

# Journal of Burn Care & Research



Official Publication of the American Burn Association

## ORIGINAL ARTICLES

### Genetic Risk Factors for Hypertrophic Scar Development

*C.M. Thompson, A.M. Hocking, S. Honari, et al.*

### Quantity and Quality of Nocturnal Sleep Affect Morning Glucose Measurement in Acutely Burned Children

*T. Mayes, M.M. Gottschlich, J. Khoury, et al.*

### Examining Triage Patterns of Inhalation Injury and TENS-SJS

*J.S. Davis, R.K. Pandya, L.R. Pizano, et al.*

### Admission Temperature and Survival in Patients Admitted to Burn Centers

*D. Hostler, M.D. Weaver, J.A. Ziembicki, et al.*

### Differences in Resuscitation in Morbidly Obese Burn Patients May Contribute to High Mortality

*L. Rae, T.N. Pham, G. Carrougher, et al.*

### Early Aggressive Acceleration of Enteral Nutrition Increases Ileus Without Perceptible Benefit in Severely Burn Patients

*J. Kelsey, S. Dissanaika*

### A Pilot Study Examining Moral Distress in Nurses Working in One United States Burn Center

*J.M. Leggett, K. Wasson, J.M. Sinacore, et al.*

### Exercise Behaviors After Burn Injury

*J. Baldwin, F. Li*

### Fluid Therapy LiDCO Controlled Trial—Optimization of Volume Resuscitation of Extensively Burned Patients through Noninvasive Continuous Real-Time Hemodynamic Monitoring LiDCO

*M. Tokarik, F. Sjöberg, M. Balik, et al.*

### Editorial: Cardiac Output Monitors: Old and New

*D. Dries*

### Donor Site Healing Dynamics: Molecular, Histological, and Noninvasive Imaging Assessment in a Porcine Model

*N.A. Mauskar, S. Sood, T.E. Travis, et al.*

### Repeated Use of Immersive Virtual Reality Therapy to Control Pain During Wound Dressing Changes in Pediatric and Adult Burn Patients

*A.W. Faber, D.R. Patterson, M. Bremer*

### Nonsurgical Scar Management of the Face: Does Early vs Late Intervention Affect Outcome?

*I. Parry, S. Sen, T. Palmieri, et al.*

### A Ten-Year Experience With Pediatric Face Grafts

*D.G. Greenhalgh, K. Hinchcliff, S. Sen, et al.*

### Evaluation of the Effect of Thymoquinone Treatment on Wound Healing in a Rat Burn Model

*C.T. Selçuk, M. Durgun, R. Tekin, et al.*

### Sexuality Following Burn Injuries: A Preliminary Study

*K.M. Connell, R. Coates, F.M. Wood*

### A Comparison of Three Different Physiotherapy Modalities Used in the Physiotherapy of Burns

*Z. Sari, M.G. Polat, B. Özgül, et al.*

### Increased Expression of Atrogenes and TWEAK Family Members after Severe Burn Injury in Nonburned Human Skeletal Muscle

*E.K. Merritt, A. Thalacker-Mercer, J. M. Cross, et al.*

### Review of Epinephrine Solution Use in 400 Consecutive Cases of Burn Reconstruction: Are Infusion Pumps Safe?

*P. Maguiña, M. Velez*

## LETTERS TO THE EDITOR

### The Use of Biobrane to Dress Split Thickness Skin Graft Adjacent to Skin Graft Donor Sites or Partial Thickness Burns

*A. Farroha, Q. Frew, N. El-Muttardi, et al.*

### Unexpected Thermal Injury Caused by Noncontact Heat Exposure in a Diabetic Patient

*M. Mutluoglu, G. Uzun, H. Ay, et al.*





---

# Nonsurgical Scar Management of the Face: Does Early Versus Late Intervention Affect Outcome?

---

Ingrid Parry, MS, PT, Soman Sen, MD, FACS, Tina Palmieri, MD, FACS,  
David Greenhalgh MD, FACS

