Original article

A randomized, double-blind, controlled trial between bacterial cellulose gauze (BC) and petrolatum gauze (PG) in the healing of epidermal ablative wounds from carbon dioxide laser

Nattaporn Sampattavanich, Chitsachee Sichanugrist and Kobkul Aunhachoke

Division of Dermatology, Department of Medicine, Phramongkutklao Hospital

Background: *Bacterial cellulose (BC) was used to dress various wounds. BC has also applied burn wounds and ulcers as skin repair treatments. The carbon dioxide (CO_2) laser has been widely used to treat numerous skin lesions. However, the benefit of BC gauze as wound dressing after CO_2 laser has yet to be defined.* ***Objectives:*** *To evaluate the efficacy of BC gauze compared with petrolatum gauze in epidermal ablative wound healing from a CO_2 laser.* ***Materials and methods:*** *We included 26 patients affected by at least two seborrheic keratosis lesions in the same area (face or non-face). After being treated by CO_2 laser, the wounds in each patient were randomized into BC and PG groups. The dressings were changed on days 2, 4, 7, and 10 post-laser. Wound healing was assessed by BWAT score and ImageJ application during each visit. Pain scores and patient satisfaction were also recorded by visual analogue scales (VAS).* ***Results:*** *Twenty-six volunteers completed the study. Most lesions were on the non-face area. BWAT scores in both BC and PG groups were not different (PG vs BC day 2 = 24.04 vs 24.19; p = 0.895, day 4 = 20.88 vs 21.96; p = 0.305, day 7 = 16.5 vs 16.42; p = 0.918, day 10 = 14.31 vs 14.92; p = 0.178). From ImageJ analysis, without statistically significant differences, BC showed a tendency for a higher percentage of wound epithelialization than PG (PG vs BC day 2 = 20.5 vs 24.6; p = 0.373, day 4 = 40.52 vs 45.32%; p = 0.354, day 7 = 58.03 vs 61.35; p = 0.369, day 10 = 67.79 vs 70.9; p = 0.426). Pain scores were not different between groups, but satisfaction scores of BC were significantly higher than PG on days 7 and 10. No complications from BC had been found in this study.* ***Conclusions:*** *BC showed comparable efficacy with conventional dressing in epidermal ablative wound healing and can be safely used for CO_2 laser wounds.*

Keywords: ● *Bacterial cellulose* ● *Carbon dioxide laser* ● *Ablative wound, wound dressing*

RTA Med J 2023;76(2):55-63.

Received 10 July 2022 Corrected 27 April 2023 Accepted 27 June 2023

Correspondence should be addressed to Lt. Col. Nattaporn Sampattavanich, MD., Division Of Dermatology, Department Of Medicine, Phramongkutklao Hospital, Bangkok 10400

นิพนธ์ต้นฉบับ

การทดลองแบบสุ่มเพื่อเปรียบเทียบประสิทธิภาพการรักษาแผลจากคาร์บอนไดออกไซด์เลเซอร์ด้วยวัสดุปิดแผลที่ทำจากเซลลูโลสของแบคทีเรียเปรียบเทียบกับแผ่นตาข่ายเคลือบปิโตรลาตุม

ณัฐพร สัมปัตตะวนิช จิตต์ศจี สิชฌนุกฤษฏ์ และ กอบกุล อุณหโชค
แผนกผิวหนัง กองอายุรกรรม โรงพยาบาลพระมงกุฎเกล้า

