*Original Article*

# Non-Woven Tape and Orange Based Adhesive Remover for Skin Graft Stabilization: A Simple and Non-Traumatic Technique

Muangman P, MD[1], Techalertsuwan N, MD[1], Namviriyachote N, PhD[1], Chinaroonchai K, MD[1]

[1] Division of Trauma, Department of Surgery, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand

***Background:*** Skin grafts are commonly used to facilitate burn wound closure. Staples or sutures used to graft skin can be painful. We studied the use of non-woven tape to fix the skin graft and an orange oil based adhesive remover to remove the tape.

***Objective:*** To compare skin graft attachment, pain and financial costs using non-woven tape and orange-based adhesive remover or staples.

***Materials and Methods:*** A randomized controlled trial was conducted in hospitalized burn patients who received skin graft for wound closure on the extremities or body. Burn patients were randomized to receive either non-woven tape (study group) or staples (control). The staples or tape were removed seven days after grafting. The non-woven tape was removed using an orange oil based adhesive remover and the staples were taken off with a standard staple remover. The skin graft attachment area, days to complete wound healing, pain score and cost of treatment were compared.

***Results:*** Non-woven tape fixed the skin graft as effectively as staples. No differences in the area of skin graft take or days to wound closure were observed. The pain score ($p<0.05$) and cost of treatment ($p<0.05$) in the present study group was significantly lower. No allergic reactions or other complications were observed.

***Conclusion:*** Non-woven tape and removal with orange oil based adhesive remover fixed skin grafts were as effective as staples but with less pain and lower costs. Non-woven tape is an effective and cost efficient method to fix skin grafts on the extremities and body.

***Keywords:*** Skin graft, Adhesive remover, Orange peel oil

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Autologous split thickness skin graft operations consists of plasmatic imbibition, inosculation and revascularization phases. This method is among the most popular procedures for extensive burns and full thickness burn wound closure[1,2]. To achieve graft survival, the split-thickness skin graft must be immobilized so that revascularization may occur. Improper fixation, poor graft size and strength, and inappropriate tensioning during graft placement lead to graft failure[3]. The most common methods currently used for skin graft fixation are sutures and skin staples[4,5]. However, multiple staples or sutures often cause pain and discomfort during dressing changes and during staple removal. Excessive staple or suture pressure may result in skin inclusion. Staples can become buried in granulation tissue leading to potential medicolegal consequences such as staple retention while insufficient pressure may fail to keep the graft seated on the wound bed[6,7].

Several methods for replacing the stapling device have been proposed such as biodegradable staple[8], fibrin glue[9], and tie over dressing[10,11]. Recently, an orange oil based solvent used to dissolve adhesives and remove wound dressings, skin protectors, and tapes was reported to improve the outcome of the grafting procedure[12,13]. The major advantage of this product was the reduction of pain during dressing removal. A case report in a burn patient also demonstrated the efficacy of this solvent in terms of lower cost and convenient movement[12]. A prospective study reported that patients with staples experienced more pain but there were no differences in graft survival or length of hospital stay[14]. A different study reported non-woven tape resulted in satisfactory outcomes characterized by easy application and a fine linear scar production[15]. The authors previously reported on the utility of non-woven tape in skin graft fixation and orange oil based adhesive remover in a single burn patient[12]. In the present study, the authors would like to enlarge this innovation in larger number of burn patients. The aim of the present study was to determine if non-woven tape is superior to staples or sutures in terms of pain, ease of

**Correspondence to:**

Muangman P.

Division of Trauma, Department of Surgery, Faculty of Medicine Siriraj Hospital, Mahidol University, 2 Wanglang Road, Bangkoknoi, Bangkok 10700, Thailand.

**Phone:** +66-2-4197727, **Fax:** +66-2-4197730

**E-mail:** pmuangman@me.com, pornprom.mua@mahidol.ac.th

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application, reduction of scar tissue and lowered treatment costs.

## Materials and Methods

The Siriraj Institutional Review Board approved this randomized-controlled trial (Ethics #Si277/2016). Hospitalized patients ages 18 to 60 years with deep second to third degree burns of the body or extremities of at least 10x10 $cm^2$ that required skin graft were enrolled. Patients with burns involving other areas such as the face, joints, fingers and toes were excluded. Patients with immuno-compromising conditions (e.g. diabetes mellitus, chronic kidney disease, acquired immune deficiency syndrome, or immunosuppressive therapy), peripheral vascular disease, chronic venous insufficiency, or allergy to oranges were excluded.

