

Comparison of Removable Rigid Dressing and Elastic Bandage in Reducing the Residual Limb Volume of below Knee Amputees

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Objective: Compare the reducing volumes of the residual limbs between the removable rigid dressing method and the elastic bandaging technique.

Study Design: Randomized controlled trial.

Setting: Department of Rehabilitation Medicine, King Chulalongkorn Memorial Hospital.

Material and Method: Twenty-six below-the-knee amputees (11 men (42.3%) and 15 women (57.69%)) who were informed and gave written consents were included in this study. The mean age was 68.19 ± 10.83 years. The patients who met the eligible criteria were randomized into two groups. Fourteen subjects (53.8%) were in the EB group and 12 (46.2%) in the RRD group. The first group was taught to use a removable rigid dressing (RRD) while the second group was taught to use an elastic bandage (EB) for stump shaping and volume reduction. Both groups were trained with the same pre-prosthetic program. The circumference of the stump was measured and calculated for volume at the beginning, 2 weeks, and 4 weeks. The volume reduction was compared between the two groups.

Results: Twenty subjects were amputated on the right side (76.92%). The majority underlying was diabetes mellitus (80.77%). Fifteen cases of amputation were peripheral vascular disease (57.69%). The stump volume reduction of the RRD group at 2 and 4 weeks were 42.73 ± 62.70 and 79.9 ± 103.33 cm³, respectively. The stump volume reduction of the EB group were 21.89 ± 118.49 and 83.03 ± 113.05 cm³, respectively. There were no statistically significant differences of volume reduction between the two groups at 4 weeks.

Conclusion: Removable rigid dressing had a tendency to reduce residual limb volume of below knee amputees faster than elastic bandage at 2 weeks but the decreasing volumes were not different at 4 weeks.

Keywords: Removable rigid dressing, Below knee amputee, Residual limb volume

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Lower limb loss is a common cause of disability that affects quality of life of the patients and their family. Effective postoperative rehabilitation is important to achieve optimal patient outcome without complications in the shortest period of time. Primary goal of early postoperative management are wound healing and pain control, followed by edema control and shaping of the residual limb⁽¹⁻³⁾. Treatment ranges

from soft, compressive dressing, and semi-rigid dressing to various forms of rigid dressing. The ideal method should be easy to apply independently, remain secure, provide progressive limb shrinkage and symmetrical shaping, prevent skin breakdown, be painless, and be cost-effective⁽⁴⁾.

Wrapping the residual limb with an elastic bandage is the traditional treatment⁽⁵⁾ and is still used widely. However, this method has a lot of problems. Stump wrapping is a fine motor skill that is difficult for many amputees, particularly geriatric patients with

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multiple problems, or care givers to do⁽⁴⁾. Elastic bandages provide poor control of stump edema and often cause distal edema⁽⁶⁻⁸⁾. The bandage does not usually remain secure, particularly when the amputee is in bed⁽⁴⁾. The elastic bandage can allow the limb to form “dog-ears” and bulbous limb shaping⁽⁷⁾. The elastic bandage can cause skin breakdown⁽⁹⁾. Wound and stump are also not protected from an elastic bandage.

Rigid dressing was first developed as the immediate postoperative prosthesis (IPOP) by Berlemont and further developed by Burgess to solve problems from an elastic bandage^(10,11). The rigid dressing can protect the wound, provide better edema control and limb shaping than a soft dressing. However, IPOP, which is non-removable has limitations in wound inspection. When residual limb edema decreases, the loosening IPOP may slip on the stump and can result in skin breakdown⁽⁵⁾.

Removable rigid dressing (RRD) for below knee amputation was presented by Wu⁸ in 1979 to solve the limitation of IPOP and elastic bandage. The RRD is better than elastic bandaging in reducing the incidence of pre-tibial skin breakdown and distal edema, producing fast stump shrinkage, and shortening the time to ambulatory discharge with a temporary prosthesis^(4,8,12).

Although it has proved to be an effective method for postoperative and pre-prosthetic care, it has never been used in Thailand. The materials and method for producing the RRD have to be modified. The difference of weather is the other factor that may affect the result. The purpose of the present study was to compare the effectiveness of RRD modified from method of Wu⁽⁸⁾ and the traditional elastic bandages in reducing the residual limb volume in below knee amputees at 2 and 4 weeks postoperative period.

