



급성 발목 골절 환자의 술 후 부종 감소에 대한 하지 거상의 효과

서동교, 강현욱, 안득숙*, 송재석[†]

강릉아산병원 정형외과, *간호부, [†]가톨릭관동대학교 의과대학 예방의학교실

Effect of Leg Elevation Height on Reduced Swelling of Patients of Postoperative Acute Ankle Fractures

Dong-Kyo Seo, Hyun Wook Kang, Deug Suk Ahn*, Jae-Seok Song[†]

Departments of Orthopedic Surgery and *Nursing, Gangneung Asan Hospital, [†]Department of Preventive Medicine & Public Health, Catholic Kwandong University College of Medicine, Gangneung, Korea

Purpose: Leg elevation is known as an effective method for reducing leg swelling, and it has been routinely used in medical practice. However, the effect of swelling reduction in relation to the degree of elevation height is not known. This study evaluated the swelling of the leg after acute ankle fracture operations at two different elevation heights and the elevated leg heights were compared.

Materials and Methods: A total of 66 patients with postoperative acute ankle fractures were classified into two groups depending on the presence of different leg elevation heights: high-elevated (HE, case) and low-elevated groups (LE, control). We checked leg swelling, pain, subjective satisfaction for the elevation device, and the American Orthopedic Foot and Ankle Society (AOFAS) score, and we retrospectively compared them between both the groups.

Results: Leg swelling and pain were reduced in both groups. However, they did not show any significant differences between both the groups ($p>0.05$). Nineteen patients in the HE group replied with uncomfortable, while no patients in LE group did so. The AOFAS score at 1 year postoperatively did not show any significant differences between both the groups ($p=0.46$).

Conclusion: High elevation of the leg after ankle fractures did not show a significant difference from low elevation in regard to leg swelling, pain, and function. Furthermore, high leg elevation resulted in discomfort during the postoperative period. Thus, low elevation with a pillow is enough for acute ankle fracture patients with little discomfort and satisfactory swelling reduction.

Key Words: Ankle fracture, Leg elevation, Swelling

INTRODUCTION

Ankle fracture is a common sports injury, and its incidence is reported as 10.2% of all bone injuries.¹⁾ Swelling of the lower leg and ankle is an inevitable physiologic problem after ankle fracture and postoperative period. Leg elevation is

known as an effective method in reducing swelling and has been used routinely.²⁾ Rucinski et al.³⁾ reported that elevation is the most appropriate treatment protocol to minimize swelling in the rehabilitation phase after ankle sprains.

However, Tsang et al.²⁾ reported that elevation could not effectively decrease ankle volume for a prolonged period in patients with acute ankle sprains. Leg elevation effect did not last over 5 minutes when limbs were returned to a gravity-dependent position. Moreover, leg elevation results in patient discomfort during the postoperative period and restriction on the bed. Postoperative early rehabilitation is also recommended after an ankle fracture operation.^{4,5)} It means that

Received February 1, 2020 Revised March 6, 2020 Accepted March 6, 2020

Corresponding Author: Jae-Seok Song

Department of Preventive Medicine & Public Health, Catholic Kwandong University College of Medicine, 24 Beomil-ro 579beon-gil, Gangneung 25601, Korea
Tel: 82-33-649-7469, Fax: 82-33-641-1074, E-mail: songjs@cku.ac.kr
ORCID: <https://orcid.org/0000-0001-5583-182X>

Financial support: None.

Conflict of interest: None.

Copyright © 2020 Korean Foot and Ankle Society. All rights reserved.

© This is an Open Access article distributed under the terms of the Creative Commons Attribution Non-Commercial License (<http://creativecommons.org/licenses/by-nc/4.0>) which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

patients cannot maintain an elevated leg position during the postoperative period, and its effect can be negated easily. So, keeping patients on the bed with the high-elevation device would be not so effective.

Thus, we hypothesized that low-elevation of the lower leg would have results similar to those of high-elevation. Furthermore, low-elevation would make patients more comfortable. We compared leg swelling, pain, subjective satisfaction for elevation device, functional score in patients with two different elevated height.

