ORIGINAL ARTICLE

EFFICACY OF MICROPOROUS TAPE IN THE PREVENTION OF ABNORMAL POST-SURGICAL SCARS AMONG A BLACK POPULATION

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Background: A scar can be defined as a mark or a blemish resulting from a healed wound. All surgical incisions give rise to scars and approximately 15% have excessive scars**.** Some scars are thin lines which are almost unnoticeable, whereas others become abnormal when the amount of fibrosis is excessive or suboptimal or when it causes functional disability or aesthetic distress to the patient. The conversion of normal scarring to hypertrophic scarring occurs six to eight weeks after surgery as a result of increasing scar tension. Thus, scar support especially with the use of microporous tape is critical during this period. Objectives were to determine the efficacy of microporous tape in the prevention of abnormal post-surgical scars. **Methods:** A randomized control study which compared the limb scar outcome between post-surgical patients who underwent scar taping with microporous tape and those who did not. The scars were assessed at six weeks, three months and six months after surgery using the Patient and Observer Scar Assessment Scale. The test group had microporous tape applied to their scars over a period of six months and worn twenty-four hours daily. The tapes were changed every fortnight or whenever they fell off. The data was analyzed using SPSS-22. The categorical variables, the relative scar height, the scar width and the OSAS score were compared using the Chi-square test and the independent t-test respectively. **Results:** At six weeks, 48.8% of non-taped scars and 97.6% of taped scars were normal; at three months 75.6% of non-taped scars and 2.4% of taped scars were abnormal while at 6 months 80.5% of non-taped scars and none of the taped scars were abnormal. **Conclusion:** Microporous tape is an effective modality for preventing abnormal scarring in post-surgical patients.

Keywords: Abnormal scarring; Microporous tape; Post-surgical scar

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INTRODUCTION

A scar can be defined as a mark or a blemish resulting from a healed wound. Scars are an integral part of human existence.[1] All surgical incisions give rise to scars. Some scars are thin lines which are almost unnoticeable, whereas others become hypertrophic scars or keloids. Mechanical forces including tension have been shown to influence scarring as demonstrated in animal models and clinical experience. Wounds closed with excess tension are known to produce more scar tissue.[2] A normal scar is characterized by minimal fibrosis; it is thin, flat and has a good colour match with the surrounding skin without distortion of the adjacent tissue. A scar is however considered abnormal when the amount of fibrosis is excessive or suboptimal or when it causes functional disability, psychosocial trauma or aesthetic distress to the patient.[2]

The conversion of normal scarring to hypertrophic scarring or the apparent overgrowth of scar beyond normal healing usually occurs six to eight weeks after injury or surgery in humans. Thus, scar support especially with the use of tape is critical during this period when increased tension across the scar would result in exaggerated scarring. Microporous tape is a dressing tape which has been discovered to have "scar modulating effects"[3] and that is why it was used in this study. Microporous tape is cost-effective and readily available for post-surgical patients.

Abnormal scarring is a worldwide problem that may be associated with substantial emotional and financial costs. Estimates indicate that each year, around 100 million people acquire scars following elective surgery and surgery for trauma.[4] Of these, approximately 15% have excessive or un-aesthetic scars.[4] Scar hypertrophy has been estimated to occur in 50–70% of surgical scars after elective surgery.[4]

African American patients and those of other races with a relatively darker complexion (i.e., Hispanics, Asians and Indians) are more likely to have hypertrophic scar formation.[5] Negroids are about 15 times more prone to develop excessive scarring than the Caucasians with a reported

incidence ratio of 2: 1 to 19:1 between the two groups.[6]

Considering the magnitude of abnormal post-operative scarring especially among the Negroid population, it is worthwhile to consider how to prevent abnormal scar following surgery. A study on limb scar is equally imperative because the limbs account for a significant percentage of the exposed body surface area and the presence of abnormal scar can be aesthetically embarrassing to the patient.