Study Design

Randomized controlled trial

Setting

Department of Rehabilitation Medicine, King Chulalongkorn Memorial Hospital

Subjects

All of the below knee amputated patients who were consulted for the pre-prosthetic rehabilitation program at King Chulalongkorn Memorial Hospital were recruited. The inclusion criteria were post-operation of below knee amputation no longer than 3 months, agree to participate in the present study and sign a consent

form. The exclusion criteria were patients who could not follow the protocol nor had severe infected stump wound.

Material and Method

All materials were already available at the authors' department. The standard 4 inches elastic bandage, which was traditionally used at our department, was used for the elastic bandage (EB) group. The removable rigid dressing (RRD) was modified from the method of Wu⁽⁸⁾. The stump sock was made from thin and thick cotton stockinette, below-knee-cast was fabricated with plaster of Paris, suspension stockinette was made from polyester stockinette and supracondylar suspension cuff was also made from plaster of Paris. (Fig. 1, 2) The stump socks were added according to stump shrinkage and new below-knee-cast was replaced when needed during the follow up period.

Method

The patients who met the eligible criteria were randomized into one of two treatment groups, RRD (group A) and EB (group B). The randomization was generated by using a table of random numbers and blocks of four techniques. The allocation was concealed and in separate opaque envelopes, which was sequentially numbered. The secretary opened the next in a series of envelopes when a new patient was enrolled. All subjects in both groups were trained with the same pre-prosthetic program such as exercise, activity of daily living, transferring, and ambulation with gait aids except for stump shaping and volume reduction method. The RRD group was taught to use removable rigid dressing while the EB group was taught to use the elastic bandage. Both groups had to wear EB or RRD continuously and removed every 4-6 hours for massage, wound inspection or bathing as prescribed in the practice guideline sheet. Volume of the stump was measured at the beginning, 2 weeks, and 4 weeks. The volume reduction was compared between two groups. Volume measurement of the residual limb was calculated by using the mathematical formula outlined by Katch and Katch⁽¹³⁾, which Boonhong J, et al⁽¹⁴⁾ proved its validity and reliability. This formula used circumferences and length for calculating the volume. Circumference measurements were taken at the tibial tubercle level and at 4-cms intervals below the tubercle with the knee fully extended. Points of measurement were marked on the skin with a permanent marker to minimize measurement error. All circumference measurements for an individual patient were taken by the same therapist.



Fig. 1 Component of RRD



Fig. 2 Removable rigid dressing

Ethical consideration

The present study was approved by the Ethics Committee of the Faculty of Medicine, Chulalongkorn University. All subjects were informed and written consents were obtained.

Statistic analysis

All data was analyzed by using SPSS software for window version 11.0. The continuous data was reported in means and standard deviations. The nominal variables including gender and cause of amputation were presented using proportions or percentage. The

baseline data of the two groups included age, gender, duration from amputation, side and cause of amputation, and beginning residual limb volume was compared using unpaired t-test or Mann-Whitney U test for continuous variables and Chi-square test or Fisher's exact test for nominal variables. The decreasing volumes of the residual limbs at 2 and 4 weeks of the two groups were compared by using unpaired t-test or Mann-Whitney U test. (The authors used t-test instead of repeated ANOVA because the authors would like to compare the decreasing volume of the two groups at the 2 and 4 weeks. For correcting the error of α , the authors used $p < \alpha/2$ ($\alpha = 0.05$))

Results

Twenty-six subject participated in the study, 11 men (42.3%) and 15 women (57.69%). Mean age was 68.19 ± 10.83 years. Twenty subjects were amputated on the right side (76.92%). The majority underlying disease was diabetes mellitus (80.77%). Most common cause of amputation was peripheral vascular disease, found in 15 subjects (57.69%). Fourteen subjects (53.8%) were in the EB group and 12 (46.2%) in the RRD group. Mean age, sex, side, and cause of amputation, underlying disease, and initial stump volume of both groups were not significantly different as shown in Table 1. The stump volume reduction of the RRD group at 2 and 4 weeks was 42.73 ± 62.70 and 79.9 ± 103.33 cm³ respectively. The stump volume reduction of the EB group was 21.89 ± 118.49 and 83.03 ± 113.05 cm³ respectively. There were no significant differences in volume reduction between the two groups as shown in Table 2.