The sequence of treatment was randomized using random number table. The individual wounds were equally divided into two parts (left and right or upper and lower of the wound), then assigned in half with one side receiving tape and the other side of the same wound receiving staples (Figure 1). The small pieces of non-woven tape were packed in the paper-plastic pouches and sterilized by ethylene oxide gas in a vacuum chamber. The secondary gauze wound dressing was changed on the 3rd and 7th day after the skin graft operation. The non-woven tape and staples were removed on the 7th postoperative day. The staples were removed with a staple remover while the non-woven tape was removed using an orange oil based adhesive remover (Orange-Sol®, Bangkok Medisupply Co. Ltd., Thailand). Orange-Sol® is a solvent skin cleanser extracted from the peel of *Citrus aurantium dulcis* and *Citrus sinensis (L.)*, and from *Centella asiatica (L.)* leaf extract. The non-woven tape was first impregnated with adhesive remover solution for 5 to 10 seconds and gently uncovered from the wound. Next, the skin graft wound was cleaned with a normal saline solution.

Subjects were followed until full epithelialization was achieved. During each visit, photographs were taken and a pain score was recorded in both groups 30 minutes after dressing removal. The area of complete graft sheet attachment was evaluated and calculated on days 3, 7, 10 and 14 postoperatively (Equation 1). The same attending surgeon measured and evaluated the wound area and graft sheet attachment using the ImageJ program [16]. The pain score was assessed using a numeric rating scale of 0 (no pain at all) to 10 (worst imaginable pain) on the 3rd, 7th, 10th and 14th day. The day of wound closure defined as complete epithelialization was recorded. If the wound did not heal within 14 days, it was assessed daily until complete wound closure was observed. The cost of treatment was calculated by totaling the cost of staples and tape used in the operation.

$$\% \text{ graft attachment area} = \frac{\text{Area of graft attachment assessed by attending surgeon}}{\text{Total area of wound which performed skin graft}} \times 100$$

The SPSS program version 22 (SPSS Inc., Chicago, IL, USA) was used for statistical analysis. Qualitative data including sex, type of burn were reported as frequency and percent. Quantitative data were described using mean $\pm$ standard deviation. The independent t-test was used to compare the graft attachment area and cost of treatment and the chi-squared test was used for pain score comparison. A *p*-value less than 0.05 was considered statistically significant. The present study was approved by the Siriraj Institutional Review Board (693/2558(EC1)).

## Results

Nineteen burn patients were enrolled and 13 (68.4%) were male. (Table 1) The mean age was 47.42$\pm$13.98 years old and the mean length of hospital stay was 23.00$\pm$2.88 days. Thirteen (68.4%) were burned by flames, five (26.3%), were scalds and one (5.3%) was a chemical burn. The mean burned area was 10.68% and the mean grafted area was 6.26%. The graft attachment area gradually increased over the observation period until full epithelialization was achieved

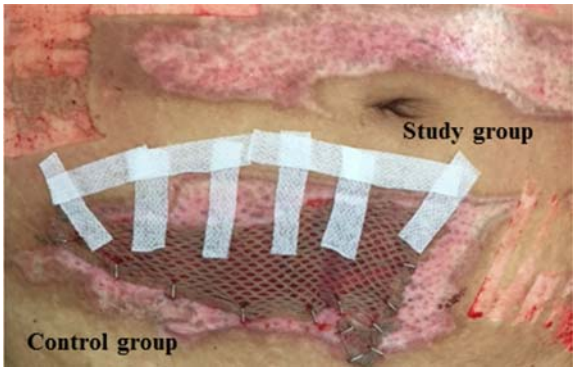


**Figure 1.** The wounds were equally divided to receive non-woven tape (study group) and staples (control group).

**Table 1.** Patient demographics and characteristics

| Characteristic | Frequency |
|---|---|
| Patients | 19 |
| Sex | |
| Male, n (%) | 13 (68.4) |
| Female, n (%) | 6 (31.6) |
| Age (years) | 47.42$\pm$13.98 |
| Degree burn | |
| Second, n (%) | 6 (31.6) |
| Second & third, n (%) | 6 (31.6) |
| Third, n (%) | 7 (36.8) |
| Type of burn | |
| Flame, n (%) | 13 (68.4) |
| Scald, n (%) | 5 (26.3) |
| Chemical, n (%) | 1 (5.3) |
| Percent burn, % | 10.68$\pm$2.82 |
| Percent graft area, % | 6.26$\pm$2.2 |
| Hospital stay, days | 23.00$\pm$2.88 |

