Jurnal Keperawatan Indonesia, 2021, 24 (3), 131–139
DOI: 10.7454/jki.v24i3.1000
Received July 2019; Accepted June 2021

pISSN 1410-4490; eISSN 2354-9203

20-DEGREE ELEVATION TO REDUCE SWELLING AND PAIN AFTER LOWER EXTREMITY OPEN REDUCTION AND INTERNAL FIXATION SURGERY

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Abstract

Surgery for open reduction and internal fixation (ORIF) causes tissue swelling and pain in the surgical area. Swelling and pain can be reduced by performing distal elevation in the area of surgical ORIF. This study aimed to determine the effect of a 20° elevation on swelling and pain level of patients after surgery for ORIF of the lower extremities. A quasi-experimental design with one intervention group (pretest and posttest) and one control group was implemented. Thirty-four post-operative ORIF patients treated in one hospital in South Sumatera met the inclusion criteria and were divided into intervention and control groups. Swelling circumference was measured using tape meters, and pain level was assessed with a numeric rating scale. Dependent t-test, independent t-test, and Pearson correlation were applied for data analysis. Results showed that the average difference in swelling circumference and pain level between pre and post intervention was 1.93 ± 0.25 and 1.29 ± 0.35, respectively. Significant differences were found in the mean swelling circumference and pain level between the intervention and control groups (p = 0.000). Therefore a 20° elevation of lower extremity on the second day after ORIF for two days can be an alternative for nursing intervention to reduce swelling and pain.

Keywords: elevation, lower extremity, open reduction and internal fixation, pain, swelling

Abstrak

Elevasi 20 Derajat untuk Menurunkan Pembengkakan dan Nyeri Pasca Bedah Open Reduction and Internal Fixation Ekstremitas Bawah. *Pembedahan* open reduction and internal fixation (ORIF) *menyebabkan pembengkakan jaringan dan nyeri pada area pembedahan. Pembengkakan dan nyeri dapat dikurangi dengan melakukan elevasi distal pada area bedah ORIF. Penelitian ini bertujuan untuk mengetahui pengaruh elevasi 20° terhadap tingkat pembengkakan dan nyeri pada pasien pasca operasi ORIF ekstremitas bawah. Desain kuasi-eksperimental dengan satu kelompok intervensi (*pre-test *dan* posttest*) dan satu kelompok kontrol diterapkan pada penelitian ini. Tiga puluh empat pasien ORIF pasca operasi yang dirawat di salah satu rumah sakit di Sumatera Selatan memenuhi kriteria inklusi dan dibagi menjadi kelompok intervensi dan kontrol. Lingkar pembengkakan diukur menggunakan meteran pita, dan tingkat nyeri dinilai dengan skala numerik.* Dependent t-test, independent t-test*, dan korelasi Pearson digunakan untuk analisis data. Hasil penelitian menunjukkan bahwa rerata perbedaan lingkar bengkak dan tingkat nyeri antara sebelum dan sesudah intervensi masing-masing adalah 1,93 ± 0,25 dan 1,29 ± 0,35. Perbedaan bermakna ditemukan pada rerata lingkar pembengkakan dan tingkat nyeri antara kelompok intervensi dan kelompok kontrol (p = 0,000). Oleh karena itu, elevasi 20° ekstremitas bawah pada hari kedua setelah ORIF selama dua hari dapat menjadi alternatif intervensi keperawatan untuk mengurangi pembengkakan dan nyeri.*

Kata Kunci: *bengkak, ekstremitas bawah, elevasi, nyeri,* open reduction and internal fixation

Introduction

Extremity fracture, especially in lower extremity, is one of the most common musculoskeletal traumas. The global incidence of fractures in 2019 reached 178 million, and there were an increase of prevalent cases of 70.1% acute or long term symptoms of fracture since 1990 (GBD 2019 Fracture Collaborators, 2021). In Indonesia, the Health Research and Development

Agency of the Ministry of Health (2019) in the Basic Health Research report reported the higher prevalence of lower extremity fractures (67.9%) than other fracture types.