Special emphasis is placed on the clinical management of facial scarring because of the profound physical and psychological impact of facial burns. Noninvasive methods of facial scar management include pressure therapy, silicone, massage, and facial exercises. Early implementation of these scar management techniques after a burn injury is typically accepted as standard burn rehabilitation practice, however, little data exist to support this practice. This study evaluated the timing of common noninvasive scar management interventions after facial skin grafting in children and the impact on outcome, as measured by scar assessment and need for facial reconstructive surgery. A retrospective review of 138 patients who underwent excision and grafting of the face and subsequent noninvasive scar management during a 10-year time frame was conducted. Regression analyses were used to show that earlier application of silicone was significantly related to lower Modified Vancouver Scar Scale scores, specifically in the subscales of vascularity and pigmentation. Early use of pressure therapy and implementation of facial exercises were also related to lower Modified Vancouver Scar Scale vascularity scores. No relationship was found between timing of the interventions and facial reconstructive outcome. Early use of silicone, pressure therapy, and exercise may improve scar outcome and accelerate time to scar maturity. (*J Burn Care Res* 2013;34:569–575)

Burns to the face and subsequent scarring can lead to one of the most challenging physical and psychological recoveries for the burn survivor. Studies of adults and children who have survived facial burns show difficult psychological adjustment including increased depression and decreased role fulfillment.<sup>1–4</sup> Managing facial scarring is also one of the greatest challenges for the burn-care provider. With increasing emphasis in burn research and clinical care on the functional impact of burn injury, facial deformity and its impact on social interactions, role fulfillment, and psychological adjustment must be considered. For this reason, special emphasis is placed on the clinical management of facial scarring.

Several studies describe surgical techniques for managing facial burns while maximizing esthetic outcome,<sup>5–8</sup> whereas other studies investigate

nonsurgical, less-invasive management of hypertrophic scarring to the face.<sup>9–13</sup> Common methods of nonsurgical management of facial scars include pressure therapy,<sup>14</sup> silicone application in combination with pressure or alone,<sup>15</sup> massage,<sup>16</sup> splinting,<sup>10</sup> and facial exercises/range of motion (ROM)<sup>11</sup> (Figure 1).

Whether scars are located on the face or other body areas, early management is a fundamental practice at most burn centers. The recommendation of early compression to scars for improved results was first reported by Panas<sup>17</sup> in 1863 and the philosophy has persisted in clinical practice to date. A study by Leung and Ng<sup>18</sup> specifically evaluating the timing of pressure therapy on scars after burn injury found that delayed treatment (scars treated > 6 months after burn injury) resulted in poorer outcome than those treated with earlier application of pressure. Applied early in the healing process, silicone gel sheeting has also been reported to be effective in the prevention of hypertrophic scarring.<sup>19</sup> Implementation of noninvasive scar management interventions as early as possible in the maturation phase of scarring is typically accepted as standard burn rehabilitation practice.

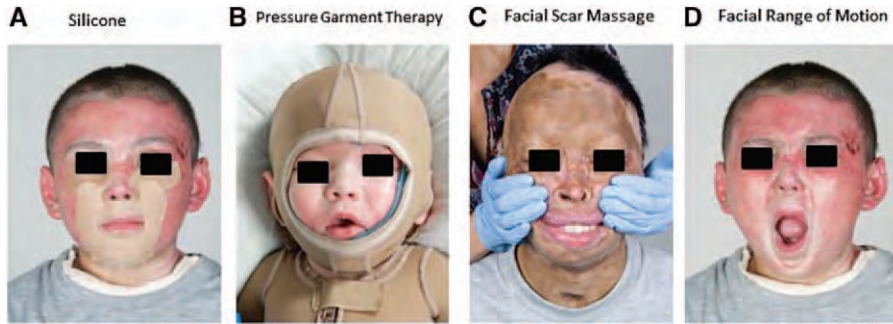
The purpose of this study was to retrospectively evaluate the timing of common scar management

*From Shriners Hospital for Children—Northern California, Sacramento.*

*Address correspondence to Parry I, Shriners Hospital for Children—Northern California, 2425 Stockton Boulevard, Sacramento, California.*

*Copyright © 2013 by the American Burn Association. 1559-047X/2013*

*DOI: 10.1097/BCR.0b013e318278906d*



**Figure 1.** Common nonsurgical scar management interventions. A. Silicone. B Pressure therapy. C. Massage. D. Facial exercise (splinting not shown).

interventions after facial grafting in children and its impact on outcome. Our hypothesis was that children who received earlier noninvasive scar management intervention (pressure, silicone, massage, or exercise) after acute skin grafting to the face had better outcomes than those who received later intervention. Specifically, we predicted positive relationships between number of days from initiation of intervention to Modified Vancouver Scar Scale (MVSS) scores and the need for facial reconstructive surgery.