**Table 2.** Pain score, day of wound closure and cost of treatment between groups

| | Study group | Control group | *p*-value |
|---|---|---|---|
| Pain score at staples and tapes removal (unit) | 0.84±0.68 | 6.21±1.07 | <0.05 |
| Day of wound closure (days) | 22.15±2.47 | 21.42±2.47 | 0.370 |
| Cost of treatment (baht) | 25.21±9.10 | 721.74±260.61 | <0.05 |

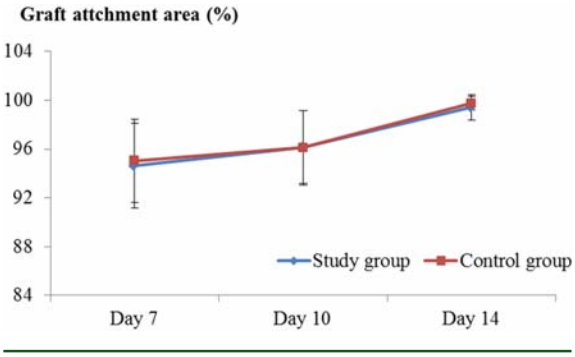


**Figure 2.** The percentage of graft attachment area between study and control groups

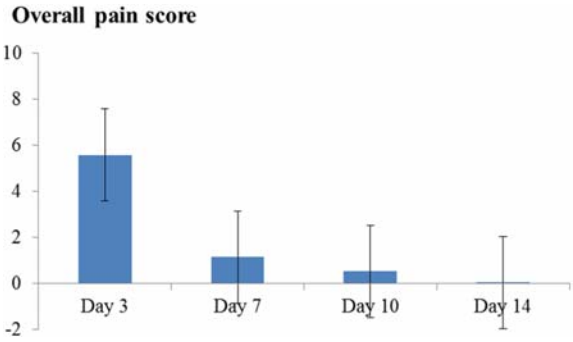


**Figure 3.** Overall pain score during the study.

in all subjects. The percentage of graft attachment area in all patients was at least 90% at day 7 and up to 99% on day 14. There was no significant difference in the days needed to achieve complete wound healing (non-woven tape 22.15±2.47; staples 21.42±2.47 days; $p = 0.370$) (Table 2) (Figure 2). The pain score dramatically decreased from day 3 (5.58±1.52) to day 7 (1.16±0.89) ($p<0.05$), then dropped slightly until day 14 (Figure 3). All subjects reported little pain by the end of the observation period. The mean pain score at removal in the non-woven tape group was less than in the control (staples) group ($p<0.05$). The cost of treatment with staples was more expensive than non-woven tape group (721.74±260.61 compared to 25.21±9.10 baht, $p<0.05$) (Table 2). No wound healing complication, infection or allergy was observed in any subject.

## Discussion

The reducing patients' pain is one of wound treatment goals[17,18]. Graft fixation using non-woven tape followed by orange oil based adhesive remover effectively immobilizes the graft, reduces pain and is less costly than staples. Using non-woven tape could increase patient compliance during dressing removal and does not damage the granulation tissue. The cost of treatment of non-woven tape was low (one staple cost 9.50 baht and tape of approximately 2x4 $cm^2$ cost 0.50 baht). Several studies have compared the advantages and disadvantages of using staples and other methods[12,14,19]. The average of overall pain on the wound from the present study which means including control and study group because both studies were done on the same wound; however, some studies claimed that patients treated with tissue adhesive experienced less pain than those where staples were used[14]. In pediatric burn patients, the use of cyanoacrylate glue facilitated rapid fixation and reduced general anesthesia[19]. The length of hospital stay may also be reduced compared to split thickness skin grafts fixed with skin staples. Fibrin glue sealant has also been reported to produce excellent graft take rates, particularly in joints and extremities where immobilization is difficult[20,21]. Murray et al reported that the use of non-woven tape in surgical wound healing was convenient and reduced scar formation[22].

Limonene, an active compound derived from orange peels, is a natural adhesive cleaner. The compound may interrupt the interaction between the tape adhesive and the skin surface[23]. Allergic contact dermatitis to citrus fruit or limonene is rare [24], and the authors did not observe such reactions in the present study. The risk of contact allergy may depend in part on the duration of exposure. In the present study, the tape was soaked with adhesive remover for 5 to 10 seconds and after tape removal, the residual adhesive solution was promptly cleaned with normal saline solution.

