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ORIGINAL ARTICLE

# Multimodality Scar Management Program

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**Abstract**
*Background* This trial was undertaken to assess the efficacy of a multimodality management regime used for the prevention of hypertrophic scars. It follows previous research and experience (A.D. Widgerow et al, Aesthetic Plast Surg, 24(3):227–234, 2000) with a similar program but with the addition of active agents with specific effects against prolonged inflammation and enhanced hydrative capacity. The modalities specifically targeted are tension on the scar, hydration of the scar, collagen maturation, and controlled inflammation.
*Methods* Tape was impregnated with a combination of agents providing an occlusive dressing aimed at combatting exaggerated scarring. Patients who had undergone surgery were stratified into four groups: Group 1, 60 patients/60 scars following simple skin excisions, 30 treated scars, 30 untreated scars; Group 2, 20 patients/40 scars, each patient with two excisions, one treated, one untreated; Group 3, 10 patients/20 scars following bilateral breast surgery, one side treated with tape alone, one side treated with tape and gel; Group 4, 30 patients with varying cosmetic procedures/50 scars, all treated and compared with historical outcomes for hypertrophic scarring. Thus, 170 scars were assessed in 120 patients.
*Results* Results were assessed at 1, 2, and 6 months using a combination of accepted scar assessment techniques. By amalgamating the Vancouver, Manchester, and morphologic table systems together with Patient and Observer Scar Assessment analyses, a comprehensive assessment of scar outcomes was undertaken and comparisons were made with control groups.
*Conclusion* Treated groups showed improvement outcomes in all variations of assessment. Patient and observer assessments correlated well, and morphologic appearances of the scars following the final assessment at 6 months showed statistically significant positive scar outcomes in the treatment groups. The multimodality approach to scar control showed significant benefits in the patient groups tested in this series.

**Keywords** Scar · Multimodality program · Tape · Gel · Support · Hydration · Collagen maturation · Inflammation

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The prevention of exaggerated scarring is an ongoing quest with continually evolving theories and product development aimed at combatting this undesirable outcome of wound healing. Most new theories have resulted from a better understanding of the underlying physiologic sequence of events that accompany closure of an open wound. Not only do exaggerated scars have psychological sequelae related to their cosmetic disfigurement, but significant discomfort and morbidity may be associated with these scars.

Our previous research, based on meta-analysis of scar management publications over three decades, identified three main areas of relevance for scar control [1]:

(1) Scar support: Tension on a scar is known to stimulate increased collagen production with haphazard laying down of these fibrils. Much of the initial research in this area was work done by Meyer and McGrouther [2] who thought that multidirectional tension on the wound/scar overstimulated the fibroblast causing it to produce excess collagen [3]. Longitudinal (along the line of the scar) support of the scar is necessary to prevent the development of hypertrophic and irregular scarring. The use of microporous paper tape has consistently proven effective in preventing hypertrophic scars by controlling or eliminating the multitude of stretch forces on the scar [4–7].
(2) Hydration: Hydration reduces water loss and restores homeostasis to the scar thereby reducing capillary hyperemia, collagen deposition, and hypertrophic scar formation [8, 9].
(3) Accelerated scar maturation: This is the conversion of immature collagen to mature collagen and its uniform distribution along the scar site.

To address these areas of scar influence, we used microporous tape (support), active extracts of *Bulbine frutescens* (hydration), and active extracts of *Centella asiatica* (collagen conversion) [10]. In the 8 years since the previous publication, further insights and physiologic considerations have resulted in advancements to this management regime.

One of the most important physiologic responses to wounding is that of inflammation. It can also be one of the most destructive: overexuberant inflammation is thought to be cause of most chronic arthritic conditions, heart disease, and chronic wound pathogenesis [11, 12]. Along the physiologic path to scar formation, excess inflammation will result in an exaggerated scar. Suture materials are frequently and unavoidably associated with this phenomenon. Controlled inflammation speeds up the process of scar maturation with minimal fibrosis.

Phenols (oleuropein) extracted from olive oil have known anti-inflammatory and antibacterial properties [13–15]. When used at low doses, helpful inflammation is unaffected, whereas exuberant inflammation, typical of foreign body reactions, can be downregulated or modulated [13–15].

The most consistently successful hydrating agent used in scar management to date has been silicone, either in the form of sheeting or various topical applications which include dimethicone. Countless clinical trials and laboratory studies have confirmed that the hydrating, occlusive effect of silicone on scars results in superior, optimized healing of these scars [16, 17].

In addition to its hydrating properties, we are investigating the extracts (peptides) of *Bulbine frutescens* in relation to their decorin-like effects on wound healing. It appears that these polypeptides mimick the effect of decorin and rearrange collagen in a uniform manner during the process of fibrillogenesis and collagen regeneration [18]. Thus, a combination of agents has been used in a product formulation that takes account of scar support, hydration, inflammation, and collagen maturation and alignment. We agree with Mustoe's theory that the tape-cream combination acts as an occlusive dressing over the scar, providing the beneficial effect of hydration [17]. In addition, the extra constituents provide for a multimodality approach to scar management covering all phases of the wound healing cascade.

The next area that we have concentrated on over the past few years is that of result reporting and scar assessment following management. For this trial we have incorporated elements of the morphologic scale [19], the Vancouver scale [20], and the Patient and Observer Scar Assessment scales [21–23]. The combination of these scales of comparison, we believe, gives us a reliable assessment modality for analysis of product efficacy.

The final addition to the scar treatment plan has been the change in timing of the application of the product to the scar. Along with others [9, 24], we have believed for some time now that efforts at controlling scar outcome (including keloid scar formation) should be initiated at the time of wounding when the trigger for the sequence of healing begins. We believe that acting right at the time of provisional scar matrix formation, the effect on subsequent matrix dissolution, maturation, and scar formation is tackled more efficiently. Thus, we have treated patients with product immediately following wound closure at the time of surgery.

## Materials and Methods

Between March 2007 and March 2008, the multimodality [ScarScience®, Biovac (Pty) Ltd South Africa] scar management program was investigated on consenting patients. Ethics clearance was obtained from the University of the Witwatersrand and patients with postsurgical scars of varied types were selected.