ที่มาและความสำคัญ *แผ่นปิดแผลจากเซลลูโลสของแบคทีเรีย (BC) สามารถใช้กับแผลหลายชนิด ได้แก่ แผลไฟไหม้ หรือแผลเรื้อรัง แต่ยังไม่มีการศึกษาการใช้ BC ในแผลจากคาร์บอนไดออกไซด์เลเซอร์ ซึ่งเป็นเลเซอร์ทางผิวหนังที่ใช้บ่อย* ***วัตถุประสงค์*** *เพื่อประเมินประสิทธิภาพของ BC เปรียบเทียบกับการใช้ แผ่นตาข่ายเคลือบปิโตรลาตุม (PG) ในการรักษาบาดแผลจากเลเซอร์คาร์บอนไดออกไซด์* ***วิธีดำเนินการ*** *อาสาสมัคร 26 คนที่มีกระเนื้อ (seborrheic keratoses) สองจุดในบริเวณเดียวกัน ได้รับการรักษาด้วยเลเซอร์คาร์บอนไดออกไซด์ แต่ละรายจะได้รับการสุ่มเลือกบาดแผลสำหรับการปิดแผลด้วย BC หรือ PG โดยวัสดุปิดแผลจะได้รับการเปลี่ยนในวันที่ 2, 4, 7 และ 10 หลังการทำเลเซอร์คาร์บอนไดออกไซด์ ร่วมกับประเมินการหายของแผลด้วยคะแนน BWAT และ ImageJ พร้อมทั้งบันทึกคะแนนความเจ็บปวดและความพึงพอใจของอาสาสมัครด้วยทุกครั้ง* ***ผลการศึกษา*** *อาสาสมัครทั้ง 26 คน สามารถเข้าร่วมงานวิจัยได้จนจบ ส่วนใหญ่เป็นรอยโรคบริเวณที่ไม่ใช่ใบหน้า จากการประเมินการหายของบาดแผลด้วย BWAT และ ImageJ พบว่า แผลที่ใช้ BC ให้ผลไม่แตกต่างจากการใช้ PG และเมื่อวิเคราะห์แผลด้วย ImageJ พบว่า แผลที่ใช้ BC มีแนวโน้มของเปอร์เซ็นต์การหายของแผลสูงกว่า แต่ยังไม่มีนัยสำคัญทางสถิติ (PG vs BC วันที่ 2 = 20.5 vs 24.6; p = 0.373, วันที่ 4 = 40.52 vs 45.32%; p = 0.354, วันที่ 7 = 58.03 vs 61.35; p = 0.369, วันที่ 10 = 67.79 vs 70.9; p = 0.426) นอกจากนี้ อาสาสมัครให้คะแนนความพึงพอใจต่อวัสดุปิดบาดแผลทั้งสองชนิดไม่แตกต่างกัน และไม่พบภาวะแทรกซ้อนในการศึกษานี้* ***สรุป*** *BC มีประสิทธิภาพไม่แตกต่างจากวัสดุปิดแผลดั้งเดิม และสามารถใช้กับบาดแผลหลังการทำเลเซอร์คาร์บอนไดออกไซด์ได้อย่างปลอดภัย*

คำสำคัญ: *● วัสดุปิดแผล ● เซลลูโลสของแบคทีเรีย ● แผลคาร์บอนไดออกไซด์เลเซอร์*

เวชสารแพทย์ทหารบก 2566;76(2):55-63.

ได้รับต้นฉบับ 10 กรกฎาคม 2565 แก้ไขบทความ 27 เมษายน 2566 รับลงตีพิมพ์ 27 มิถุนายน 2566

ต้องการสำเนาต้นฉบับติดต่อ พ.ท.หญิง ณัฐพร สัมปัตตะวนิช แผนกผิวหนัง กองอายุรกรรม โรงพยาบาลพระมงกุฎเกล้า ถนนราชวิถี เขตราชเทวี กรุงเทพฯ 10400

Introduction

A defect or breakage of the skin resulting from physical or thermal damage can be described as a wound. Wounds can be classified as acute or chronic wounds based on the nature of the repair process. The tissue injuries that heal entirely with minimal scarring within 8-12 weeks are usually described as acute wounds, while longer healing wounds are defined as chronic wounds. Due to abrasions and tears, mechanical injuries are the primary causes of acute wounds.[1]

One of the essential factors for wound healing is the moist environment that can increase cell proliferation and activity, promoting epithelialization. Furthermore, moisture can retain an optimum level of wound exudate, containing vital proteins and cytokines produced in response to injury.[2] This knowledge paved the way for the modern class of moisture-retentive dressings, which retain optimal moisture or have a low enough moisture vapor transmission rate (MVTR) to permit optimal healing rates.[3] Various options of the above dressings, including films, hydrogels, hydrocolloids, foams, alginates, and hydrofibers, are widely used for different wounds.[4]

Hydrogels are cross-linked starch polymers comprising up to 96% of water. The ability to rehydrate and maintain a moist environment makes the hydrogels the best wound dressing materials for dry wounds. Moreover, their cooling effect on the injury can decrease perceived pain.[4]