## Conclusion

Non-woven tape and orange oil based adhesive remover decreased pain, lowered treatment costs and effectively immobilized the graft allowing for complete healing without complications. This method is an alternative to staples or sutures for skin graft fixation especially on the extremities and body.

## What is already known on this topic?

Staples are commonly used in skin graft fixation but can be painful and may become embedded in the granulation tissue. Other methods including non-woven tape

and orange oil based adhesive remover have been proposed to avoid these problems.

## What this study adds?

Using non-woven tape followed by orange oil based adhesive remover can reduce pain and treatment costs. The efficacy of this method is similar to staple fixation and no complications were observed.

## Potential conflicts of interest

The authors declare no conflicts of interest.

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## เทคนิคอย่างง่ายและไม่ทำลายเนื้อเยื่อของการใช้พลาสเตอร์กาวปิดแผลและสารละลายจากสารสกัดเปลือกส้มเพื่อประสิทธิผลในการผ่าตัดปลูกถ่ายผิวหนัง

พรพรหม เมืองแมน, ณัฐวดี เตชะเลิศสุวรรณ, นันทพร นามวิริยะโชติ, กุสุมา ชินอรุณชัย

***ภูมิหลัง:*** การผ่าตัดปลูกถ่ายผิวหนังเป็นวิธีการหนึ่งที่นิยมในการปิดบาดแผลไหม้ อย่างไรก็ตามการใช้ลวดเย็บแผลและฝีเย็บจำนวนมาก อาจเป็นสาเหตุให้ผู้ป่วยเจ็บปวดและไม่สะดวกสบาย เพื่อลดความเจ็บป่วยดังกล่าว ผู้วิจัยจึงสนใจการใช้พลาสเตอร์กาวปิดแผลสำหรับยึดผิวหนังที่ปลูกถ่ายไว้ รวมถึงสารละลายจากสารสกัดเปลือกส้มเพื่อนำมาใช้ลอกพลาสเตอร์ปิดแผล

***วัตถุประสงค์:*** ศึกษาประสิทธิผลของการปลูกถ่ายผิวหนังจากการใช้พลาสเตอร์กาวปิดแผลและสารละลายจากสารสกัดเปลือกส้มเปรียบเทียบกับการใช้ลวดเย็บแผล

***วัสดุและวิธีการ:*** การศึกษาเป็นลักษณะแบบสุ่มและมีกลุ่มควบคุมในผู้ป่วยแผลไหม้ที่ได้รับการปลูกถ่ายผิวหนังเพื่อปิดบาดแผลบริเวณ แขน ขา และลำตัว บาดแผล จะถูกแบ่งออกเป็นสองส่วนเพื่อเข้ารับการรักษาในกลุ่มศึกษา คือได้พลาสเตอร์กาวปิดแผล และกลุ่มควบคุมคือได้รับลวดเย็บแผล ทั้งสองวัสดุนี้จะถูกนำออกในวันที่ 7 หลังจากผ่าตัดปลูกถ่ายผิวหนัง โดยพลาสเตอร์กาวปิดแผลจะใช้สารละลายจากสารสกัดเปลือกส้ม ขณะที่ลวดเย็บแผลจะใช้อุปกรณ์สำหรับถอนลวด วัดและประเมินพื้นที่ การติดของผิวหนัง ระยะเวลาการหายของแผล คะแนนประเมินอาการปวด และค่าใช้จ่ายในการรักษา

***ผลการศึกษา:*** พลาสเตอร์กาวปิดแผลสามารถยึดผิวหนังได้มีประสิทธิภาพใกล้เคียงกับลวดเย็บแผล จากการศึกษาไม่พบความแตกต่างในด้านพื้นที่การติดของผิวหนังและระยะการหายของแผลในทั้งสองกลุ่ม สำหรับคะแนนประเมินอาการปวดและค่ารักษาในกลุ่มศึกษาน้อยกว่ากลุ่มควบคุมอย่างมีนัยสำคัญทางสถิติ ไม่พบอาการไม่พึงประสงค์ทางผิวหนัง

***สรุป:*** วิธีการยึดผิวหนังกับพื้นแผลด้วยพลาสเตอร์กาวปิดแผลและลอกกาวออกด้วยสารละลายจากสารสกัดเปลือกส้มมีข้อดีในด้านลดความเจ็บปวดและค่ารักษา รวมถึงเพิ่มคุณภาพการรักษาบาดแผล วิธีนี้เป็นวิธีอย่างง่ายที่มีประสิทธิภาพในการปลูกถ่ายผิวหนังบริเวณแขน ขา และลำตัว