MATERIALS AND METHODS

1. Patients selection

The Institutional Review Board of the Gangneung Asan Hospital approved this study. A total of 66 patients who underwent the operation of acute ankle fracture from March 2014 to December 2015 were reviewed retrospectively. Inclusion criteria were Arbeitsgemeinschaft für Osteosynthesefragen/Orthopaedic Trauma Association (AO/OTA) classification types 43 (distal tibia/fibula fractures) and 44 (malleolar fractures). Exclusion criteria were fractures combined with an open wound, proximal and shaft tibiofibular fractures, neurovascular injury, compartment syndrome, and amputation. Patients with a history of atherosclerosis, chronic systemic disease (e.g., renal, pulmonary, or heart failure), diabetes mellitus, postoperative hospitalization period less than 2 weeks, follow-up period less than one year, voluntary ces-

sation of elevation or change of method were also excluded. In the selection of patients, we included distal tibiofibular and malleolar fractures. Moreover, systemic diseases that can influence whole body circulation were also excluded. The operative method was confined to open reduction and internal fixation.

Patients were classified into two groups, which were 32 patients for high-elevated group (HE group) and 34 patients for low-elevated group (LE group) depending on the height of leg elevation. Detailed demographic values of two groups were described in Table 1.

2. Operative method

The operation was performed within 2 weeks after initial injury after excessive swelling and bullae were resolved. All operations were performed under regional spinal anesthesia with the application of a pneumatic tourniquet. All patients were treated with open reduction and internal fixation using plate and screw. There were no cases of external fixation, intramedullary nailing, and minimally invasive percutaneous plate osteosynthesis. Operative drainage was not used in all patients. After skin suture, sterile dressing and short leg splint were applied.

3. Rehabilitation and leg elevation

Short leg splint was applied for 2 weeks on non-weight-bearing state. Leg elevation with cushion was performed from March 2014 to December 2014. Due to patients com-

Table 1. Demographic Parameters and Distribution of Fractures in Two Groups

Variable	HE group	LE group	p-value
Patient	32	34	-
Follow-up period (yr)	1	1	-
Mean age (yr)	53.9±15.0 (19.0~76.0)	51.2±16.6 (29.0~84.0)	0.09
BMI (kg/m ²)	23.8±2.4 (18.5~26.4)	24.2±3.2 (19.4~28.1)	0.55
Sex ratio (male:female)	20:12	18:16	0.30
Left to right ratio	15:17	14:20	0.79
AO/OTA type (patients)			0.67
43A	6	7	
43B	1	2	
43C	1	2	
44A	11	8	
44B	12	15	
44C	1	0	

Values are presented as number only or mean±standard deviation (range).

HE: high-elevated, LE: low-elevated, -: not available, BMI: body mass index, AO/OTA: Arbeitsgemeinschaft für Osteosynthesefragen/Orthopaedic Trauma Association.

plain of discomfort by the height of cushion elevator, we substituted it with pillow elevator from January 2015 to December 2015. Postoperative patient control was done by the orthopedic surgeon and specially educated nurses during hospitalization.

Non-weightbearing ambulation with a wheelchair was allowed from the postoperative day (POD) 2. Patients were managed to lie on the bed with leg elevation except for wheelchair or 2 crutches ambulation time. High leg elevation with cushion elevator (Fig. 1A) was set for the HE group until POD 2 weeks. The LE group was allowed to lie down with the operated leg on the pillow, same duration with HE group (Fig. 1B). Used cushion elevator and pillow was the same for each group, and height was 30 and 10 cm, respectively.

At 2 weeks postoperatively, the splint was removed, and short leg cast was applied for 4 weeks on non-weightbearing state. All patients were discharged at POD 2 weeks. The non-weightbearing state was maintained until 6 weeks postoperatively. At POD 6 weeks, the cast was removed and controlled ankle motion walking boot (Rebound® Air Walker; Össur, Foothill Ranch, CA, USA) was applied. Tolerable toe-touch weightbearing walk with walker and crutch was initiated from 6 weeks postoperatively.

4. Measurement

We checked leg swelling, leg pain, discomfort on elevation, and functional score. The swelling was measured at two points: (1) ankle and (2) calf. Ankle swelling was estimated with the figure-of-eight method, which was reported by Esterson (Fig. 2).⁶⁾ The method is very easy, convenient, and reliable.⁶⁻⁹⁾ Calf circumference was measured at the widest circumference in a sitting position with the hip, knee, and ankle flexed 90 degrees using a nonelastic flexible plastic ruler not compressing the subcutaneous tissue.

The swelling was measured on the injured leg at 4 days, 2 weeks, 6 weeks, and 1 year postoperatively. Two values (ankle and calf) were gathered at one time. Two orthopedic surgeons who were not involved in the operation performed the measurement twice. Pain scores were measured simultaneously with swelling by visual analogue scale (VAS). Subjective satisfaction on elevation height was measured at POD 2 weeks using four degrees of answers for the questions: very comfortable, a little comfortable, a little uncomfortable, and very uncomfortable. The functional score was measured using the American Orthopaedic Foot and Ankle Society (AO-FAS) score at 1 year postoperatively.