Bacterial cellulose (BC) is one of the biological dressings classified as hydrogels. It is produced by acetic acid-producing bacteria in synthetic and non-synthetic mediums through oxidative fermentation. The most studied and the most efficient BC producer is *Acetobacter xylinum*.[5] BC exhibits remarkable properties such as unique nanostructure, high mechanical strength, high water holding capacity, broad chemical modifying ability, improved crystallinity, slow water evaporation capability, and biocompatibility.[6] Previous studies had shown that BC and its derivatives had great properties as ideal scaffolds for protecting injured tissues through wound dressings and accelerating granulation.[7] Due to these characteristics, BC has also been applied as skin repair treatment in burn wounds and ulcers.[6]

The carbon dioxide (CO_2) laser has been widely used to treat various skin lesions, including actinic and seborrheic keratosis, warts, skin tags, epidermal and dermal nevi, xanthelasma, and sebaceous gland hyperplasia. Proper close-dressings, including hydrocolloid and topical antibiotics, have always been used as the option to provide a good environment and promote wound healing.[8] Due to the properties mentioned above of BC, we hypothesized that BC gauze could be used as a wound dressing in CO_2 laser ablative wounds.

A recent unpublished study of BC in ablative wounds from CO_2 laser from our center showed unsatisfied efficacy of BC compared with petrolatum gauze (PG). We hypothesized that the long interval between wound dressings and material changes at 3-4 days caused dry adhered dressing and affected wound healing ability. Therefore, we designed to shorten the interval between wound dressing changes and evaluate the efficacy of BC compared with PG in epidermal ablative wound healings from carbon dioxide lasers.

Materials and methods

Trial design

A single-center, double-blind, randomized controlled trial was conducted at Phramongkutklao Hospital, Bangkok, Thailand (TCTR20200527003).

Participants

Eligible 26 participants were all adults over 18 years of age with at least two lesions of seborrheic keratosis that were approximately similar in size on the same body area. The exclusion criteria were active dermatitis or rashes in the treated area, history of allergic contact reaction to the wound dressing materials, and history of keloid scar. Pregnant and breastfeeding women and people who had skin cancer or took any immunosuppressive drug were also excluded.

Interventions, blinding, and randomization

The wounds of each participant were randomized in a 1:1 ratio to be covered with two different kinds of dressings: PG or BC (Bio-cellulose composite by Petroleum and Petrochemical Process Technology Research Department, Thailand). The BC in our study were produced from three strains of bacteria (Davinci ST_14_01, Davinci ST_31_03, Davinci ST_31_03_01). Except for the assigned assistant, the patients and the physician were blinded to the kinds of dressings used for each lesion.

Study protocol

On day 0 (operative day), the lesions were randomly labeled as A and B. CO2 laser ablation (MultipulseCO_2, Germany) was done to each lesion and photographs were taken before and after the laser and by the same physician. The code A and B were randomly matched with two dressings for each patient and were given to the assistant in charge to dress the wounds. The dressings were changed at the hospital on days 2, 4, 7, and 10 post-operation (Figure 1). The same assistant uncovered the wounds before they were photographed and clinically evaluated by the same physician on each visit. The clinical wound healing was assessed by the Bates-Jensen Wound Assessment Tool (BWAT). The sizes of the wound and areas of epithelialization were measured by the ImageJ program in square millimeters (mm^2). The patients were also asked to do the questionnaires composed of visual analog scales (VAS) for the pain during dressing changes and satisfaction with each wound dressing. If there were any signs of inflammation, infection, or allergy to the wound dressing, these volunteers were promptly treated and excluded from the study.

Outcomes

The primary objective of this study was to evaluate the efficacy of BC in clinical wound healing, areas of epithelialization, pain during a dressing change, and satisfaction compared with PG on days 2, 4, 7, 10 post-operation in patients aged above 18 years with ablative wounds from a CO_2 laser. The secondary objective was to evaluate the safety of BC as the wound dressing material.

Statistical analysis

All statistical analyses were performed using STATA software (version 14, StataCorp, College Station, TX). The demographic data were summarized using frequency, percent, means, and standard deviations. The BWAT, wound size, percentage of epithelialization, pain scores, cosmetic appearance, and overall satisfaction for each dressing were compared using the general linear model (GLM). Statistical significance was defined as a *p*-value less than 0.05.