Patients undergoing skin surgery were stratified into four groups:

Group 1–60 patients/60 scars following simple skin excisions, 30 treated scars, 30 untreated scars (10 face, 10 limbs, 10 back in each group)
Group 2–20 patients/40 scars, each patient with two excisions, one treated, one untreated (10 back, 5 face, 5 limbs)

Group 3–10 patients/20 scars following bilateral breast surgery, one side treated with tape alone, one side treated with tape and gel (5 breast augmentations, 5 breast reductions)
Group 4–30 patients with varying cosmetic procedures/50 scars all treated and compared with historical outcomes for hypertrophic scarring (10 breast augmentations, 10 breast reductions, 10 abdominoplasties)
Total scars evaluated $N = 170$; total patients $N = 120$

The study included 120 patients ranging in age from 18 to 82 years.

Following the procedure, patients within each group were randomized to receive either routine postoperative care with tape alone (bilateral cosmetic cases) or combined tape with topical gel or no treatment (routine for small skin excisions). Where one side was treated, the side selected for treatment was also randomized (at the end of surgery, the nursing staff drew lots to choose the right or left side for treatment). All scars were assessed and photographed at follow-up at 1, 2, and 6 months following surgery.

In contrast to previous management programs, scar management was initiated immediately following surgery. Thus, for small local excisions of skin tumors, the wounds were left without a dressing on the face and gel was applied directly to the site and continued twice daily by the patient. On the back and limbs the site was covered with microporous tape. Scar gel was applied immediately following surgery onto the surface of the tape, saturating it and producing an occlusive type of dressing. Patients were instructed to apply scar gel to the surface of the tape twice a day.

In patients who had undergone cosmetic surgical procedures, scar gel was applied liberally to the area prior to application of the dressing. The gel was not massaged in but was left on the surface to ensure a reasonable amount of gel on the scar surface while the dressing was left undisturbed for 7–10 days. In cases where the dressing was changed the following day (breast reduction procedures), scar gel was reapplied to the selected side (Fig. 1). Following the dressing change after 7–10 days, patients continued with the program for 3–6 months until the scar was considered mature (nonsymptomatic, white).

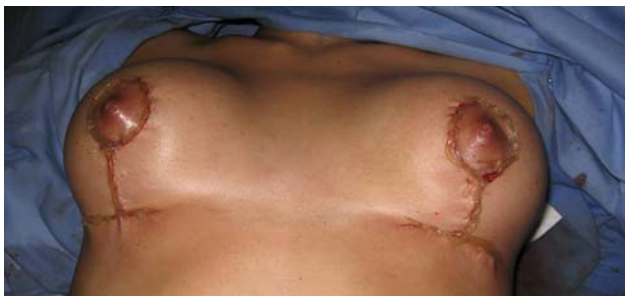

**Fig. 1** Application of scar gel at time of surgery

### Scar Assessment

In an effort to combine all recent recommendations for scar assessment, elements of different scales were incorporated into the assessment parameters. Thus, elements of the Vancouver Scar Scale [20] were incorporated into the scale of morphologic features [19]. Patient and observer assessment charts were also included in the assessments as previously recommended [12, 21, 23]. The patient record assessment document is summarized in Table 1.

### Data Analysis

The data were revised into a format compatible with the statistical program using SAS v9. Differences between treated and untreated patients were determined using the Kruskal–Wallis test with $p < 0.05$ considered significant. Data were summarized in tables and graphs.

## Results

### Scar Morphology

In the patients with simple skin excisions (Group 1; 30 treated vs. 30 untreated), although there were no significant differences apparent 1 month after the operation, the scars were significantly improved by 2 and 6 months in the treated versus the untreated group ($p < 0.0001$; Table 2). Over the 6 months the morphologic grading scores improved only in treated but not untreated patients.

In patients with two excisions where one was treated and the other not (Group 2; Table 3), the differences in scar morphology became significantly apparent at 6 months. As with Group 1, the treated but not the untreated scars showed significant improvement over the 6 months. Similar results were shown in the small group of breast augmentation and reduction patients (Group 3; Table 4) in which treated scars showed significant morphologic improvement after 2 months with borderline significance ($p = 0.06$) at 1 and 6 months compared to the untreated scars. These results were confirmed in 50 patients who underwent a variety of procedures (Group 4; Table 5) and showed improvement ($p < 0.0001$) in scar morphology over the 6 months of follow-up. Overall morphology improved in all the groups, with the small Group 3 showing borderline significance.

**Table 1** ScarScience Record Document

NAME _____

CONTACT DETAILS _____

DATE OF SURGERY _____

INVESTIGATOR _____

NATURE OF SURGERY _____

ScarScience TYPE OF PRODUCT AND LENGTH OF TIME USED

- TAPE AND CREAM _____
- CREAM ALONE _____

ASSESSMENT: (Grade)

ONE MONTH _____

TWO MONTHS _____

SIX MONTHS _____

Classification of scars according to morphologic features

| | |
|---|---|
| Grade 1 (normal) | Flat, soft, normal color, matching surrounding skin or slight mismatch, normal texture |
| Grade 2 (mildly hypertrophic) | Slightly elevated (height <2mm), moderately hard, light to dark pink color, just palpable, slight skin mismatch, supple |
| Grade 3 (hypertrophic) | Elevated (within wound margins, height 2-5mm),hard, dark pink to dark red color, obvious color mismatch, firm pliability |
| Grade 4 (keloid) | Very elevated (height >5mm), larger than wound margins, very hard, red to brown color, hard ropes, obvious mismatch |

PROBLEMS OR SIDE EFFECTS _____

Observer Scar Assessment Scale

| | normal skin 1 2 3 4 5 6 7 8 9 10 worst scar imaginable |
|---|---|
| Vascularization | ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ |
| Pigmentation | ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ Hypo ☐ Mix ☐ Hyper ☐ |
| Thickness | ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ |
| Relief | ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ |
| Pliability | ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ |

Total score Observer Scar Scale:

Patient Scar Assessment Scale

| | No, no complaints 1 2 3 4 5 6 7 8 9 10 Yes, worst imaginable |
|---|---|
| Is the scar painful ? | ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ |
| Is the scar itching? | ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ |

| | No, as normal skin 1 2 3 4 5 6 7 8 9 10 Yes, very different |
|---|---|
| Is the color of the scar different? | ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ |
| Is the scar more stiff ? | ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ |
| Is the thickness of the scar different? | ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ |
| Is the scar irregular? | ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ |

Total score Patient Scar Scale:

**Table 2** Changes and differences in morphologic and assessment scores of the treated versus the untreated patients in Group 1

| | Scar morphologic grading | | Difference |
|---|---|---|---|
| | Treated ($n = 30$) | Untreated ($n = 30$) | Treated vs. untreated ($p$) |
| 1 month | | | NS (0.39) |
| Grade 1 | 0 (0%) | 0 (0%) | |
| Grade 2 | 28 (93%) | 26 (87%) | |
| Grade 3 | 2 (7%) | 4 (13%) | |
| 2 months | | | <0.0001 |
| Grade 1 | 12 (40%) | 0 (0%) | |
| Grade 2 | 17 (57%) | 20 (66%) | |
| Grade 3 | 1 (3%) | 10 (33%) | |
| 6 months | | | <0.0001 |
| Grade 1 | 24 (80%) | 4 (13%) | |
| Grade 2 | 5 (17%) | 14 (47%) | |
| Grade 3 | 1 (3%) | 12 (40%) | |
| Change with time significance ($p$) | <0.0001 | NS (0.25) | |

*NS* not significant

**Table 3** Changes and differences in morphologic and assessment scores of the treated versus the untreated patients in Group 2

| | Scar morphologic grading | | Difference |
|---|---|---|---|
| | Treated ($n = 20$) | Untreated ($n = 20$) | Treated vs. untreated ($p$) |
| 1 month | | | NS (0.97) |
| Grade 1 | 1 (5%) | 0 (0%) | |
| Grade 2 | 16 (80%) | 18 (90%) | |
| Grade 3 | 3 (15%) | 2 (10%) | |
| 2 months | | | NS (0.16) |
| Grade 1 | 8 (40%) | 3 (15%) | |
| Grade 2 | 10 (50%) | 15 (75%) | |
| Grade 3 | 2 (10%) | 2 (10%) | |
| 6 months | | | 0.006 |
| Grade 1 | 16 (80%) | 8 (40%) | |
| Grade 2 | 4 (20%) | 8 (40%) | |
| Grade 3 | 0 (0%) | 4 (20%) | |
| Change with time significance ($p$) | <0.0001 | NS (0.21) | |

*NS* not significant

## Patient Assessment (POSA)

Patients assessed whether the scar was painful, itchy, stiff, thick, and regular, and the color of the scar (representative stiffness and thickness, Figs. 2, 3). In Group 1, treated patients' scar assessment ratings were significantly better

**Table 4** Changes and differences in morphologic and assessment scores of the treated versus the untreated the patients in Group 3

| | Scar morphologic grading | | Difference |
|---|---|---|---|
| | Treated ($n = 10$) | Untreated ($n = 10$) | Treated vs. untreated ($p$) |
| 1 month | | | NS (0.06) |
| Grade 1 | 2 (20%) | 0 (0%) | |
| Grade 2 | 7 (70%) | 6 (60%) | |
| Grade 3 | 1 (1%) | 4 (40%) | |
| 2 months | | | 0.032 |
| Grade 1 | 6 (60%) | 2 (20%) | |
| Grade 2 | 4 (40%) | 5 (50%) | |
| Grade 3 | 0 (0%) | 3 (30%) | |
| 6 months | | | NS (0.06) |
| Grade 1 | 8 (80%) | 4 (40%) | |
| Grade 2 | 2 (20%) | 4 (40%) | |
| Grade 3 | 0 (0%) | 4 (20%) | |
| Change with time significance ($p$) | 0.020 | NS (0.19) | |

*NS* not significant

**Table 5** Changes and differences in morphologic and assessment scores of the treated versus the untreated patients in Group 4

| | Scar morphologic grading | | Difference |
|---|---|---|---|
| | Treated ($n = 50$) | Untreated ($n = 0$) | Treated vs. untreated ($p$) |
| 1 month | | | |
| Grade 1 | 0 (0%) | – | – |
| Grade 2 | 44 (88%) | | |
| Grade 3 | 6 (11%) | | |
| 2 months | | | |
| Grade 1 | 14 (28%) | – | – |
| Grade 2 | 32 (64%) | | |
| Grade 3 | 4 (8%) | | |
| 6 months | | | |
| Grade 1 | 39 (78%) | – | – |
| Grade 2 | 11 (22%) | | |
| Grade 3 | 0 (0%) | | |
| Change with time significance ($p$) | <0.0001 | | |

for all the parameters, except the regularity of the scar ($p = 0.12$), compared to the untreated patients. In Group 2, scar thickness (Fig. 3) and regularity were rated as being significantly better than untreated scars, with scar stiffness (Fig. 2) reaching borderline significance ($p = 0.06$). In the small Group 3, only treated scars showed significant improvement in itchiness, with scar stiffness, thickness, and regularity approaching significance. In Group 4, in which all patients were treated, the rating pattern was similar to Group 1.

## Observer Assessment (OSA) (Figs. 4, 5)

Observers rated scar vascularization, pigmentation, thickness, relief, and pliability of the scar. In Group 1, all these parameters were significantly improved ($p < 0.005$) in treated patients compared with the parameters of untreated patients. In Group 2, except for the vascularization rating, all other parameters were significantly improved. Vascularization and pigmentation were improved in treated scars in Group 3, with scar thickness, relief, and pliability reaching borderline significance. In Group 4, the observer rating of the scars was similar to that of Group 1.

## Scar Pigmentation

In Group 1 observers noted scar hypopigmentation, hyperpigmentation, and mixed (hypo/hyperpigmentation) scars in 16/18 (89%), 1/18, and 1/18 treated patients, respectively. This compared favorably ($p = 0.04$) with the untreated patients in whom 14/23 (61%), 4/23, and 5/23 had hypo-, hyper-, and mixed pigmentation (hypo/hyperpigmentation) scars, respectively. The percentages of patients with scar hyperpigmentation were similar in the treated patients in Group 4 (12/16, 2/16, and 2/16, respectively). Scar hypo/hyperpigmentation was similar in treated and untreated scars of Groups 2 and 3. We believe hypopigmentation is unreliable and variable as a parameter because most scars have a degree of hypopigmentation. Thus, in the important areas of scar assessment, the program showed statistically significant improvement in all parameters. Morphologic features together with stiffness, thickness, and irregularity in POSA and thickness and relief in OSA are probably the most important parameters for analyzing scar hypertrophy.

An interesting added observation was made in patients who had undergone previous surgery: the first scars were compared with those produced by the new surgical procedure where the scar program was used. Two examples are seen in Fig. 6 which shows cases in which previous inframammary scars were excised in patients who had undergone reduction surgery elsewhere. The new inframammary scars demonstrate superior scar outcomes to those of the previous midline and periareolar scars.