5. Statistics

We compared the demographic values and functional

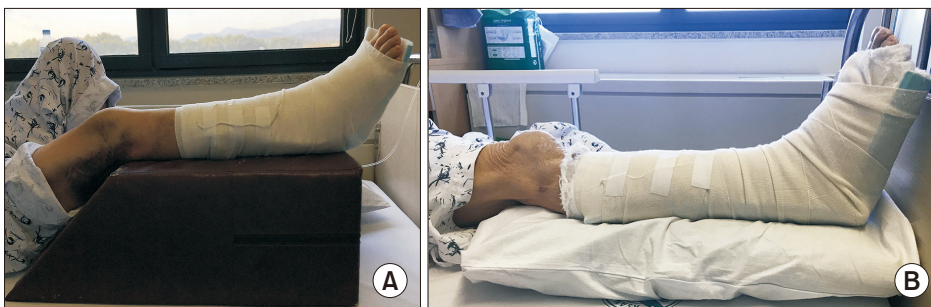


Figure 1. (A) Elevated leg with cushion elevator (30 cm-height) and (B) pillow elevator (10 cm-height) on the bed.

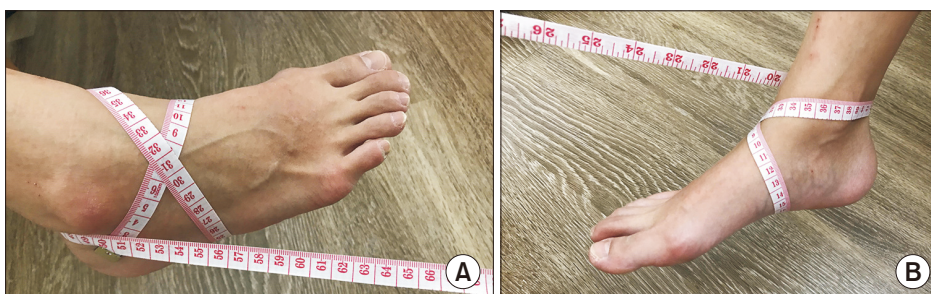


Figure 2. Figure-of-eight method. Flexible tape runs through from the tip of lateral malleolus, tuberosity of navicular, base of fifth metatarsal bone, tip of medial malleolus, and then returns to tip of lateral malleolus. (A) Medial side; (B) lateral side.

Table 2. Comparison of Ankle and Calf Swelling and VAS in Both Groups

Variable	Postoperative day				p-value
	4-day	2-week	6-week	1-year	
Ankle swelling (cm)					0.92
HE	55.0±3.7 (47~61)	53.2±3.8 (46~60)	53.2±4.0 (46~62)	50.5±4.0 (42~58)	
LE	55.7±3.9 (48~63)	53.9±3.6 (47~61)	53.2±3.4 (47~60)	51.1±3.4 (44~58)	
Calf swelling (cm)					0.21
HE	34.3±3.8 (26~42)	32.5±3.5 (25~40)	32.2±3.4 (24~39.5)	31.2±3.3 (23~38)	
LE	36.2±4.3 (28~52)	34.5±4.5 (26~51)	34.2±4.6 (25~52)	32.7±4.5 (24~51)	
VAS					0.28
HE	4.5±1.8 (2~8)	2.8±1.6 (0~6)	1.9±1.2 (0~5)	0.3±0.4 (0~1)	
LE	4.8±1.7 (2~8)	2.3±0.9 (1~4)	1.4±0.7 (1~3)	0.2±0.4 (0~1)	

Values are presented as mean±standard deviation (range).

VAS: visual analogue scale, HE: high-elevated, LE: low-elevated.