Open reduction and internal fixation (ORIF) is a medical treatment for extremity fractures consisting of a surgical method paired with internal fixation. Sharr et al. (2016) showed that 89% of patients have experienced swelling in the area around the operation on the second day after ORIF surgery. Swelling is one of the inflammatory response symptoms for almost all postoperative patients, when ignored, this condition can lead to peripheral neurovascular dysfunction (Wilkinson & Ahern, 2012). Most patients also experience pain, Mwaka et al. (2013) found that 13% to 11.7% of patients experienced moderate to severe postoperative pain from days 1–2, and greatest pain from days 2–4 after surgery (Septiani, 2011).

Owing to the development of medical science supported by related research, pharmacological pain management such as the administration of opioids, non-opioids, and analgesics has become a priority (Tarau, 2011). Among which, ketorolac works as an analgesic and anti-inflammatory but can cause side effects such as indigestion, gastrointestinal bleeding, impaired kidney function, and headaches (Katzung et al., 2012). Severe pain after ORIF surgery is treated with analgesic drugs, but 50% of patients still feel pain and require non-pharmacological pain management (Priliana & Kardiyudiani, 2014). According to observation at hospitals in South Sumatera, Indonesia, 67% of the studied patients still complained of pain and swelling of the area around the operation on days 3 and 4 after ORIF surgery. The nurse's role as a health care team member in providing intervention to promote comfort and pain management is of great importance.

Physiological positioning and limb immobilization after ORIF surgery can be adopted as nursing intervention to reduce swelling and pain. Extremity elevation aims to minimize skin tension in the injured area and reduce swelling, thereby decreasing local pressure in the swollen area and ameliorating pain (Wilkinson & Ahern, 2012). The elevation degree can be adjusted to the height of the heart or as high as 20° to assist the veins in returning blood from the injured area to the heart to avoid blood pooling or accumulation in the injured area and improve arterial circulation (Solomon et al., 2010). Schnetzke et al. (2017) adopted elevation for 24 hours in the preoperative and postoperative period, with the time adjusted to the soft tissue swelling that occurred. Al-Ashhab (2015) performed limb elevation in pediatric patients with intra-articular calcaneal fractures during the first week of postoperative. Although the effect of limb elevation has been reported and research on the effect of elevation on swelling recommend this strategy as a standard care after ORIF surgery, however the angle of elevation, elevation device, duration and schedule, and elevation procedure are still not standardized. The present work aimed to determine the influences of 20° elevation on the swelling and pain levels of patients after ORIF surgery for lower extremity.

Methods

This research is a quantitative study using a quasi-experimental design with one intervention group (pretest and posttest) and one control group. Subjects were post-ORIF surgery patients who were treated at a hospital in South Sumatera. Inclusion criteria were as follows: aged 18 years; fully conscious; post-ORIF surgery on the second day with fractures of the femur, tibia, or fibula; receiving opioid or non-opioid analgesic therapy. Exclusion criteria included hearing loss, comorbidities with diabetes mellitus, heart problems, kidney failure, fluid overload, elephantiasis, hypoproteinemia, fever (temperature 38.5°C), fracture of the collum femur, and history of psychological disorders. Respondents were informed about the research, including a description of the procedure, the objectives and benefits of the study, the advantages and disadvantages, and the confidentiality of the data of respondent. Respondents' participation is voluntary, and consent is given if they are will-

ing to participate in the research. This work passed the ethical review from the Faculty of Nursing (No. 40/UN2.F12D/HKP. 02.04/2019) and the research hospital (No. 71/kepkrsmhfkunsri/2019).

The research sample included 34 patients that divided into two groups. The first 17 respondents were designated as control and received 30 mg of intravenous ketorolac therapy every 8 hours. The remaining 17 respondents were labeled as intervention group who received 30 mg of intravenous ketorolac therapy every 8 hours plus an intervention of 20° elevation of lower extremities accompanied by alternating dorso-plantar flexion movements at the ankle (pumping action). Pretest-posttest data were collected on D+2 and D+4 after ORIF surgery. Pain measurement was carried out with the Numeric Rating Scale (NRS) 30 minutes after analgesic administration. Swelling circumference was measured using a tape measure where the upper leg (femur) was positioned in three places, namely, 5 cm above the greater trochanter, the midpoint between the greater trochanter and the tibial tuberosity, and 5 cm proximal to the tibial tuberosity. If the ORIF on the lower leg (tibia, fibula, or both) the measurement is performed at three places measured starting from the lateral malleolus, namely at a distance of 12, 20, and 30 cm, then the mean value is taken. Measurement points were marked with non-erasable markers to ensure measurements are always recorded in the same section.