Discussion

At King Chulalongkorn Memorial Hospital, EB was used for stump shaping and volume reduction in pre-prosthetic period because of low price, available material and familiar to all physical therapists and physicians. However, the authors found many problems, including bulbous stump, skin necrosis and traumatic wound stump, leading to delayed prosthetic fitting. The presented patients usually need many months for the pre-prosthetic period. IPOP is not suitable for the patient's condition, hot weather of Thailand and available time of the surgeon. The RRD is the method to solve problems from elastic bandage and IPOP as claimed by Wu and may be more suitable for the presented patients. The Department of Rehabilitation Medicine serves amputated patients for pre-prosthetic training and prosthetic fitting. The authors already

Table 1. Characteristics of the patients

Characters	RRD group (n = 12)	EB group (n = 14)	Total (n = 26)	p-value
Age (year)	67.58 ± 13.57	68.7 ± 8.32	68.19 ± 10.83	0.797
Sex				0.632
Male	5	6	11	
Female	7	8	15	
Side				0.099
Right	11	9	20	
Left	1	5	6	
Underlying				0.759
DM	10	11	21	
Non-DM	2	3	5	
Causes of amputation				0.632
Infection	3	6	9	
Vascular	8	7	15	
Tumor	1	1	2	
Duration from amputation (day)	12.25 ± 6.38	15.71 ± 12.46	14.12 ± 10.09	0.099
Beginning stump volume (cm ³)	621.53 ± 198.68	779.28 ± 318.44	706.47 ± 276.64	0.138

Table 2. Comparison of volume reduction between two groups

Measured time	Volume reduction (cm ³)		p-value
	RRD	EB	
0-2 weeks (n = 14:12)	42.73 ± 62.70	21.89 ± 118.49	0.064
2-4 weeks (n = 11:11)	39.67 ± 50.34	55.54 ± 117.24	0.082
0-4 weeks (n = 11:11)	79.90 ± 103.33	83.03 ± 113.05	0.690

No significant difference between two groups

have the stump sock, cast and well-trained prosthetists to prepare the cast.

Eighty percent of amputations in the present study were diabetes related. The majority cause of amputation was peripheral vascular disease. These were similar to the previous study⁽⁴⁾. All of the subjects, except one, were over 50 years old. Mean age was 68.19 years. Because of disability from these factors and also the Thai culture, not surprising, about half of the subjects had relatives or care givers applying EB or RRD for them.

RRD showed a tendency to reduce stump volume faster than EB in the first 2 weeks similar to the study by Mueller⁽¹⁾. The first reason was possibility of earlier application of RRD even in the case of an active wound. The authors could also relieve pressure of active wound lesion while making the below-knee cast of RRD. In contrast, the authors could not control the

EB to decrease local pressure of the wound so EB usually applied inadequate pressure at the early period to avoid pressure at the wound. The second reason was patients could learn to apply RRD faster than EB. However, at 4 weeks, RRD could reduce volume the same as EB. The first reason was the low qualified material. The authors used available cotton stockinette for stump sock which was not durable and had low pressure compared to athletic tube sock used by Wu. When edema was decreased and the cotton stockinette was worn out, without stump sock replacement, the RRD had inadequate pressure to the stump. The second reason was the follow up frequency in the study of Mueller was three times a week but in the present study was every 2 weeks. The duration was too long so patients did not get new more stump socks or change the cast in the proper timing. These suggest that the authors should use more appropriate material for stump

sock and follow up in a shorter period. However, due to transportation and financial problems, it is difficult to follow up more frequently than 1 week so phone calls to stimulate patients to wear an adequate number of stump socks in real practice may be useful.

Residual limb protection is another benefit of RRD as claimed by Wu. There were two patients, one of EB group and one of RRD group, who fell on their residual limb and got wound trauma leading to delayed wound healing. The subject from the RRD group got wound trauma because he did not apply RRD while falling. There were no other complications in both groups. Early weight bearing and mobility are also very important for amputated patient psychology. The RRD has proved to shorten the pre-prosthetic time⁽⁴⁾. The patients in RRD group were ready for prosthetic fitting faster than the EB group and learned to use the prosthetic socket faster, too. The initial cost of material for RRD was higher than EB (700 vs. 300 baht) but it was highly cost-effective because of the shorter time required for functional ambulation. Compliance of patients in RRD group was good. All of the patients, except one, applied RRD all the time as prescribed in the guideline sheet. Only one patient applied RRD 80% of the prescribed time.