Ethical approval

This study received ethical approval from the Research Ethics Committee of Phramongkutklao College of Medicine (S063h/62).

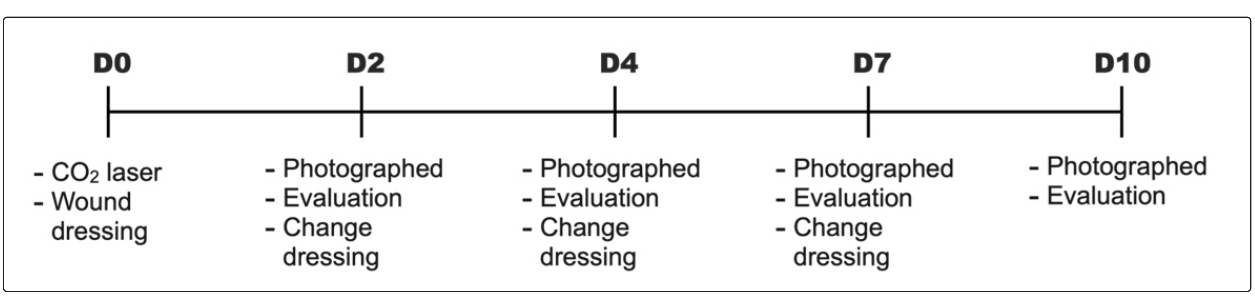

Figure 1 Study protocol

Results

Participant demographics

The total of 26 patients' demographic data is documented in Table 1. Their mean age was 65.12 years, with 9 males (45%) and 11 females (55%). Most of the treated areas were on the non-face area (11). The underlying diseases were dyslipidemia, hypertension, benign prostate hyperplasia, and diabetes mellitus. PG and BC's average initial wound sizes were 19.75±23.16 cm^2 and 14.57±9.72 cm^2, respectively, and considered not different among both groups.

Clinical outcomes

The evaluation of wound healing assessed by BWAT is shown in Table 2. All of the wounds were healed within ten days. The total BWAT scores of PG and BC

Table 1 Demographic data

Demographic data	
Age (year)	64.65 ± 9.63 (47-76)
Male (n)	10 (38%)
Female (n)	16 (62%)
Locations (n)	
Face	10 (38%)
Non-face	16 (62%)
Underlying diseases (n)	
Dyslipidemia	13
Hypertension	7
BPH	4
Diabetes mellitus	3
Initial wound sizes (cm^2)	
Petrolatum gauze (PG)	0.14 ± 0.09
Bacterial cellulose gauze (BC)	0.13 ± 0.08

Table 2 Wound healing assessed by BWAT

	Day 2	Day 4	Day 7	Day 10	*p*-value
Size					
PG	1±0	1±0	1±0	1±0	N/A
BC	1±0	1.04±0.2	1±0	1±0	0.561
Mean difference (95%CI)	N/A	-0.04 (-0.12, 0.04)	N/A	N/A	
p-value	1	0.327	1	1	
Depth					
PG	2±0.28	1.96±0.2	1.65±0.49	1.27±0.45	< 0.001*
BC	2±0	1.88±0.33	1.54±0.51	1.23±0.43	< 0.001*
Mean difference (95%CI)	0 (-0.11, 0.11)	0.08 (-0.08, 0.24)	0.12 (-0.06, 0.29)	0.04 (-0.14, 0.22)	
p-value	1	0.327	0.185	0.664	
Edge					
PG	2.46±0.58	2.15±0.67	1.62±0.57	1.15±0.37	< 0.001*
BC	2.54±0.58	2.31±0.74	1.5±0.65	1.27±0.53	< 0.001*
Mean difference (95%CI)	-0.08 (-0.35, 0.2)	-0.15 (-0.47, 0.16)	0.12 (-0.15, 0.38)	-0.12 (-0.29, 0.06)	
p-value	0.574	0.327	0.376	0.185	
Undermine					
PG	1.15±0.37	1.12±0.33	1±0	1±0	0.007*
BC	1.27±0.45	1.19±0.4	1.04±0.2	1±0	< 0.001*
Mean difference (95%CI)	-0.12 (-0.29, 0.06)	-0.08 (-0.27, 0.12)	-0.04 (-0.12, 0.04)	N/A	
p-value	0.185	0.425	0.327	1	
Necrotic type					
PG	1.58±0.64	1.58±0.81	1.35±0.56	1.15±0.37	0.004*
BC	1.69±0.93	1.65±0.69	1.27±0.53	1.15±0.46	0.001*
Mean difference (95%CI)	-0.12 (-0.63, 0.4)	-0.08 (-0.5, 0.35)	0.08 (-0.15, 0.3)	0 (-0.16, 0.16)	
p-value	0.649	0.713	0.49	1	