In the intervention group, elevation was performed while the patient was in the supine position. The lower extremity undergoing ORIF was elevated at 20° using a special tool built from rebounded super foam material with Rounded Fiber Foam technology for 1 hour, accompanied by four times dorso-plantar flexion at the ankle. Afterward, the extremity was rested in a horizontal position for 1 hour. Movement pattern was repeated six times in one day and repeated the next day. Univariate and bivariate data analyses were performed using data processing software with t-dependent test, t-independent test, or Pearson correlation.

Results

The average age of respondents was 37.88 years in the intervention group and 37.53 years in the control group. Most of the respondents were male. Traffic accidents were the most common cause of fractures, and the upper leg was the most common location as described in Table 1.

As shown in Tables 2 and 3, the mean swelling circumference and pain level in both groups significantly decreased before and after the intervention ($p = 0.000$; $\alpha < 0.05$). As shown in Tables 4 and 5, the average decrease in swelling circumference and pain level in the intervention group was higher than that in the control group.

Table 1. Respondents' Characteristics

Variables	Categories	Intervention group		Control group		Total	
		n	%	n	%	n	%
Sex	Male	10	58.8	12	70.6	22	64.7
	Female	7	41.2	5	29.4	12	35.3
Orthopedic Surgery History	Yes	6	35.3	6	35.3	12	35.3
	No	11	64.7	11	64.7	22	64.7
Causes	Traffic accident	11	64.7	13	76.5	24	70.6
	Fall	4	23.5	3	17.6	7	20.6
	Pathologic disease	2	11.8	1	5.9	3	8.8
ORIF Location	Upper Leg	11	64.7	11	64.7	22	64.7
	Lower Leg	6	35.3	6	35.3	12	35.3

Table 2. Differences in Swelling Circumference Before and After Treatment

Variable	Group	n	Mean ± SD	Mean Differences ± SD	95% CI	p
Circumference of swelling	Intervention					
	Before	17	45.22 ± 6.71	4.49 ± 0.77	4.09 – 4.88	0.000*
	After		40.73 ± 6.75			
	Control					
	Before	17	47.92 ± 8.05	2.57 ± 0.70	2.21 – 2.93	0.000*
	After		45.35 ± 8.04			

*t-dependent test significant at α < 0.05

Table 3. Differences in Pain Level Before and After Treatment

Variable	Group	n	Mean ± SD	Mean Differences ± SD	95% CI	p
Pain level	Intervention					
	Before	17	5.76 ± 1.30	2.94 ± 0.97	2.44 – 3.44	0.000*
	After		2.82 ± 1.29			
	Control					
	Before	17	5.53 ± 1.23	1.65 ± 1.06	1.10 – 2.19	0.000*
	After		3.88 ± 1.22			

*t-dependent test significant at α < 0.05

Table 4. Differences in Post-treatment Swelling Circumference Between Groups

Variable	Group	N	Mean ± SD	Mean Differences ± SD	95% CI	p
Difference of Circumference of Swelling	Intervention	17	4.48 ± 0.76	1.93 ± 0.25	1.42 – 2.44	0.000*
	Control	17	2.55 ± 0.69			

*t-independent test significant at α < 0.05

Table 5. Differences in Post-treatment Pain Level Between Groups

Variable	Group	n	Mean ± SD	Mean Differences ± SED	95% CI	p
Difference of Pain Level	Intervention	17	2.94 ± 0.97	1.29 ± 0.35	0.59 – 2.00	0.001*
	Control	17	1.65 ± 1.06			

*t-independent test significant at α < 0.05

Discussion

Frequency distribution analysis showed that the average age of respondents was 37.88 years in the intervention group and 37.53 years in the control group. This finding is in accordance with the results of a descriptive–correlational study conducted in India (Thomas & Fatima, 2015), which reported that 85% of patients with lower extremity fracture were aged 21–50 years, and only 15% were over 50 years of age. The age range of respondents who experienced lower

extremity fractures in these two studies was mainly 15–64 years. This age group was included in the productive age group, a risk factor for traffic accidents causing lower extremity fractures. This population tends to have a high level of daily physical activity and mobility.