Morphologic assessment of scars at 2 months (not 1 month) were usually (although not always) reasonable predictors of long-term scar outcome (Fig. 7). Predictors of poor outcome of long-term results appeared to be that of early signs of scar thickening or hypertrophy (Grade 3 morphologic scale).

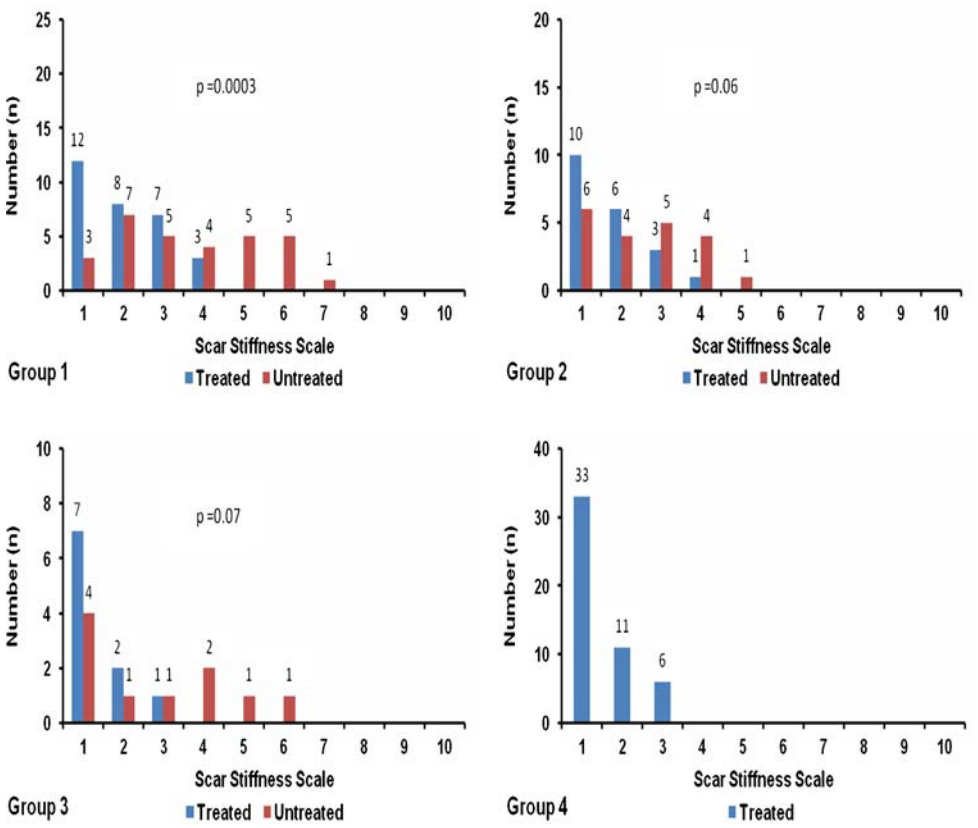


**Fig. 2** Scar stiffness—(POSA) graphical representation

The most difficult exercise in this trial was assessment of Group 3. Some patients were unhappy about continuing the trial when the advantage of the treated group was evident (Fig. 8). This group therefore had the smallest numbers.

Hypertrophic scarring (Fig. 9) has been reported as occurring in up to 64% of surgical incisions [20, 25]. In this series, hypertrophic scars did not occur to that extent; 18/60 (30%) of untreated patient scars were assessed as hypertrophic. This may relate to the fact that plastic surgery principles were used in all cases for closure of their wounds. It is noteworthy, however, that no patient in this series on the scar management program demonstrated hypertrophic scarring. Our Group 4 patients—cosmetic surgery cases—all treated on the program, showed no hypertrophic scars at 6 months (Table 5; Figs. 2, 4).

## Discussion

Scar control or the prevention of exaggerated scarring is an ongoing challenge. It is our contention that as with many complex physiologic processes, the approach to control needs to be multipronged. It has been repeatedly demonstrated that targeting just one parameter in the wound-healing sequence does little to influence the end result. Our multimodality approach of support, hydration, and collagen modulation has proven successful in the past [1]. At this stage we have introduced modifications and new additions that we believe bring us closer to the ideal of scar control.

Microporous tape, *Centella asiatica* extract, and the hydrative effects of extract of *Bulbine frutescens* have been previously elucidated [1, 10]. The details of the newly researched additions to the mix and changes in the program follow.

### Inflammation

It is well accepted that ongoing inflammation retards wound healing. This is especially important in chronic nonhealing wounds where proteases and reactive oxygen metabolites are responsible for much on the ongoing damage, antiproliferative effects, and nonhealing seen in these wounds [26]. The negative effects of exuberant inflammation are not limited to chronic wounds: in acute wounds low-grade ongoing inflammation results in increased cytokine elaboration (especially TGF$\beta$1 and 2) and a profibrotic state with a resultant exaggerated scar [25]. This inflammation can be initiated by tension on the scar, foreign material (long-standing subcuticular sutures), bacteria, biofilm, and many other scenarios common to a

