org/10.2519/jospt.2014.5294>
- Imron, M. A. (2025). [Effectiveness of Infrared Therapy on Pain in Musculoskeletal Disorders: A Narrative Review Based on Recent Literature](#). *Majalah Ilmiah Fisioterapi Indonesia*, *13*(1), 104-111. <https://doi.org/10.24843/mifi.2025.v13.i01.p18>
- Lewis, S. R., Pritchard, M. W., Parker, R., Searle, H. K., Beckenkamp, P. R., Keene, D. J., ... & Lin, C. W. C. (2024). [Rehabilitation for ankle fractures in adults](#). *Cochrane Database of Systematic Reviews*, (9). <https://doi.org/10.1002/14651858.CD005595.pub4>
- Moseley, A. M. ... EXACT Team. (2015). Rehabilitation After Immobilization for Ankle Fracture: The EXACT Randomized Clinical Trial. *JAMA*, *314*(13), 1376–1385. <https://doi.org/10.1001/jama.2015.12180>
- Putra, Y. W. (2013). *The effectiveness of infrared distance on pain thresholds*. 1–8.
- Riskesdas. (2018). Riskesdas Report 2018 Nasional.pdf. In *IAARD Publishing Institute* (p. p. 156).
- Shah, A. ... Griffin, X. L. (2022). [Incidence and quality of care for open fractures in England between 2008 and 2019 : a cohort study using data collected by the Trauma Audit and Research Network](#). *The Bone & Joint Journal*, *104-B*(6), 736–746. <https://doi.org/10.1302/0301-620X.104B6.BJJ-2021-1097.R2>
- Shim, D.-G. ... Lee, K.-B. (2017). Rectus femoris muscle atrophy and recovery caused by preoperative pretibial traction in femoral shaft fractures-comparison between traction period. *Orthopaedics & Traumatology: Surgery & Research*, *103*(5), 691–695. <https://doi.org/10.1016/j.otsr.2017.05.006>
- Stevens, J. E. ... Vandenborne, K. (2004). Muscle adaptations with immobilization and rehabilitation after ankle fracture. *Medicine and Science in Sports and Exercise*, *36*(10), 1695–1701. <https://doi.org/10.1249/01.mss.0000142407.25188.05>
- STEVENS, J. E. ... VANDENBORNE, K. (2004). Muscle Adaptations with Immobilization and Rehabilitation after Ankle Fracture. *Medicine & Science in Sports & Exercise*, *36*(10), 1695–1701. <https://doi.org/10.1249/01.MSS.0000142407.25188.05>

Case Study: Post-Orif Joint Stiffness Following a Distal Third Right Tibial Fracture Managed with Infrared Radiation Therapy and Exercise

- Tattva, P. (2021). *Infrared Radiation Therapy in Physiotherapy*. Physio Tattva.
- Tsagkaris, C., Papazoglou, A. S., Eleftheriades, A., Tsakopoulos, S., Alexiou, A., Găman, M. A., & Moysidis, D. V. (2022). [Infrared radiation in the management of musculoskeletal conditions and chronic pain: a systematic review](https://doi.org/10.3390/12030024). *European journal of investigation in health, psychology and education*, 12(3), 334-343. [https://doi.org/https://doi.org/10.3390/ pp. 12030024](https://doi.org/10.3390/12030024)
- Usman, Z. ... Kaka, B. (2019). Effects of combination therapy and infrared radiation on pain, physical function, and quality of life in subjects with knee osteoarthritis: A randomized controlled study. *Hong Kong Physiotherapy Journal : Official Publication of the Hong Kong Physiotherapy Association Limited = Wu Li Chih Liao*, 39(2), 133–142. <https://doi.org/10.1142/S1013702519500124>
- UTAMA, F. (2022). *PENATALAKSANAAN FISIOTERAPI PADA TOTAL KNEE REPLACEMENT ET CAUSA OSTEOARTRITIS SINISTRA DENGAN INFRA RED, TRANSCUTANEUS ELECTRICAL NERVE STIMULATION DAN TERAPI LATIHAN* (Doctoral dissertation, Universitas Widya Husada Semarang).
- Yamauchi, K. ... Ishida, K. (2017). Muscle atrophy and recovery of individual thigh muscles as measured by magnetic resonance imaging scan during treatment with cast for ankle or foot fracture. *Journal of Orthopaedic Surgery*, 25(3). <https://doi.org/10.1177/2309499017739765>
- Yuliati, S. ... Kartina, I. (2019). *DESCRIPTION OF QUALITY OF LIFE IN PATIENTS WITH OPEN REDUCTION EXTERNAL FIXATION (OREF) OF THE LOWER EXTREMITIES AT ORTHOPEDIC HOSPITAL OF THE BACHELOR OF NURSING STUDY PROGRAM*.