Lower extremity fractures were more common in men (64.7%) than in women (35.3%). Fractures due to traffic accidents are more likely to occur in males than in females (Ngunde et al., 2019). Pan et al. (2014) concluded that men are considered a significant risk factor for lower limb fractures due to traffic accidents. Their mobility, especially related to driving activities, is higher than that of women, resulting in a higher risk of traffic accidents that often lead to lower extremity fractures.

Among the respondents, 12 (35.3%) had previously experienced orthopedic surgery, including ORIF surgery, previous ORIF surgery, skeletal traction installation, and skin traction installation. Some patients with extremity fractures, especially those caused by traffic accidents, sometimes have multiple fractures that require more than one surgery. Most of the fractures were caused by traffic accidents, high-speed driving behavior that results in fatal accidents is the cause of the high incidence of fractures in men (Riyadina & Suhardi, 2009).

Most of the respondents underwent ORIF surgery in the upper leg area, namely, fractures in the femur (64.7%) and lower leg area (35.3%) such as the tibia, fibula, or both. When an accident occurs, the position of the bones of the upper limbs is more challenging to maintain than that of the bones of the lower limbs (Ayu, 2017). The position of the femur while driving a car is parallel to the location of the car's bumper. Hence, this bone is under pressure and receives high energy from the trauma, which can eventually lead to a fracture (traumatic fracture). Femur fracture due to a motorcycle accident is usually due to strong impact of the asphalt on the femur bone and being hit by a vehicle.

Swelling Circumference. Swelling after ORIF surgery usually occurs from days 1 to 5. Vasodilation and increased blood flow to tissues occur in this postoperative inflammatory phase. Hence, redness ensues in the trauma area. The permeability of blood vessels also increases, thus allowing fluid, protein, and white blood cells to move from the circulation to the site of tissue damage; as a result, accumulation and swelling transpire (Sherwood, 2012). In this study, the intervention and control groups intravenously received an anti-inflammatory therapy consisting of 30 mg of ketorolac every 8 hours. One of the functions of ketorolac is anti-inflammatory by inhibiting the attachment of granulocytes to damaged blood vessels, stabilizing lysosomal membranes, and suppressing the migration of polymorphonuclear leukocytes and macrophages to the inflammation site to prevent the accumulation of excessive plasma fluid, tissue cells, blood cells, and other substances in the injured area. In addition, swelling slowly decreases with the inflammation in the wound (Golan et al., 2008).

The initial focus of postoperative ORIF care includes sustained wound drainage and reduced fluid accumulation in the surgical area by maintaining limb alignment, elevating the surgical area of the extremity, and ensuring the dressing to be not constrictive (Lewis et al., 2011). Elevation of extremities after ORIF surgery can adequately increase blood flow through blood vessels to maintain tissue function and nerve ability in conveying sensory and motor impulses. In addition, counteracting the gravitational force leads to an increase in venous and lymphatic blood flow to the legs and thus reduce swelling (Singh et al., 2014). In this study, the combination of ketorolac administration and 20° elevation with an elevation device minimized the swelling circumference by 1.93 cm compared with that of ketorolac administration alone. These results are in line with the research of Vasanad et al. (2013), who stated that one of the best strategies for patients with tibial plateau fractures after ORIF surgery is to elevate the leg with a

range of motion angle of 0–20° for 2–5 days. Limb elevation involves the effect of gravity to reduce local edema when easily mobilized (Villeco, 2012). In the present study, the 20° elevation began on the 2nd day after ORIF surgery. The researcher was not able to control whether the respondent had carried out elevation on the 1st day by using stacked pillows or elevating the bottom of the bed, this setting can affect the decrease in swelling that occurred the next day.

Agarwal et al. (2013) studied the treatment management of closed tibia plateau fractures performed by percutaneous cancellous screw fixation, and they found that patients experienced complications such as infection, wound dehiscence, or other problems after good presurgical, during, and post-surgical management. One of the strategies was maintaining the extremities over the heart for 2 postoperative days. Positioning the legs by lifting them passively from a horizontal position will stimulate blood movement from the lower limbs to the intrathoracic compartment and reduce the hydrostatic pressure of the blood vessels. As a result, venous and lymphatic flow is increased to ultimately reduce capillary filtration pressure in the arteries (Marik et al., 2013). This phenomenon reduces the swelling circumference on the elevated lower extremity.