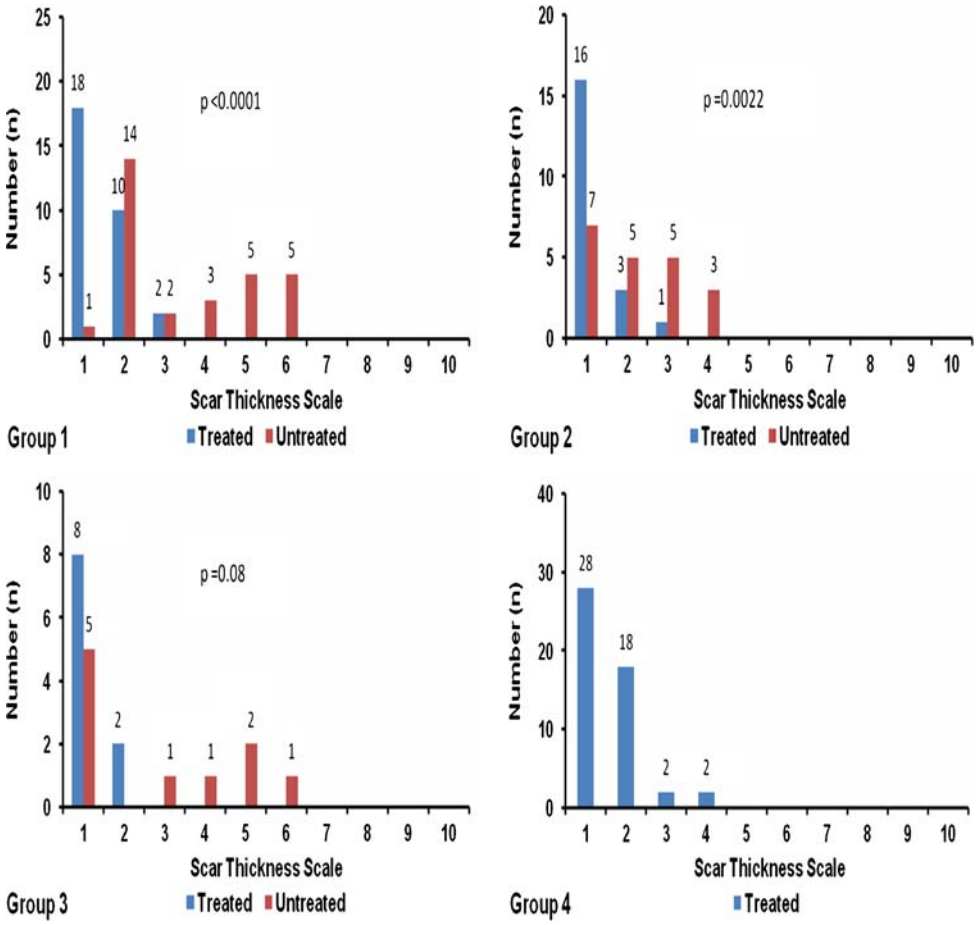


**Fig. 3** Scar thickness—(POSA) graphical representation

newly sutured wound. Thus, control of inflammation during the healing phase is a desired goal.

Newly pressed extra-virgin olive oil contains phenolic compounds (oleocanthal, oleuropein) that act as a natural anti-inflammatory compound that has a potency and profile strikingly similar to that of ibuprofen. Although structurally dissimilar, both these molecules inhibit the same cyclooxygenase enzymes in the prostaglandin-biosynthesis pathway [13, 15]. This anti-inflammatory effect makes it a natural choice for use in scar control.

## Collagen

*Bulbine frutescens* is a common garden plant that grows in South Africa. It has been identified as an extremely effective hydrating agent [1, 27]. Recently, attention has been drawn to the glycopeptide constituents of this plant. It appears that these peptides have decorin-like effects on collagen, arranging the collagen fibrils uniformly during the process of fibrillogenesis [22]. This could prove extremely important as an adjuvant to the *Centella asiatica* extract in modulating, uniformly arranging, and maturing collagen during the process of healing.

## Hydration

The most consistent reports on beneficial scar-modulating agents have been related to silicone in all its forms [3, 16, 19, 28]. Dimethicone has been added to the mix as an extremely efficient hydrating agent complementing the action of *Bulbine frutescens*. An additional consideration in this new formulation was to manufacture a product with a short-term "sticky" consistency that works synergistically with the tape. This has been successfully achieved; the tape saturated with the gel adheres to the wound more effectively than previous formulations. In Group 3 (comparing gel and tape with tape alone), patients repeatedly observed that the tape and gel combination had far superior adhesive qualities and needed to be changed much less frequently. A comprehensive efficient occlusive dressing is thus achieved. In situations where tape was not used, this stickiness did not last long and no patient complained of any problem or unpleasantness with its application. Thus, support, hydration, collagen maturation, and balanced inflammation are areas targeted in this multimodality regime. We believe that the tape–cream combination represents an interactive occlusive dressing that positively effects scar outcome.