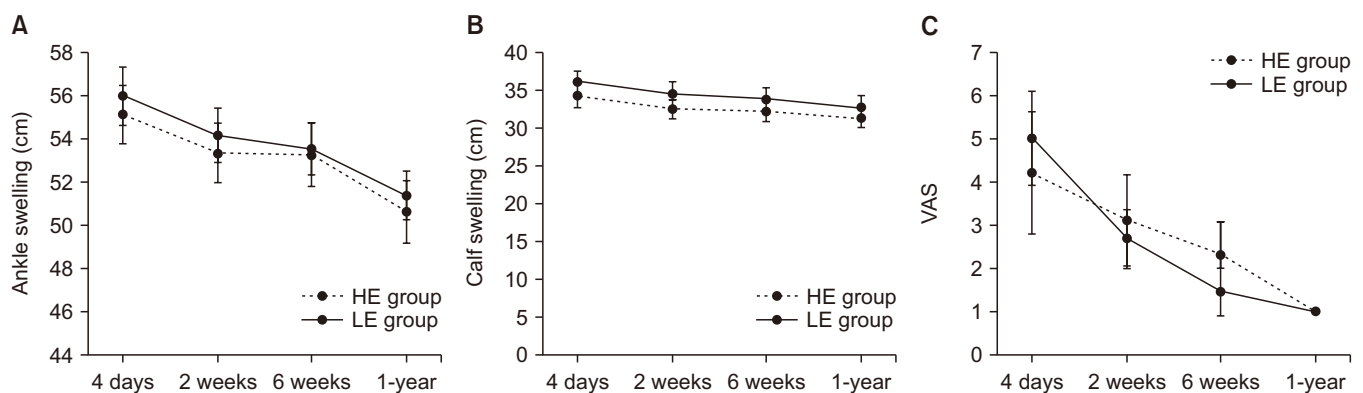


Figure 3. Change of swelling in the ankle (A), calf (B), and visual analogue scale (VAS) (C) in both groups. All parameters were checked four times at 4-day, 2-week, 6-week, and one-year postoperatively. HE: high-elevated, LE: low-elevated.

score using Mann-Whitney test or chi-squared test. The intraclass correlation coefficient (ICC) as suggested by Shrout and Fleiss⁹ was used to evaluate interobserver and intraobserver reliability of swelling measurement.⁷⁾ The values ranged from 0 (not correlated at all) to 1 (completely agree). The mean values of the swelling were used for statistics when the reliability showed high agreement (ICC>0.8). Leg swelling and pain were compared between groups using repeated measures analysis of variance. A p-value of less than 0.05 was set for statistical significance. All statistical analyses were performed using the Statistical Package for the Social Sciences (ver. 21.0; IBM Corp., Armonk, NY, USA).

RESULTS

All demographic parameters did not show any differences between the two groups ($p>0.05$; Table 1). Ankle swelling gradually diminished with time from POD 4 days to 1 year

Table 3. Comparison of Subjective Satisfaction about Elevation Height in Both Groups

Subjective satisfaction	HE group	LE group	p-value
Very comfortable	6	9	<0.001
A little comfortable	7	25	
A little uncomfortable	14	0	
Very uncomfortable	5	0	
Total patients	32	34	

Values are presented as number.

HE: high-elevated, LE: low-elevated.

in both groups, and it was statistically significant ($p<0.001$). However, the difference between both groups regarding time was not significant ($p=0.92$; Table 2, Fig. 3A). Calf swelling showed the same pattern ($p=0.21$; Table 2, Fig. 3B). VAS significantly decreased from POD 4 days to 6 weeks in both groups ($p<0.001$); however, did not show any difference between groups ($p=0.28$; Table 2, Fig. 3C). About subjective satisfaction on leg elevation, nineteen patients in HE group

replied with a little uncomfortable or very uncomfortable, while all patients in LE group replied with very comfortable or a little comfortable (Table 3). Finally, the mean AOFAS score was 80.0 ± 8.8 in the HE group and 78.0 ± 11.2 in the LE group, which did not show any significant differences between groups ($p=0.46$).

DISCUSSION

Leg swelling after an ankle fracture and its operation is a natural process of local inflammation. An effort to reduce the swelling is necessary because it can be the cause of pain, skin blister, wound dehiscence, and focal skin necrosis. Leg elevation is one of the methods to reduce swelling, and its effectiveness is already reported.^{3,10} The effect has been proved in a short-term period but is doubtful in the mid- or long-term because the common protocol of postoperative rehabilitation is performed in gravity-dependent positions. These exercises and resistance from gravity increase leg swelling.^{10,11} This effect was demonstrated in the uninjured ankles.¹⁰ Sims¹⁰ reported significant differences in leg volume in their subjects comparing seated and elevated leg position for 20 minutes. This report shows not only the effectiveness of leg elevation in decreasing swelling but also the reduction of swelling in gravity-dependent rehabilitation. Increased ankle volume after the dependent position was also reported.¹² Thus, we thought elevation height is not a critical factor for swelling reduction. So, we compared the effect of leg elevation after acute ankle fracture operation in two different height.