Few studies have researched into the prevention of abnormal post-operative scarring. Most of the previous studies have focused more on the management of already formed post-operative abnormal scar and less on how to prevent them.[7,8] The aim of this study is to find out whether microporous taping reduces the tendency to form abnormal post-surgical scars or not. Research question- Does microporous taping reduce the tendency to form abnormal scars following limb surgeries? Null hypothesis- Microporous taping does not reduce the tendency to form abnormal scars following limb surgeries.

MATERIAL AND METHODS

This was a randomized controlled study which compared the limb scar outcome between post-surgical patients who underwent scar taping with microporous hypoallergenic tape and those who did not. A total of 72 patients with 92 scars [test group A (n=36); control group B (n=36)] were recruited in the study and they were followed up over a period of six months from the time of recruitment. However, 63 patients with 83 scars completed the study. The patients were assigned into two groups (A and B); group A underwent post-operative scar microporous taping and group B did not. The study population included males and females with primary closure of limb wounds following surgeries like benign tumour excisions, open reduction and internal fixation of closed fractures, corrective osteotomies, arthroplasties etc. and whose ages ranged between 15 and 65 years.

The following patients were included in the study: patients aged 15–65 years who were scheduled for open elective limb surgeries like benign tumour excisions, open reduction and internal fixation of closed fractures, corrective osteotomies, arthroplasties etc., done under local, regional or general anaesthesia with or without the use of a tourniquet and performed by a Senior Registrar or a Consultant. The patients who were excluded from the study include those with infected post-operative wounds and whose wounds were closed secondarily or healed by secondary intention, patients who were keloid formers, those with uncontrolled diabetes mellitus, and hypertension and patients with previous idiosyncratic and hypersensitivity reaction to microporous tape.

The patients were recruited from Plastic Surgery and Orthopaedic Surgery Outpatient Clinics when they were scheduled for open limb surgery and also when admitted into the ward for surgery. Open limb surgeries are surgeries performed on the extremities with relatively wider incision without endoscopic access or manipulation. Consecutive patients were recruited into the study. A detailed explanation was made to the patient in written form. Informed consent was taken and filling of proforma with information was done before surgery.

The Patient and Observer Scar Assessment Scale was the scar assessment scale used for the study. It is composed of two measurement tools; the Patient Scar Assessment Scale (PSAS) completed by the patient and the Observer Scar Assessment Scale (OSAS) completed by the researcher. PSAS consisted of six items including pain, itching, colour, stiffness, average thickness of scar edge, surface irregularities. OSAS investigates six scar features including: vascularity, pigmentation, average thickness of the edge, relief, pliability, surface area of the scar.

The total score for each scale ranged from 6 (best, i.e., similar to normal skin) to 60 (worst i.e., scar different from normal skin). Also, the researcher and the patient expressed their opinions on the overall appearance of the scar with a score from 0 (similar to normal skin) to 10 (worst i.e., scar different from normal skin)

Based on the calculated sample size, an equal number of ballot papers were pre-labelled with either scar taping {A} or no scar taping {B}. Each of the paper was sealed in a similarly opaque brown envelope. Each of the recruited patients picked the sealed envelope shortly before the surgery was carried out.

The sample size was calculated using the formula[9]:

$$N = \frac{Z_{1-\alpha/2}^2 \, p(1-p)}{d^2}$$

Where:

N = Minimum sample size

$Z_{1-\alpha/2}$ = Standard normal variant (at 5% type I error) = 1.96

p^* = Expected proportion in population based on pilot study = 21%

d = Absolute error or precision= 0.05

$$N = \frac{(1.96)^2 \, 0.21(1-0.21)}{0.05^2}$$

= 32 patients

Assuming a 10% attrition rate, the adjusted sample size was 35 patients for each group; making a total sample size of 70 patients.