The limitation of the present study was the small number of patients. Because of the improvement of diabetic foot care in our hospital, more limbs can be saved than in the past. Toes and partial foot amputation were increased and number of below the knee amputations was decreased. Below or above the knee amputations were made in patients with relatively poor condition that were not appropriate to participate in the present study. Many patients from other provinces, referred from other hospitals, were not included in this study because the patients had to go back home and were not willing to come for follow up every two weeks.

Conclusion

Removable rigid dressing had a tendency to reduce volume of below knee amputees faster than the elastic bandage at 2 weeks but the decreasing volumes were not different at 4 weeks.

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การศึกษาเปรียบเทียบผลของการลดปริมาตรต่อขา ระหว่างเฟือกชนิดถอดได้กับการใช้ผ้ายืดพัน ในผู้ที่ถูกตัดขาระดับใต้หัวเข่า

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วัตถุประสงค์: เพื่อเปรียบเทียบผลของการลดปริมาตรต่อขา ระหว่างเฟือกชนิดถอดได้กับการใช้ผ้ายืดพัน ในผู้ที่ถูกตัดขาระดับใต้หัวเข่า

รูปแบบการศึกษา: การศึกษาชนิดการทดลองแบบสุ่ม และมีกลุ่มควบคุม

สถานที่ทำการศึกษา: ฝ่ายเวชศาสตร์ฟื้นฟู โรงพยาบาลจุฬาลงกรณ์

ประชากรที่ศึกษา: ผู้ป่วยที่ได้รับการตัดขาระดับใต้หัวเข่าและส่งมารับการฟื้นฟูที่ฝ่ายเวชศาสตร์ฟื้นฟู

วัสดุและวิธีการ: ผู้ป่วยที่ผ่านเกณฑ์การคัดเข้าจะถูกสุ่มแบ่งออกเป็น 2 กลุ่ม โดยกลุ่มแรกจะได้รับเฟือกชนิดถอดได้และกลุ่มที่ 2 ได้รับการสอนให้พันต่อขาด้วยผ้ายืดเพื่อให้ยุบวมโดยทุกคนจะได้รับโปรแกรมการฟื้นฟูอื่น ๆ ที่เหมือนกัน ผู้ป่วยจะได้รับการวัดเส้นรอบวงของต่อขาวันแรก ที่ 2 สัปดาห์ และที่ 4 สัปดาห์ตามลำดับ นำผลที่ได้ไปคำนวณ หาปริมาตรของต่อขาและวิเคราะห์หาค่าความแตกต่างทางสถิติระหว่างกลุ่ม

ผลการศึกษา: ผู้ป่วยที่ถูกตัดขาระดับใต้หัวเข่าทั้งหมด 26 คน อายุเฉลี่ย 68.19 ± 10.83 ปี เพศชาย 11 คน (ร้อยละ 42.3) และเพศหญิง 15 คน (ร้อยละ 57.69) ถูกตัดข้างขวา 20 คน (ร้อยละ 76.92) เป็นเบาหวาน 21 คน (ร้อยละ 80.77) สาเหตุการตัดขาส່วนใหญ่เกิดจากหลอดเลือดส่วนปลายตีบตัน 15 คน (ร้อยละ 57.69) สุ่มได้กลุ่มใช้เฟือกชนิดถอดได้ 12 คน (ร้อยละ 46.2) และกลุ่มที่ใช้ผ้ายืด 14 คน (ร้อยละ 53.8) กลุ่มที่ใช้เฟือกชนิดถอดได้ สามารถลดปริมาตรต่อขาในช่วง 2 และ 4 สัปดาห์ ได้เฉลี่ย 42.73 ± 62.70 และ 79.9 ± 103.33 ลูกบาศก์เซนติเมตรตามลำดับ ส่วนกลุ่มที่ใช้ผ้ายืดพัน สามารถลดปริมาตรต่อขาได้เฉลี่ย 21.89 ± 118.49 และ 83.03 ± 113.05 ลูกบาศก์เซนติเมตรตามลำดับ โดยทั้ง 2 กลุ่ม ลดปริมาตรต่อขาได้แตกต่างกันอย่างไม่มีนัยสำคัญทางสถิติ ที่ 4 สัปดาห์

สรุป: เฟือกชนิดถอดได้ มีแนวโน้มที่จะสามารถลดปริมาตรต่อขา ในผู้ที่ถูกตัดขาระดับใต้หัวเข่า ได้เร็วกว่าการใช้ผ้ายืดพัน ในช่วง 2 สัปดาห์แรก แต่ที่ 4 สัปดาห์ ไม่มีความแตกต่างกัน