## METHODS

A retrospective review of medical records was conducted on pediatric patients who underwent excision and grafting of the face because of burn injury, at Shriners Hospital for Children—Northern California between 2000–2010. Charts were reviewed for noninvasive scar management interventions including pressure therapy, silicone application, massage, and facial exercise/ROM. This study was approved by the University of California, Davis, Human Subjects Review Committee.

A total of 160 patients underwent excision and grafting at our center during the 10-year time period. Twenty-two patients expired, leaving 138 patient charts for review of noninvasive scar management interventions and scar outcome indicators. Incomplete documentation required that 56 of those records be excluded, leaving 82 patients for the study. (Figure 2)

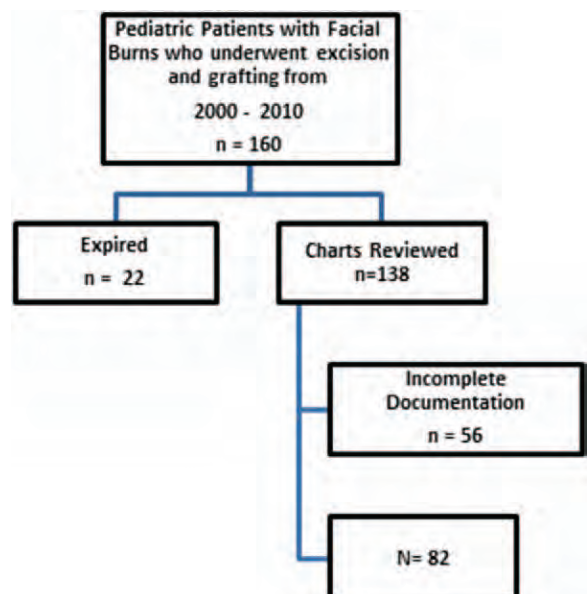
The time frame for initiation of the four interventions after burn injury was recorded. In addition, charts were reviewed for demographic data, burn size or TBSA, and length of hospital stay (LOS).

The outcome measures used for this study were 1) MVSS scores<sup>20</sup> and 2) the need for facial reconstructive surgery. The MVSS was used clinically over the 10-year period and recorded in the patient's medical record. The scale has four different subscales

including vascularity, pigmentation, pliability, and height, and can be scored from 0 to 14 (Table 1).

The outcome variable of whether a child underwent later reconstructive surgery was dichotomized and had two options: “poor outcome” for those patients who required facial reconstructive surgery after their initial grafting and “good outcome” for those who did not.

The range of days to initiation of all four interventions were very large for our sample (pressure therapy = 11–415; massage = 15–328; silicone = 24–303; and exercise/ROM = 1–546). With a wide range of days to initiation of intervention but relatively few patients per group, we decided to limit the number of scores for the independent variable to bring greater stability to the analyses. Specifically, patients were placed in six categories based on increments of 16.7% for the range of days within each intervention



**Figure 2.** Medical records excluded or reviewed for the study.

**Table 1.** Modified Vancouver Scar Scale (Baryza,1995)

Pigmentation	
Normal	0
Hypopigmented	1
Mixed	2
Hyperpigmented	3
Pliability	
Normal	0
Supple	1
Yielding	2
Firm	3
Rope-like	4
Contracture	5
Vascularity	
Normal	0
Pink	1
Red	2
Purple	3
Height	
Flat	0
<2 mm	1
2–5 mm	2
> 5 mm	3

group. Six categories were selected to provide a balance between a satisfactory number of observations per category and a sufficient level of variability to test the study hypotheses. Table 2 presents the range of days across the group for each intervention.

The categorical variables representing days to intervention were regressed linearly with MVSS scores. Logistic regression was used to test the relationship between days and the need for facial reconstructive surgery.