Prior to this study, a mini pilot study was carried out at the outpatient clinic of another hospital among orthopaedic patients who have had open limb

surgeries; 10 out of the 48 patients studied had hypertrophic scars. Thus, the prevalence of hypertrophic scar in the mini pilot study was 21%.

The procedures considered were open elective limb surgeries which included benign tumour excisions, open reduction and internal fixation of fractures, corrective osteotomies, arthroplasties etc, done under local, regional or general anaesthesia with or without the use of a tourniquet and performed by a Senior Registrar or a Consultant.

The surgical incision was oriented mostly along the Langer's lines. The length of the incision was measured before wound closure. Wound closure was done without tension by the researcher and two other Senior Registrars (Orthopaedics and Plastic Surgery respectively). The subcutaneous tissue was closed with Ethicon (polyglactin 910) 2-0 sutures while the skin was closed with staples or Ethicon (polypropylene) 3-0 sutures (with an atraumatic needle) in simple interrupted fashion with the wound edges everted. All skin sutures or staples were removed two weeks after surgery. A protocol designed proforma was used to collect the personal data of the patients which included the biodata, the scar types, scar location, scar height and scar width.

Microporous tape was applied on scars of patients that were randomized into group A (scar taping group). After suture or staple removal, the microporous hypo-allergenic tape (2nm pore size transpore tape, 3M Health Care, St Paul, Minnesota) was applied directly over the new scar and worn by the patient twenty-four hours daily over a period of six months. It laid in the direction of the wound and overlapped each side by approximately 0.5–1cm. The surrounding skin was migrated towards the scar before applying the tape. The tape was changed every fortnight at the clinic by the research assistant. The patients bathed or showered normally on daily basis. The patients were given extra tape and the tape application was demonstrated to them and their caregiver at the clinic, in case the tape mistakenly peels off at the edge or completely at home.

The scars were assessed at intervals of six weeks, three months and six months after the surgery in both study groups. During the follow-up visits at 6 weeks, 3 months and 6 months, each section of the protocol designed proforma was completed. The scar height and the scar width were measured using a pair of calipers. Each patient was assessed by only one of the two observers. The tape was removed by the patient at home the morning before an assessment and the scar area was washed with mild soap during bathing to remove remnant tape adhesive. During every scar assessment session, the patient was positioned in a well-lit enclosure at room temperature so that the scar was easily accessible with gravity and dependence eliminated. This was uniformly applied to each patient.

The study was approved by Ethics and Research Committee. Informed consent was obtained from each participant after explaining the purpose of the study, risks and benefits to them and having read through and understood the subject information sheet. Confidentiality was maintained at every stage of the study. No extra cost was incurred by the patient for participating in the study aside from the usual cost of treatment. Refusal to participate in this study was respected with no attempt at coercion or inducement. The patients were also freely allowed to exit the study at will without any negative consequence on their treatment. The Declaration of Helsinki was strictly adhered to.

The data collected was entered into the Statistical Package for Social Sciences (SPSS version 22.0). The descriptive variables were expressed as mean ± standard deviation for normally distributed continuous variables, and as number (proportion) for categorical variables. The mean scar width was compared using the two-sided t-test whereas Chi-square test was used to compare categorical variables. The significance criterion was set at 0.05

RESULTS

The patients that completed the study were 63, 32 in Group A and 31 in Group B. Thirty-eight participants were male whereas 25 were female.

Table-1 shows the biodata of patients who took part in the study. The mean age was 42.10±15.49 years. 79.5% of the scars were located on the lower limb while the remaining were located on the upper limb. The distribution of the scars between the upper and lower limbs was similar with no significant difference statistically.

At six weeks, 97.6% of the taped scars were normal while only one (2.4%) was atrophic. Twenty (48.8%) of the non- taped scars were normal and twenty (48.8%) were hypertrophic. This was statistically significant with *p*-value of <0.0001. At three months, ten (24.4%) of the non-taped scars were normal, twenty-two (53.7%) were hypertrophic and seven (17.1%) were stretched scars; there was no change in the number of normal scars in the taped group. This was also statistically significant with *p* value of <0.0001. At six months, 100% of taped scars were normal while eight (19.5%) of the non-taped scars were normal. Twenty-two (53.6%) were hypertrophic while nine (22.0%) were stretched. This was also statistically significant with *p* value of <0.0001.