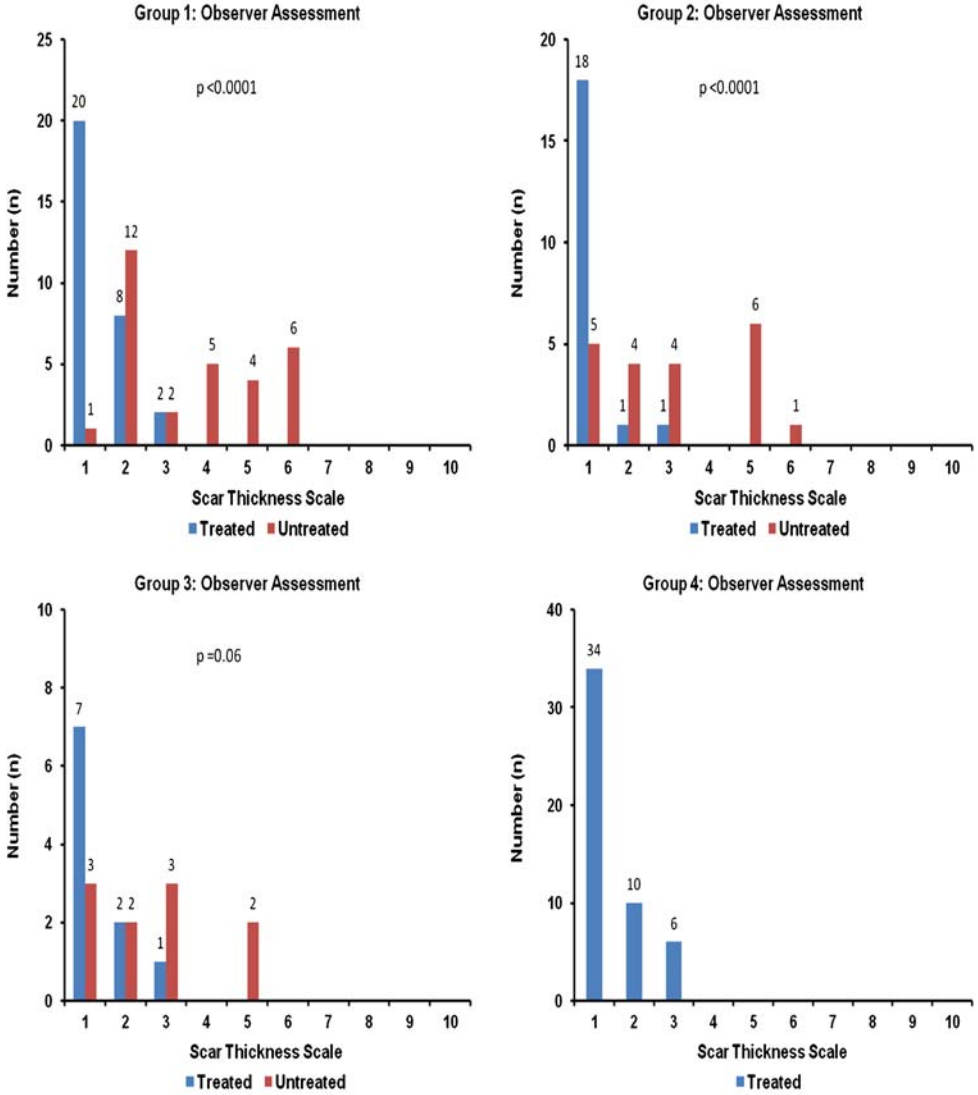


**Fig. 4** Scar stiffness—(OSA) graphical representation

Timing

Early scar control starting at the time of wounding is new in the improvement of scar outcome [9, 24]. We believe that this practice impacts positively on the appearance of the scar (Fig. 10). This was particularly evident in Group 3 where those treated immediately with tape and gel had better outcomes in all parameters measured (Fig. 8). Thus, our current recommended practice is application of scar gel at the time of initial dressing at the end of the surgical procedure or the following day after surgery and as an immediate and continued application to the wound for small local excisions of skin lesions. We believe the outcome of this multimodality treatment and the timing of such treatment has resulted in the best scar results we have seen to date.

Although results of this study and the overall clinical impressions are very favorable, there are limitations to the study. It was not possible to blind the evaluators of the scars, except in Group 1. This was the only group in which it was not obvious to the observer what type of treatment modality was used. Even in Group 1, treated patients often had residue from the taping (adhesive marks, outline of tape). However, we still believe that the results of treatment were apparent enough to not let the nonblinding assessment influence the analysis.

It was not possible to single out which particular mode of treatment had the most effect on scar outcome. Support by microporous tape may not always be critical to the process because the wound is supported in many cases by subcuticular sutures; this is not the case in smaller excisions of skin lesions, but tension on the skin would be

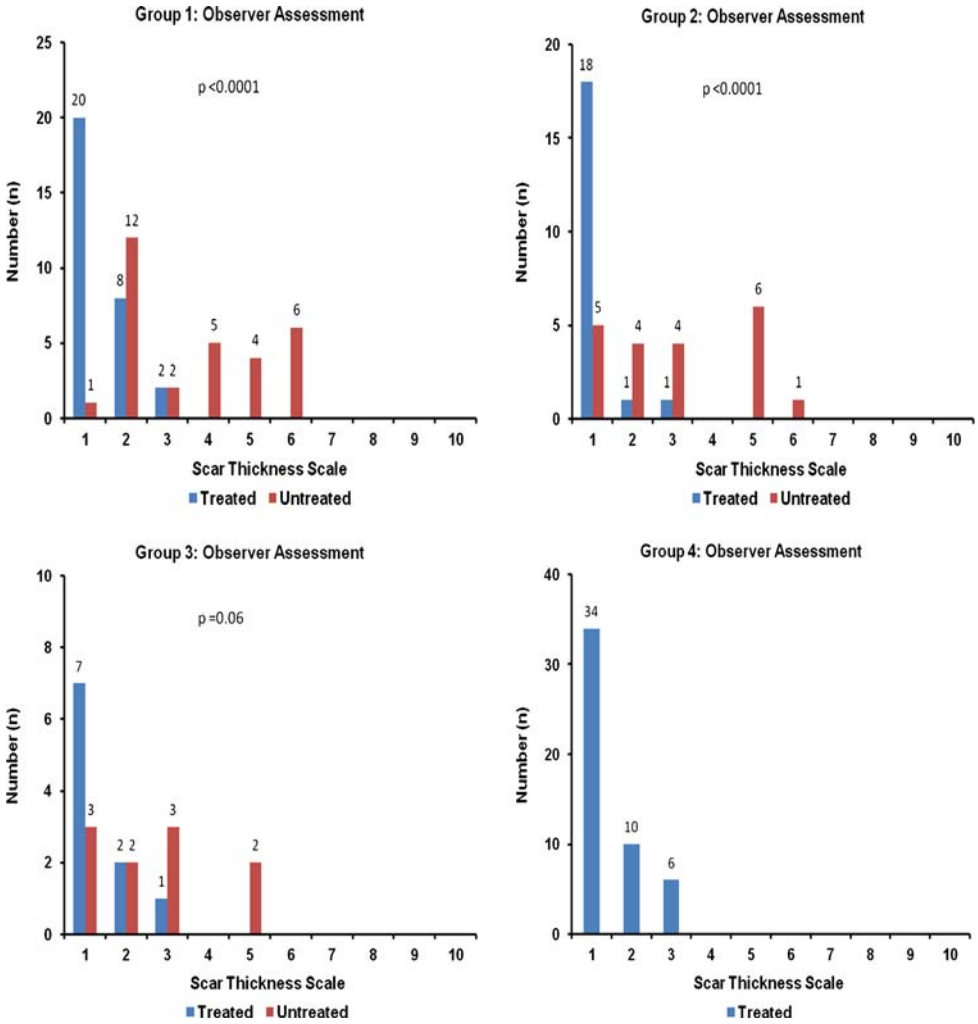


**Fig. 5** Scar thickness—(OSA) graphical representation

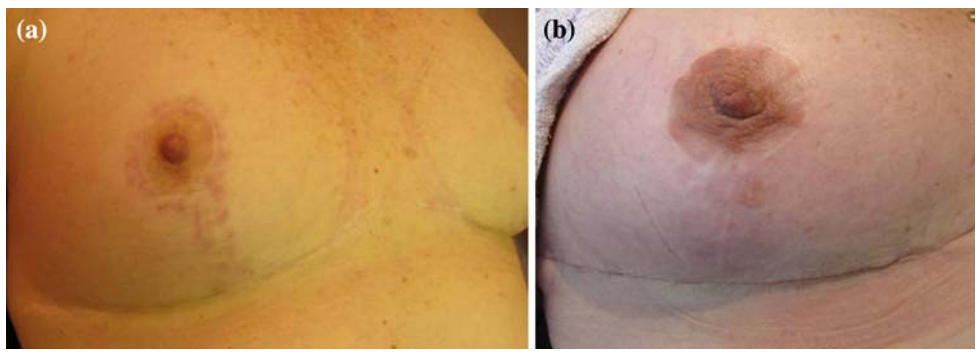


**Fig. 6** **a**, **b** New inframammary incisions in patients who had undergone previous surgery. Contrast previous existing scars (periareolar and midline vertical) with new inframammary scars managed with scar program

expected to be much less in these cases. Thus, microporous tape use was halted following 6 weeks of use. Hydration, controlled inflammation, and collagen maturation are all expected to be advantageous.