Table 2 Wound healing assessed by BWAT (continue)

	Day 2	Day 4	Day 7	Day 10	*p*-value
Necrotic amount					
PG	1.81±1.06	1.77±1.24	1.35±0.56	1.15±0.37	0.001*
BC	2.04±1.51	1.92±1.02	1.35±0.69	1.12±0.33	< 0.001*
Mean difference (95%CI)	-0.23 (-1.01, 0.55)	-0.15 (-0.83, 0.52)	0 (-0.26, 0.26)	0.04 (-0.1, 0.18)	
p-value	0.546	0.642	1	0.574	
Exudate type					
PG	1.65±0.85	1.19±0.49	1.04±0.2	1±0	< 0.001*
BC	1.42±0.81	1.5±0.65	1.08±0.27	1.12±0.43	0.006*
Mean difference (95%CI)	0.23 (-0.12, 0.58)	-0.31 (-0.53, -0.09)	-0.04 (-0.12, 0.04)	-0.12 (-0.29, 0.06)	
p-value	0.185	0.008	0.327	0.185	
Exudate amount					
PG	1.65±0.69	1.38±0.85	1.04±0.2	1±0	< 0.001*
BC	1.46±0.81	1.81±0.94	1.15±0.61	1.12±0.43	0.005*
Mean difference (95%CI)	0.19 (-0.22, 0.6)	-0.42 (-0.75, -0.1)	-0.12 (-0.29, 0.06)	-0.12 (-0.29, 0.06)	
p-value	0.346	0.013	0.185	0.185	
Color					
PG	1.65±0.69	1.35±0.49	1.04±0.2	1.04±0.2	< 0.001*
BC	1.58±0.5	1.42±0.5	1.23±0.65	1.08±0.27	< 0.001*
Mean difference (95%CI)	0.08 (-0.28, 0.44)	-0.08 (-0.33, 0.18)	-0.19 (-0.45, 0.06)	-0.04 (-0.18, 0.1)	
p-value	0.664	0.538	0.134	0.574	
Edema					
PG	1.15±0.37	1.27±0.45	1.15±0.37	1.04±0.2	0.102
BC	1.35±0.49	1.27±0.45	1.12±0.33	1.08±0.27	0.005*
Mean difference (95%CI)	-0.19 (-0.42, 0.04)	0 (-0.23, 0.23)	0.04 (-0.17, 0.25)	-0.04 (-0.18, 0.1)	
p-value	0.096	1	0.713	0.574	
Induration					
PG	1.27±0.45	1.31±0.47	1.27±0.67	1.04±0.2	0.062
BC	1.35±0.56	1.31±0.47	1.15±0.37	1.12±0.33	0.025*
Mean difference (95%CI)	-0.08 (-0.4, 0.24)	0 (-0.26, 0.26)	0.12 (-0.12, 0.35)	-0.08 (-0.19, 0.03)	
p-value	0.627	1	0.327	0.161	
Granulation					
PG	3±1.39	2.08±1.09	1.35±0.8	1.15±0.37	< 0.001*
BC	2.81±1.3	1.96±0.82	1.23±0.59	1.23±0.65	< 0.001*
Mean difference (95%CI)	0.19 (-0.56, 0.94)	0.12 (-0.39, 0.62)	0.12 (-0.21, 0.45)	-0.08 (-0.27, 0.12)	
p-value	0.602	0.64	0.478	0.425	
Epithelialization					
PG	3.77±1.37	2.73±1.22	1.65±0.8	1.31±0.47	< 0.001*
BC	3.73±1.15	2.65±1.09	1.77±0.86	1.5±0.86	< 0.001*
Mean difference (95%CI)	0.04 (-0.52, 0.59)	0.08 (-0.35, 0.5)	-0.12 (-0.4, 0.17)	-0.19 (-0.52, 0.13)	
p-value	0.887	0.713	0.416	0.232	
Total					
PG	24.04±4.17	20.88±5.2	16.5±3.25	14.31±1.98	< 0.001*
BC	24.19±4.81	21.96±4.97	16.42±4.85	14.92±3.57	< 0.001*
Mean difference (95%CI)	-0.15 (-2.54, 2.23)	-1.08 (-3.2, 1.04)	0.08 (-1.44, 1.59)	-0.62 (-1.53, 0.3)	
p-value	0.895	0.305	0.918	0.178	