At six weeks, twenty-five (61.0%) of the scars in the non-taped group were above the skin level but ≤1mm while twenty-six (61.9%) scars in the

taped group were at the same level as the skin and both were statistically significant. At three months, twenty (48.8%) of the non-taped group had their scars greater than 1mm above the skin level while none of the taped group had their scar greater than 1mm above skin level. At six month, twenty-two (53.7%) of the non-taped group had their scars greater than 1mm above the skin level while none of the taped group had their scar greater than 1mm above skin level. This was also statistically significant with *p* value <0.0001.

The mean scar width at six weeks was 1.91±0.49mm (non-taped group) and 1.45±0.66 mm (taped group); it was statistically significant with p value of <0.0001. The mean scar width at three months was 2.67±1.26 mm (non-taped group) and 1.33±0.54 mm (taped group); this was also statistically significant with *p* value of <0.0001. The mean scar width at six months was 3.30±2.14mm (non-taped group) and 1.35±0.60 mm (taped group); it was also statistically significant with *p* value of <0.0001.

At six months, the highest number of scars in the group A 29(69.0%) had an overall POSAS observer score of 1 (closer to normal skin) while the highest number of scars in the group B 19(46.3%) had an overall POSAS observer score of 4 which is statistically significant with a *p* value of <0.0001. (Figure-2)

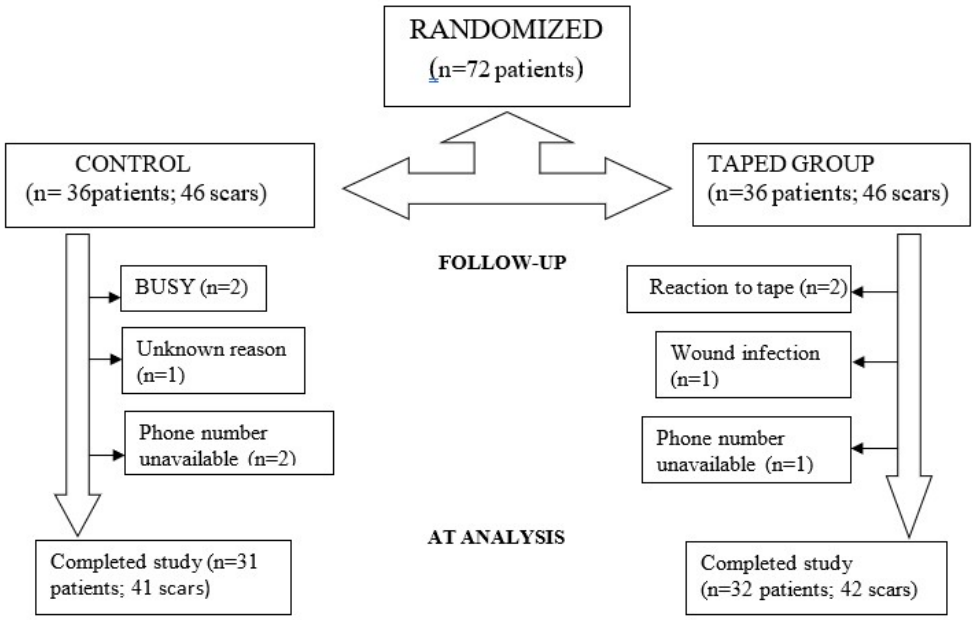

Figure-1: Flow chart showing patient distribution from randomization to final analysis