We are not too concerned about identifying one particular dominant modality because we believe the secret of success lies in the very nature of multimodality synergy. The agents all acting in unison, converting the microporous tape to an occlusive interactive dressing, is likely the mechanism of action of this treatment. However, we do believe that the choice of agents, with their individual different effects, is more beneficial than a simple hydrating agent. Reactivity and redness of wounds were markedly decreased in the treated cases; this was likely the positive effect of diminished inflammation, with its ultimate beneficial effect on scar outcome. All the components chosen

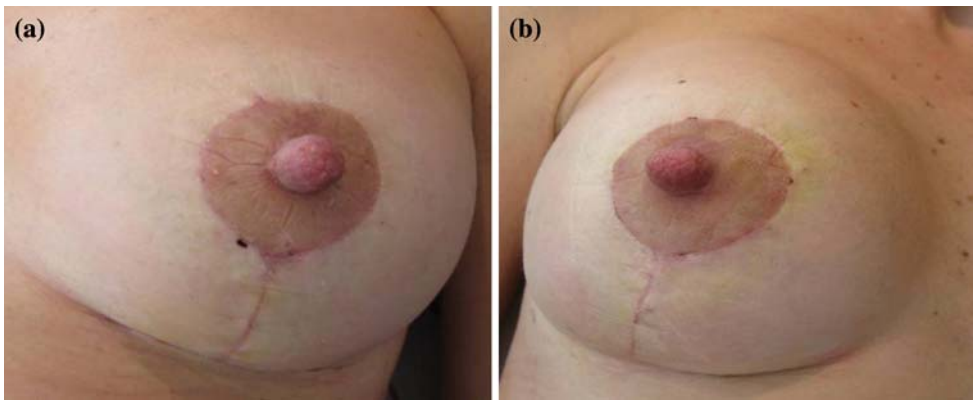


**Fig. 7** **a** Results at 2 months. **b** Predictable good results at 6 months

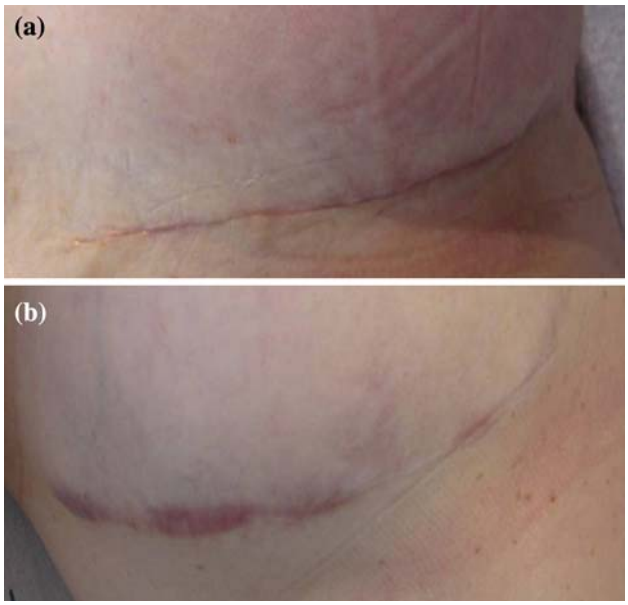


**Fig. 8** Comparison of left treated (**a**) and right untreated (**b**) inframammary scars

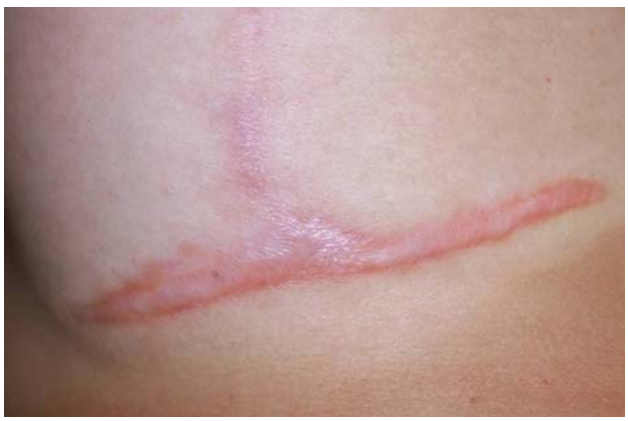

**Fig. 9** Hypertrophic scarring in inframammary region of untreated scar

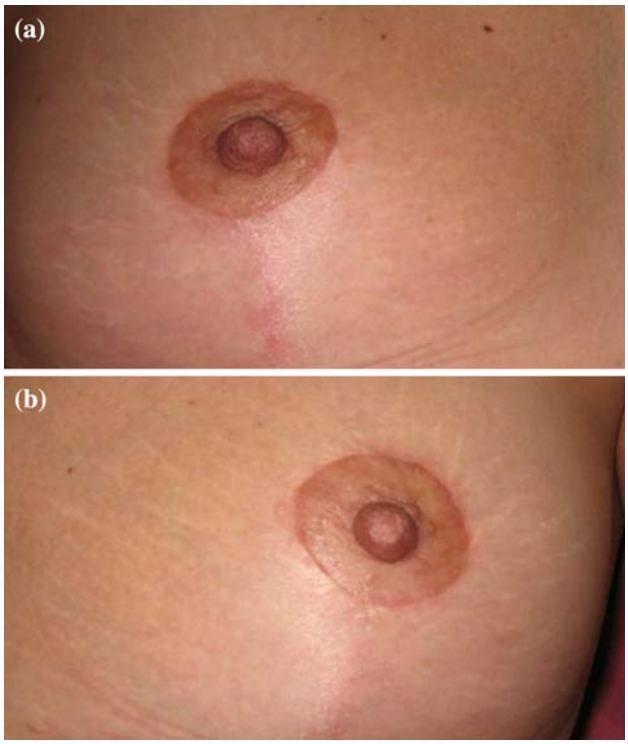


**Fig. 10** **a**, **b** Typical good results assessed at 6 months

for the mix were selected because of their particular desired effects on scar maturation based on publications and trials over the past three decades.