In this study, elevation intervention was accompanied by alternating dorso-plantar flexion movements at the ankle (pumping action) to pump the blood vessels. This action increased the peripheral blood flow resistance, blood flow, and venous flow, thereby stimulating reabsorption and draining fluid from the stagnant area (Kisner & Colby, 2012). Furthermore, a static muscle contraction compresses the veins, and the inflammatory fluid is brought to the proximal direction to participate in blood circulation and consequently reduce swelling (Thomas, 2011). The movement was carried out four times in one elevation.

Pain Level. Respondents in the intervention group of the present study reported the pain level, which was lower than in the control group. Ketorolac administration to all respondents aimed to reduce postoperative pain. In addition to being anti-inflammatory, ketorolac also acts as an analgesic in reducing moderate to severe pain (Oliveira et al., 2012). The combination of pharmacological and non-pharmacological management is expected to provide an enhanced pain reduction effect. In the present study, the intervention of 20° elevation of lower extremities accompanied by alternating dorsoplantar flexion movements at the ankle was performed to contract the quadriceps and hamstring muscles. Extremity elevation aims to minimize tension in the skin closure and reduce edema, which decreases local pressure in the swollen area and minimizes pain (Wilkinson & Ahern, 2012). Persistent muscle spasm or hypertonus and swelling increase tissue tension and muscle hypoxia, and result in pain (Black & Hawks, 2014). Xianfeng et al. (2013) evaluated the early postoperative complications of ORIF using a "soft tissue control" strategy for the surgical treatment of complex pilon fractures and concluded that one way to control soft tissue damage after ORIF surgery is through the early elevation of the extremity to minimize the tension of skin closure and reduce swelling. The pumping action in this study optimizes metabolism and local circulation due to vasodilation, thereby relaxing the muscles (Marlina, 2015). When muscle tension decreases, muscle sarcomere shortens due to spasm and begins to stretch, the muscle lengthens again and becomes relaxed, tension decreases, and pain is finally reduced (Kisner & Colby, 2012).

Patient comfort must also be considered when using an elevation device. In this study, the elevation device did not have an elevation angle that was extremely high due to the patient's comfort factor. Nevertheless, this tool can still restore the systemic circulation's physiological function. In addition, the recommended postoperative lower extremity elevation is 15–25 cm above the heart (Wilkinson & Ahern, 2012). The elevation tool only has one standard size. Hence, modifications to adjust the size of the

patient's extremities were made by placing towels on the right and left of the tool indentation to maintain the stability of their lower extremity upright position. The unstable position of the foot during elevation can worsen the pain.

Research Limitations. This study has several limitations, including not selecting a sample based on the number of fractures (single fracture or multiple fractures) that may affect the pain level. In addition, the indentation of the elevation device only has one standard size to allow the respondents with small lower extremities to use a towel on either side of the indentation to keep their lower extremities stable and immobile. Another limitation was that the elevation started on the 2nd day after ORIF surgery. Hence, the researcher could not control the possibility that the respondent had independently performed elevation on the 1st day that might affect swelling. Other limitations include the absence of investigation of swelling confounding factors such as the degree of difficulty of ORIF, the type and degree of fracture, pre-anesthesia physical status according to the classification of the American Society of Anesthesiologists (ASA), the incidence of bleeding, and the extent of wound.

Conclusion

Elevation accompanied by a combination of dorso-plantar flexion movements at the ankle can reduce swelling and pain in post-ORIF surgery patients. This intervention can be optimized as an alternative to independent nursing interventions to increase patient comfort and reduce the risk of complications, the use of severe anti-inflammatory-analgesic drugs, and hospital and patient costs. Once discharged, the patient can independently continue this intervention at home. Further research is recommended to use an extensive and varied sample size, modify the indentation on the elevation device with the sand method (sand pillow) whose shape will follow the size of the respondent's feet, and set a long time and a high frequency of elevation intervention.

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