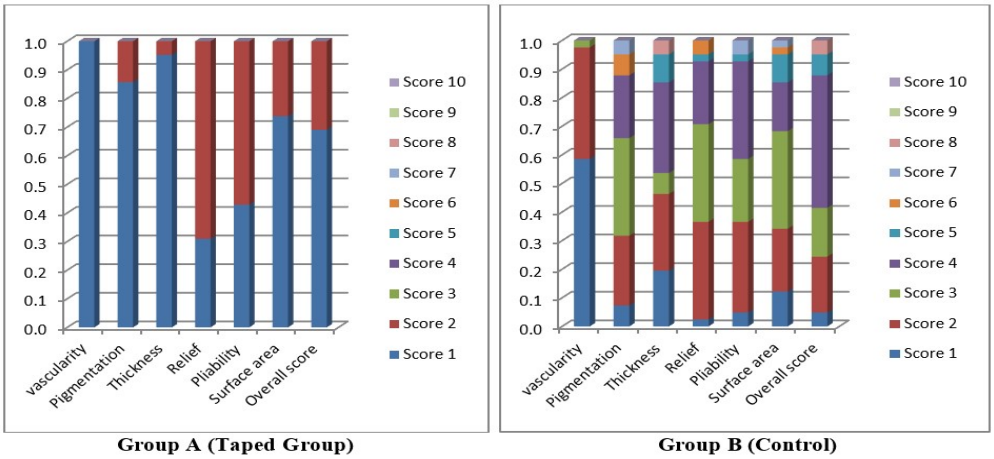

Figure-2: The OSAS score distribution at six months

Table-1: The biodata of patients who took part in the study

Variables	Groups			Statistics
	Group A	Group B	Total	
Age (years)			**(n=63)**	
<20	2 (6.5)	3 (9.4)	5 (7.9)	t=1.394
21-30	6 (19.4)	8 (25.0)	14 (22.2)	df=7
31-40	4 (12.8)	7 (21.9)	11 (17.5)	*p*-value=0.168
41-50	6 (19.4)	6 (18.8)	12 (19.0)	
51-60	6 (19.4)	2 (6.3)	8 (12.8)	
>60	7(22.5)	6(18.8)	13(20.6)	
Sex			**(n=63)**	χ2=2.714
Male	15 (48.4)	23 (71.9)	38 (60.3)	df=1
Female	16 (51.6)	9 (28.1)	25 (39.7)	*p*-value=0.074
Tribe			**(n=63)**	
Yoruba	29 (93.6)	32 (100.0)	61 (96.8)	χ2= 2.904
Igbo	1 (3.2)	0 (0.0)	1 (1.6)	df=2
Edo	1 (3.2)	0 (0.0)	1 (1.6)	*p*-value=0.234

*The values in parentheses are the percentages

Table-2: The patients' scar types

Variables	Groups			Statistics
	Group A	Group B	Total	
Type of scar at 6 weeks			**(n=83)**	
Normal scar	20 (48.8)	41 (97.6)	61 (73.5)	χ2=35.093
Hypertrophic scar	20 (48.8)	0 (0.0)	20 (24.1)	df=2
Atrophic scar	1 (2.4)	1 (2.4)	2 (2.4)	*p*-value< 0.0001
Type of scar at 3 months			**(n=83)**	
Normal scar	10 (24.4)	41 (97.6)	51 (61.4)	χ2=58.540
Hypertrophic scar	22 (53.7)	0 (0.0)	22 (26.6)	df=3
Atrophic scar	2 (4.8)	0 (0.0)	2 (2.4)	*p*-value <0.0001
Stretched scar	7 (17.1)	1 (2.4)	8 (9.6)	
Type of scar at 6 months			**(n=83)**	
Normal scar	8 (19.5)	42 (100)	50 (60.2)	χ2=71.083
Hypertrophic scar	22 (53.6)	0 (0.0)	22 (26.6)	df=3
Atrophic scar	2 (4.9)	0 (0.0)	2 (2.4)	pvalue < 0.0001
Stretched scar	9 (22.0)	0 (0.0)	9 (10.8)	