As far as scar assessment is concerned, morphologic assessment with added information proved reliable. POSA and OSA scales were very useful as supplementary observations by patients and independent observers. Different parameters within the POSA and OSA scales had varying significance. Pigmentation as a measurement needs to be accurately defined because most scars heal with some hypopigmentation that cannot be considered preventable. Therefore, criteria for abnormal pigmentation should be reserved for those with significantly abnormal pigmentation. In this series "pain" and "itchiness" also had limited usefulness and did not necessarily indicate hypertrophy.

## Conclusion

Scar assessment using combined scales of measurement that have been successfully used previously appears to be a reliable measure of scar outcome. Timing of scar management from the time of wounding appears to be beneficial. The multimodality approach to scar control showed statistically significant benefits in the patient groups tested in this series.

## References


1. Widgerow AD, Chait LA, Stals R, Stals PJ (2000) New innovations in scar management. Aesthetic Plast Surg 24(3):227–234
2. Meyer M, McGrouther DA (1991) A study relating wound tension to scar morphology in the presternal scar using Langers technique. Br J Plast Surg 44(4):291–294
3. Murison M, James W (2006) Preliminary evaluation of the efficacy of Dermatix silicone gel in the reduction of scar elevation and pigmentation. J Plast Reconstr Aesthet Surg 59(4):437–439
4. Atkinson JM, McKenna KT, Barnett AG, McGrath DJ, Rudd M (2005) A randomized, controlled trial to determine the efficacy of paper tape in preventing hypertrophic scar formation in surgical incisions that traverse Langer's skin tension lines. Plast Reconstr Surg 116(6):1648–1656
5. Petroni A, Blasevich M, Salami M, Papini N, Montedoro GF, Galli C (1995) Inhibition of platelet aggregation and eicosanoid production by phenolic components of olive oil. Thrombosis Res 78(2):151–160
6. Sawada Y, Sone K (1992) Hydration and occlusion treatment for hypertrophic scars and keloids. Br J Plast Surg 45(8):599–603
7. Soderberg J (1982) Treatment of keloids and hypertrophic scars with adhesive zinc tape. Scand J Plast Surg 16:261
8. Chang CC, Kuo YF, Chiu HC, Lee JL, Wong TW, Jee SH (1995) Hydration, not silicone, modulates the effects of keratinocytes on fibroblasts. J Surg Res 59(6):705–711
9. Shah M, Foreman DM, Ferguson MW (1994) Neutralising antibody to TGF-beta 1, 2 reduces cutaneous scarring in adult rodents. J Cell Sci 107(5):1137–1157
10. Atiyeh BS (2007) Nonsurgical management of hypertrophic scars: evidence-based therapies, standard practices, and emerging methods. Aesthetic Plast Surg 31(5):468–492
11. Hertog MG, Feskens EJ, Hollman PC, Katan MB, Kromhout D (1993) Dietary antioxidant flavonoids and risk of coronary heart disease: the Zupthen Elderly Study. Lancet 342(8878):1007–1011
12. Powers PS, Sarkar S, Goldgof DB, Cruse CW, Tsap LV (1999) Scar assessment: current problems and future solutions. J Burn Care Rehabil 20(1 Pt 1):54–60
13. Beauchamp GK, Keast RS, Morel D, Lin J, Pika J, Han Q, Lee CH, Smith AB, Breslin PA (2005) Phytochemistry: ibuprofen-like activity in extra-virgin olive oil. Nature 437(7055):45–46
14. de la Puerta R, Martinez-Dominguez E, Ruiz-Gutiérrez V (2000) Effect of minor components of virgin olive oil on topical anti-inflammatory assays. Z Naturforsch [C] 55(9–10):814–819
15. Tranter HS, Tassou SC, Nychas GJ (1993) The effect of the olive phenolic compound, oleuropein, on growth and enterotoxin B production by *Staphylococcus aureus*. J Appl Bacteriol 74(3):253–259
16. Mustoe TA (2008) Evolution of silicone therapy and mechanism of action in scar management. Aesthetic Plast Surg 32(1):82–92
17. Niessen FB (1997) Effectiveness of silicone sheets in the prevention of hypertrophic breast scars. Ann Plast Surg 38(5):547 (letter)
18. Reiffel R (1995) Prevention of hypertrophic scars by long term use of paper tape application. Plast Reconstr Surg 96(7):171–175
19. Signorini M, Clementoni MT (2007) Clinical evaluation of a new self-drying silicone gel in the treatment of scars: a preliminary report. Aesthetic Plast Surg 31(2):183–187
20. Baryza MJ, Baryza GA (1995) The Vancouver Scar Scale: an administration tool and its interrater reliability. J Burn Care Rehabil 16(5):535–538
21. Draaijers LJ, Tempelman FR, Botman YA, Tuinebreijer WE, Middelkoop E, Kreis RW, van Zuijlen PP (2004) The patient and observer scar assessment scale: a reliable and feasible tool for scar evaluation. Plast Reconstr Surg 113(7):1960–1965
22. Puig A, Anton GM, Mangues M (2007) A new decorin-like tetrapeptide for optimal organization of collagen fibres. IFSCC Mag 10(4):309
23. Truong PT, Lee JC, Soer B, Gaul CA, Olivotto IA (2007) Reliability and validity testing of the Patient and Observer Scar Assessment Scale in evaluating linear scars after breast cancer surgery. Plast Reconstr Surg 119(2):487–494
24. Ono I, Akasaka Y, Kikuchi R, Sakemoto A, Kamiya T, Yamashita T, Jimbow K (2007) Basic fibroblast growth factor reduces scar formation in acute incisional wounds. Wound Repair Regen 15(5):617–623
25. Wilgus TA, Vodovotz Y, Vittadini E, Clubbs E, Oberyszyn T (2003) Reduction of scar formation in full-thickness wounds with topical celecoxib treatment. Wound Repair Regen 11(1):25–34
26. Chen WY, Rogers AA (2007) Recent insights into the causes of chronic leg ulceration in venous diseases and implications on other types of chronic wounds. Wound Repair Regen 15(4):434–449
27. van Wyk BE, Van Oudtshoorn B, Gericke N (1997) Medicinal plants of South Africa. Briza Publications, Arcadia, South Africa, p 64
28. Mustoe TA, Cooter RD, Gold MH, Hobbs FD, Ramelet AA, Shakespeare PG, Stella M, Téot L, Wood FM, Ziegler UE (2002) International Advisory Panel on Scar Management. International clinical recommendations on scar management. Plast Reconstr Surg 110(2):560–571 (review)