As a result, ankle and calf swelling diminished postoperatively in both groups. However, the difference between the two groups was not significant. The HE group did not show superior swelling reduction over the LE group. It means two different elevation height showed similar effective swelling reduction. We believe this result was relevant to postoperative patient movement and early rehabilitation. From POD 2, patients were allowed to move with a wheelchair or 2 crutches. The operative leg was in gravity-dependent position whenever they move with wheelchair or 2 crutches. Leg elevation could not be maintained for full time during the hospitalization period. Moreover, postoperative rehabilitation exercise was done in an upright, gravity-dependent

position also after discharge. Tsang et al.² reported that leg elevation and intermittent compression were negated by gravity-dependent position. Swelling in the HE group would have been reduced more than that in the LE group during leg elevation. However, it would have been negated by the gravity-dependent position described above. The effect of leg elevation on swelling reduction is well known, but it means that the gravity-dependent position also reverses its result.^{10,12} Thus, high leg elevation did not make differences on leg swelling reduction in the postoperative period and made patients uncomfortable.

There are some limitations to our study. First, this is a retrospective study. Second, leg elevated time is not the same in all patients. We could not control the time which patients elevate their leg in the hospital nor after discharge. Third, the number of patients was relatively small. We hope to investigate in a large group prospectively in the future study.

CONCLUSION

In conclusion, high elevation of the leg after ankle fractures did not show a significant difference from low elevation in regard to leg swelling, pain, and function. Furthermore, high leg elevation resulted discomfort in the postoperative period. So, the low elevation with pillow is enough for acute ankle fracture patients with little discomfort and satisfying swelling reduction.

ORCID

Dong-Kyo Seo, <https://orcid.org/0000-0002-5071-6870>

Hyun Wook Kang, <https://orcid.org/0000-0002-4427-2185>

Deug Suk Ahn, <https://orcid.org/0000-0002-2714-7219>

REFERENCES

1. Elsoe R, Ostgaard SE, Larsen P. Population-based epidemiology of 9767 ankle fractures. *Foot Ankle Surg.* 2018;24:34-9. doi: 10.1016/j.fas.2016.11.002.
2. Tsang KK, Hertel J, Denegar CR. Volume decreases after elevation and intermittent compression of postacute ankle sprains are negated by gravity-dependent positioning. *J Athl Train.* 2003;38:320-4.
3. Rucinkski TJ, Hooker DN, Prentice WE, Shields EW, Cote-Murray DJ. The effects of intermittent compression on edema in postacute ankle sprains. *J Orthop Sports Phys Ther.* 1991;14:65-9. doi: 10.2519/

- jospt.1991.14.2.65.*
4. **Dehghan N, McKee MD, Jenkinson RJ, Schemitsch EH, Stas V, Nauth A, et al.** Early weightbearing and range of motion versus non-weightbearing and immobilization after open reduction and internal fixation of unstable ankle fractures: a randomized controlled trial. *J Orthop Trauma.* 2016;30:345-52.
 5. **Jansen H, Jordan M, Frey S, Hölscher-Docht S, Meffert R, Heintel T.** Active controlled motion in early rehabilitation improves outcome after ankle fractures: a randomized controlled trial. *Clin Rehabil.* 2018;32:312-8. doi: 10.1177/0269215517724192.
 6. **Esterson PS.** Measurement of ankle joint swelling using a figure of 8*. *J Orthop Sports Phys Ther.* 1979;1:51-2. doi: 10.2519/jospt.1979.1.1.51.
 7. **Donner A, Donald A.** Analysis of data arising from a stratified design with the cluster as unit of randomization. *Stat Med.* 1987;6:43-52. doi: 10.1002/sim.4780060106.
 8. **Petersen EJ, Irish SM, Lyons CL, Miklaski SF, Bryan JM, Henderson NE, et al.** Reliability of water volumetry and the figure of eight method on subjects with ankle joint swelling. *J Orthop Sports Phys Ther.* 1999;29:609-15. doi: 10.2519/jospt.1999.29.10.609.
 9. **Shrout PE, Fleiss JL.** Intraclass correlations: uses in assessing rater reliability. *Psychol Bull.* 1979;86:420-8. doi: 10.1037//0033-2909.86.2.420.
 10. **Sims D.** Effects of positioning on ankle edema. *J Orthop Sports Phys Ther.* 1986;8:30-3. doi: 10.2519/jospt.1986.8.1.30.
 11. **Cloughley WB, Mawdsley RH.** Effect of running on volume of the foot and ankle. *J Orthop Sports Phys Ther.* 1995;22:151-4. doi: 10.2519/jospt.1995.22.4.151.
 12. **McCulloch J, Boyd VB.** The effects of whirlpool and the dependent position on lower extremity volume. *J Orthop Sports Phys Ther.* 1992;16:169-73. doi: 10.2519/jospt.1992.16.4.169.