Values presented as mean±SD. *p*-value corresponds to the general linear model (GLM) showed a reduction in wound severity from mild severity to minimal severity (PG vs BC day 2 = 24.04±4.17 vs 24.19±4.81, day 10 = 14.31±1.98 vs 14.92±3.57). Comparing between PG and BC groups in all parameters, the BWAT scores were not significantly different (PG vs BC day 2 = 24.04 vs 24.19; *p* = 0.895, day 4 = 20.88 vs 21.96; *p* = 0.305, day 7 = 16.5 vs 16.42; *p* = 0.918, day 10 = 14.31 vs 14.92; *p* = 0.178). BC tended to show better results in depth score than in PG without statistically significant differences (PG vs BC day 2 = 2±0.28 vs 2±0; *p* = 1, day 4 = 1.96±0.2 vs 1.88±0.33; *p* = 0.327, day 7 = 1.65±0.49 vs 1.54±0.51; *p* = 0.185, day 10 = 1.27±0.45 vs 1.23±0.43; *p=0.664*).

Baseline wound sizes in both groups were not different, as shown in Table 3. Wound sizes evaluated by the ImageJ program are shown in Table 4. A decrease in wound size within ten days was observed in both groups. Without statistically significant differences, BC showed a tendency for a higher percentage of wound epithelialization than PG (PG vs BC day 2 = 20.5 vs 24.6; *p* = 0.373, day 4 = 40.52 vs 45.32%; *p* = 0.354, day 7 = 58.03 vs 61.35; *p* = 0.369, day 10 = 67.79 vs 70.9; *p* = 0.426) (Table 4, Figure 2).

From visual analog scales (VAS), shown in table 5, only minimal pain was reported for all dressing materials. The mean VAS scores were not significantly different between materials (PG vs BC day 2 = 1±0 vs 1.12±0.59; *p* = 0.327, day 4 = 1±0 vs 1.08±0.39; *p* = 0.327, day 7 = 1±0 vs 1±0; *p* = 1, day 10 = 1±0 vs 1±0; *p* = 1). Satisfaction for convenience, cosmetic appearance, and overall satisfaction of BC were higher than PG on days 7 and 10 with statistically significant. No complications from BC had been found in this study.

Discussion

BC is a biological material with outstanding properties providing a suitable environment for wound healing. Many studies revealed the benefits of BC as a wound dressing on chronic wounds with limited data on acute injuries.[6,7] This randomized, double-blind controlled trial was designed to evaluate the efficacy of BC gauze compared with PG in epidermal ablative wound healing from the CO_2 laser. By BWAT score and ImageJ program, BC showed promising efficacy for wound healing comparable to PG in our study. Neither infection nor complication was found in both groups.

Table 3 Wound size measured by the ImageJ program (cm^2)

	Day 0	Day 2	Day 4	Day 7	Day 10	*p*-value
PG	0.14±0.09	0.16±0.19	0.13±0.17	0.09±0.13	0.07±0.1	< 0.001*
BC	0.13±0.08	0.12±0.09	0.09±0.09	0.07±0.09	0.05±0.07	< 0.001*
Mean difference (95%CI)	0.01 (-0.01, 0.02)	0.04 (-0.01, 0.09)	0.04 (-0.01, 0.08)	0.02 (-0.01, 0.05)	0.02 (-0.01, 0.05)	
p-value	0.536	0.099	0.101	0.147	0.229	

Table 4 Percentage of epithelialization compared with baseline wound size (%)