*The values in parentheses are the percentages

Table-3: The scar parameters of the patients (Scar height)

Variables	Groups			Statistics
	Group A	Group B	Total	
Scar height at six weeks			**(n=83)**	
At the skin level	11 (26.8)	26 (61.9)	37 (44.6)	χ2=14.320
Above skin level but less than 1.0mm	25 (61.0)	15 (35.7)	40 (48.2)	df=3
Greater than 1.0 mm above skin level	4 (9.8)	0 (0.0)	4 (4.8)	*p*-value=0.003
Below the skin level	1 (2.4)	1 (2.4)	2 (2.4)	
Scar height at three months			**(n=83)**	
At the skin level	14 (34.1)	39 (92.9)	53 (63.9)	χ2=43.266
Above skin level but less than 1.0mm	5 (12.2)	3 (7.1)	8 (9.6)	df=3
Greater than 1.0mm above skin level	20 (48.8)	0 (0.0)	20 (24.1)	*p*-value<0.0001
Below the skin level	2 (4.9)	0 (0.0)	2 (2.4)	
Scar height at six months			**(n=83)**	
At the skin level	14 (34.1)	39 (92.9)	53 (63.9)	χ2=45.533
Above skin level but ≤ 1.0mm	3 (7.3)	3 (7.1)	6 (7.2)	df=3
Greater than 1.0mm above skin level	22 (53.7)	0 (0.0)	22 (26.5)	*p*-value <0.0001
Below the skin level	2 (4.9)	0 (0.0)	2 (2.4)	
*The values in parentheses are the percentages				

Table-4: The scar parameters of the patients (scar width)

Variables	Groups			Statistics
	Group A	Group B	Total	
Scar width at 6 weeks (mm)			**(n=83)**	t=3.542
≤1.0	7 (17.1)	20 (47.6)	27 (32.5)	df=5
1.1-3.0	34 (82.9)	22 (52.4)	56 (67.5)	*p*-value <0.0001
Scar width at 3 months (mm)			**(n=83)**	
≤1.0	4 (9.8)	22 (52.4)	26 (31.4)	
1.1-3.0	27 (65.9)	20 (47.6)	47 (56.6)	t=6.260
3.1-5.0	8 (19.5)	0 (0.0)	8 (9.6)	df=3
5.1-7.0	2 (4.8)	0 (0.0)	2 (2.4)	*p*-value <0.0001
Scar width at 6 months (mm)			**(n=83)**	
≤1.0	5 (12.2)	24 (57.1)	29 (34.9)	
1.1-3.0	25 (61.0)	18 (42.9)	43 (51.9)	t=5.689
3.1-5.0	6 (14.6)	0 (0.0)	6 (7.2)	df=5
5.1-7.0	2 (4.9)	0 (0.0)	2 (2.4)	*p*-value <0.0001
7.1-9.0	2 (4.9)	0 (0.0)	2 (2.4)	
>9.0	1 (2.4)	0 (0.0)	1 (1.2)	
*The values in parentheses are the percentages				

DISCUSSION

This study has evaluated the efficacy of microporous taping in reducing the tendency to form abnormal post-surgical scar and improving scar parameters. The baseline characteristics of the patients showed a slight male predominance (60.3%) which is comparable to previous studies.[10,11] In contrast, a similar randomized control trial by Atkinson *et al*[3] in Australia was done only among women who had caesarean sections. Almost all the patients are of Yoruba ethnicity; a previous study has also documented abnormal scarring among this race.[12]

More than two-third of the scars in the participants were located in the lower limbs which are similar to the finding in the study by Li-Tsang *et al*[10] . Li-Tsang[10] also observed that most severe site of hypertrophic scar formation was at or near the knee region probably due to the frequent movement of scar tissue causing excessive collagen fibers deposition. This observation however could not be established in this study.

This study found that the use of microporous tapes on scars reduced the rate of abnormal scarring and it also improved scar parameters at 6weeks, 3months and 6 months in the patients. None of the patients in the test group developed hypertrophic scar at 3 months and 6 months of the study. The scar parameters which include scar height and width were improved in patients treated with microporous tape. Our study shows better results than those reported by Moshreff *et al* in their 2006 study in which zinc tape was applied on already formed scars.[13]

The average incidence rates of hypertrophic scarring have been found to vary from 40–70% following surgical incision, depending on the depth of the wound.[4] In our study, no case of hypertrophic scar was observed in the microporous taping group at 6 weeks, 3 months and 6 months respectively while 48.8%, 53.7% and 53.6% of hypertrophic scars were observed in the control group at 6weeks, 3months and 6 months respectively (Table 4). The prevalence of hypertrophic scarring among the control group was comparable to the range observed in the literature.[4]

It has been observed that scars that stretch do so at a constant rate, almost doubling their width between 3 weeks and 3 months and increasing by nearly 50% between 3 and 6 months but stretching very little thereafter.[14] In this study however, stretched scars were not present at 6 weeks in control group but there were seven in number at 3 months and nine at 6 months in the control group. In the microporous group, however, only a stretched scar was noticed at 3 months but none at other periods of scar assessment. This further emphasizes the effect of microporous taping in preventing stretched scars as previously described by Rosengren *et al*.[11]

In this study, at six weeks, median scar width was 0.5 mm less in taped participants (1.5 mm, IQR = 1.0, 2.0) than controls (2.0 mm, IQR = 2.0,2.0); at 3 months, median scar width was 1.5 mm less in taped participants (1.0 mm, IQR = 1.0, 2.0) than controls (2.5 mm, IQR = 2.0,3.0); at 6 months, median scar width was 2.0 mm less in taped participants (1.0 mm, IQR = 1.0, 2.0) than controls (3.0 mm, IQR = 2.0,4.5). In Rosengren study[11], however, at 3 months, the median scar width was 1 mm less in taped participants (3.0 mm, IQR = 2.0, 5.0) than controls (4.0 mm, IQR = 2.5,6.0) while at 6 months the median scar width was 1 mm less in taped participants than controls. In this work, there was no statistically significant difference in scar width between male and female during scar assessment; in contrast, Rosengren et al[11] was able to demonstrate a significant difference in the scar width for male and female participants. The mean of the overall observer score at six months was 1.31 in the microporous tape group and 3.56 in the control group respectively. The observer score in the microporous group is lower (closer to that of the normal skin) than that obtained by Consorti *et al*[15] among patients who had neck incision for thyroidectomy where the mean of the overall observer score was 2.06 and 2.71 in the test and control group respectively.

Assessment of scar vascularity and pigmentation in dark skin individuals has been a major limitation using the POSAS scar scale. As a result of this, two scar raters were employed who had practised the use of the instrument on a series of patients before the commencement of the study until they achieved a good level of agreement; the vascularity was also measured by blanching the scar for a prolonged period of 4 seconds (2 seconds more than the recommended duration). Further studies will be required to determine the efficacy of microporous tapes in other regions of the body apart from the limbs and to also know if there is any difference in taping the scar for more than six months. In addition, it will also be important to know if there is any difference in the scar modulating effect of different types of microporous tapes available.

CONCLUSION

Microporous tape application is effective in preventing hypertrophic and stretched scar formation following upper and lower limb open surgeries with a significant reduction in scar height and width. It is recommended that all post-surgical patients irrespective of their risk of developing hypertrophic scars or stretched scars should have their scars

supported with microporous tape for at least a period of six months.

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AUTHORS' CONTRIBUTION

IOS: Conceptualization, literature search, study design, data collection, data interpretation, write-up. OAO: Literature search, study design, proof reading. IOR: Study design, data analysis, proof reading. ODA: Study design, proof reading.

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