%Change	Day 2	Day 4	Day 7	Day 10	p-value
PG	-20.5±20.65	-40.52±21.01	-58.03±20.7	-67.79±17.52	< 0.001*
BC	-24.6±18.69	-45.32±25.65	-61.35±25.71	-70.9±24.44	< 0.001*
Mean difference (95%CI)	4.1 (-5.21, 13.4)	4.79 (-5.66, 15.25)	3.32 (-4.16, 10.79)	3.11 (-4.8, 11.02)	
p-value	0.373	0.354	0.369	0.426	

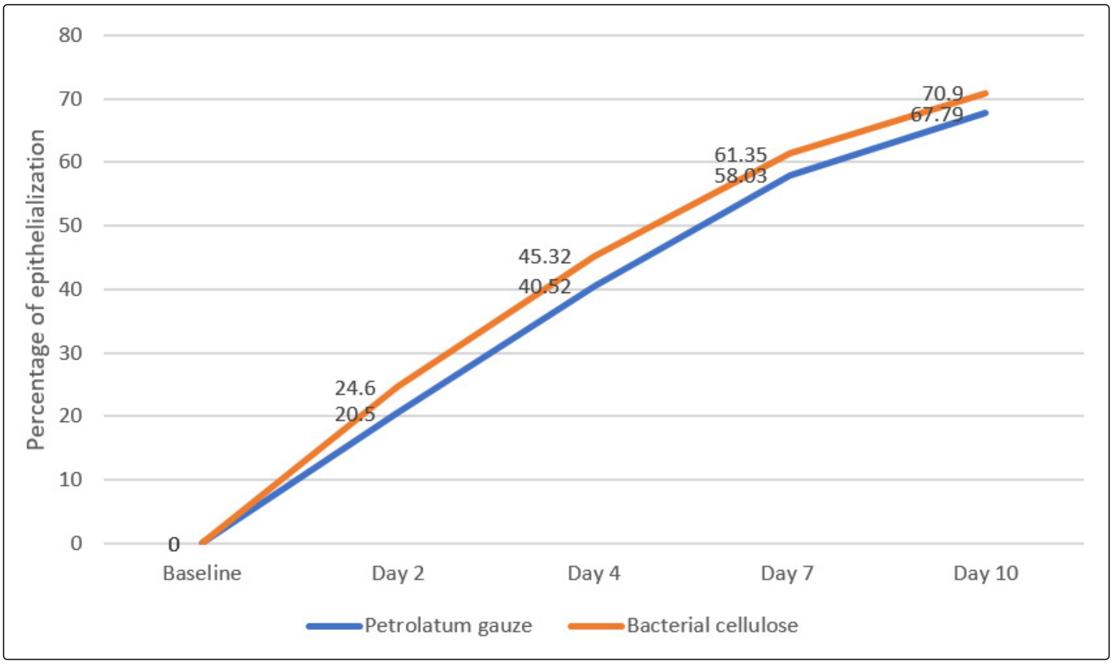

Figure 2 Percentage of epithelialization of the wounds compared between groups

Table 5 Pain on dressing changes and satisfaction scores reported by volunteers in visual analog scales

	Day 2	Day 4	Day 7	Day 10	p-value
Pain					
PG	1±0	1±0	1±0	1±0	N/A
BC	1.12±0.59	1.08±0.39	1±0	1±0	0.169
Mean difference (95%CI)	-0.12 (-0.35, 0.12)	-0.08 (-0.24, 0.08)	N/A	N/A	
p-value	0.327	0.327	1	1	
Healing					
PG	8.31±0.93	8.58±0.76	8.88±0.82	9.15±0.67	< 0.001*
BC	8.54±0.86	8.77±0.65	9.15±0.73	9.46±0.51	< 0.001*
Mean difference (95%CI)	-0.23 (-0.66, 0.2)	-0.19 (-0.59, 0.2)	-0.27 (-0.75, 0.21)	-0.31 (-0.56, -0.06)	
p-value	0.282	0.327	0.258	0.018	
Convenient					
PG	7.96±1.34	8.46±0.95	8.69±0.68	9.08±0.63	< 0.001*
BC	8.31±0.88	8.73±0.78	9.12±0.65	9.35±0.49	< 0.001*
Mean difference (95%CI)	-0.35 (-0.95, 0.26)	-0.27 (-0.76, 0.22)	-0.42 (-0.75, -0.1)	-0.27 (-0.45, -0.09)	
p-value	0.249	0.271	0.013	0.006	
Cosmetic					
PG	8.23±0.91	8.54 ± 0.76	8.77 ± 0.65	9.19±0.63	< 0.001*
BC	8.35±1.23	8.77 ± 0.82	9.15 ± 0.67	9.46±0.51	< 0.001*
Mean difference (95%CI)	-0.12 (-0.58, 0.35)	-0.23 (-0.61, 0.15)	-0.38 (-0.69, -0.08)	-0.27 (-0.45, -0.09)	
p-value	0.611	0.228	0.015	0.006	
Total					
PG	8.5±0.76	8.69±0.74	8.81±0.75	9.19±0.69	0.001*
BC	8.54±1.07	8.88±0.71	9.35±0.69	9.54±0.51	< 0.001*
Mean difference (95%CI)	-0.04 (-0.44, 0.37)	-0.19 (-0.55, 0.17)	-0.54 (-0.87, -0.21)	-0.35 (-0.57, -0.12)	
p-value	0.846	0.284	0.002	0.004	

BWAT was initially developed as the Pressure Sore Status Tool (PSST) and is widely used for pressure ulcers assessment. Although BWAT was not designed for acute wound assessment, the study by Garbuio DC et al. showed the validity and reliability of this tool in this kind of wound.[9] However, the lower sensitivity in acute wound assessment of BWAT score due to many more suitable parameters with chronic wounds, such as granulation or necrotic tissue, might fail to show the significant changes in our study. Thus, we added another wound assessment tool, the ImageJ program, offering a more objective wound assessment to evaluate the size of the wound in this study.[9]

The previous unpublished study of BC in CO_2 laser wounds done in our center revealed different results of a slight delay of epithelialization on days 7 and 10. With 3-4 days intervals of dressing changes, most BC got dry and adhered to the wound base resulting in disruption of epithelialization. In this study, with less interval between wound dressing changes at 2-3 days, we found that BC tended to have a higher percentage of wound epithelialization than PG. However, this difference had no statistical significance. Therefore, further study with the daily change of the dressing materials and increasing the study population might lead to a significant difference in wound epithelialization between groups.

The safety of BC as a wound dressing material was demonstrated. There was no infection or any complication in this study. However, the cosmetic appearance and dressing convenience are also the crucial factors determining the usage of BC as a wound dressing for this kind of wound.

Limitations included a relatively small number of patients in both groups, limiting the conclusions drawn for subgroup analysis.

Conclusion

BC showed comparable efficacy with conventional dressing in epidermal ablative wound healing and can be safely used for CO_2 laser wounds.

References

1. *Boateng JS, Matthews KH, Stevens HN, Eccleston GM. Wound healing dressings and drug delivery systems: a review. J Pharm Sci. 2008;97(8):2892-923.*
2. *Junker JP, Kamel RA, Caterson EJ, Eriksson E. Clinical Impact Upon Wound Healing and Inflammation in Moist, Wet, and Dry Environments. Adv Wound Care (New Rochelle). 2013;2(7):348-56.*
3. *Jennifer Gloeckner Powers LMM, Tania J Phillips. Dressings for chronic wounds. Dermatol Ther. 2013;26(3):197-206.*
4. *Broussard KC, Powers JG. Wound dressings: selecting the most appropriate type. Am J Clin Dermatol. 2013;14(6):449-59.*
5. *Wang J, Tavakoli J, Tang Y. Bacterial cellulose production, properties and applications with different culture methods - A review. Carbohydr Polym. 2019;219:63-76.*
6. *Shah N, Ul-Islam M, Khattak WA, Park JK. Overview of bacterial cellulose composites: a multipurpose advanced material. Carbohydr Polym. 2013;98(2):1585-98.*
7. *Portela R, Leal CR, Almeida PL, Sobral RG. Bacterial cellulose: a versatile biopolymer for wound dressing applications. Microb Biotechnol. 2019;12(4):586-610.*
8. *Krupa Shankar D, Chakravarthi M, Shilpakar R. Carbon dioxide laser guidelines. J Cutan Aesthet Surg. 2009;2(2):72-80.*
9. *Cristina Garbuio D, Mara Zamarioli C, Chantal Magalhães da Silva N, Oliveira-Kumakura ARDS, Carvalho EC. Assessment tools for the healing of wounds: an integrative review. Rev Eletr Enf. 2018;20.*