## RESULTS

The mean age of the patients was 5.4 (+4.5) years, 62% were males. The mean burn size was 35.2 (+22.5) %TBSA and LOS was 68 (+65) days.

The majority of patients (73%) were of Hispanic ethnicity, 5% were Caucasian, and 5% were African-American. As seen in Table 3, pressure therapy was used with most patients, followed by massage, silicone, then ROM/exercise. The intervention applied the earliest was massage, whereas silicone was initiated last. Splinting was excluded from the analysis because only one patient underwent splinting of the face.

### MVSS Outcome

TBSA was significantly associated with MVSS scores and was controlled in the linear regression analysis of category days and MVSS scores. It was found from these analyses that later application of silicone was significantly related to higher MVSS scores (Table 4). That is, as number of days to initiation of silicone increase, patients demonstrated poorer outcomes as determined by the MVSS.

The rate or extent of change in the subscales of the various versions of the Vancouver Scar Scales have not been well identified, which results in lost or misinterpreted information and scaling issues when using a total or summed scar score.<sup>21,22</sup> Therefore, for this study, analysis was conducted on the individual subscale scores of the MVSS as well. None of the interventions predicted pliability or height scores. However, when evaluating vascularity, we found that earlier application of silicone, pressure, and exercise were each related to lower vascularity scores and earlier use of silicone to lower pigmentation scores. (Table 5)

### Reconstructive Outcome

Thirty-seven percent of patients did not receive reconstructive surgery and were dichotomized to the “good outcome” group, whereas 63% underwent reconstruction and were considered “poor outcome.” Controlling for burn size and LOS,

**Table 2.** Range of days across six categories by type of intervention

Day Category	%	Massage (N = 70)		Exercise (N = 50)		Pressure (N = 77)		Silicone (N = 57)	
		n	Range (Days)	n	Range (Days)	n	Range (Days)	n	Range (Days)
1	16.7	12	15–27	9	1–27	13	11–34	10	11–36
2	33.3	12	28–36	8	28–36	13	35–45	10	39–55
3	50.0	12	38–52	9	40–57	15	46–61	9	57–70
4	66.7	11	53–69	9	61–77	12	66–77	10	71–103
5	83.4	12	71–93	7	80–118	12	80–119	9	105–172
6	100.0	11	96–328	8	127–546	12	146–415	9	181–303

**Table 3.** Frequency and timing of therapeutic interventions

	% Subjects	Days to Start mean (SEM)	Median Days
Pressure therapy	94%	81.3 ( $\pm 7.6$ )	61
Massage	85%	61.6 ( $\pm 5.7$ )	52
Silicone	70%	97.7 ( $\pm 10.1$ )	70
Exercise/ROM	61%	84.5 ( $\pm 14$ )	57

logistical analysis found no relationship between timing of each of the interventions and reconstructive outcome.

## DISCUSSION

Although massage, exercise, pressure therapy, and silicone gel sheeting are commonly applied early in the maturation of scars, the optimal timing of initiation and duration of use have not been determined. Our study is one of few that specifically examine the effects of earlier vs later application of noninvasive scar management interventions on scar outcome. By evaluating the timing of common noninvasive scar management interventions in our clinical burn setting, we established a relationship between early or late intervention with MVSS scores. In our study, we found that early initiation of silicone gel sheeting to the face is associated with an improved MVSS scar outcome score, specifically in the vascularity and pigmentation subscales.

Silicone gel sheeting has been used in the clinical management of hypertrophic scars since the 1980s<sup>23</sup> and has become a standard of care in plastic surgery.<sup>24</sup> Previous studies have shown improvements in various aspects of surgical and burn scars with the use of silicone. Silicone is associated with improved scar elasticity,<sup>25,26</sup> decreased hypertrophy,<sup>27</sup> decreased scar roughness,<sup>28,29</sup> and improved itch<sup>28,30,31</sup> in surgical and/or burn scars. Studies combining silicone with pressure therapy have shown diminished scar thickness<sup>15,30,32</sup> and improved pliability.<sup>30</sup>

**Table 4.** Linear regression analysis of therapeutic interventions and MVSS score

	B	P
Massage	0.21	0.23
Exercise	0.25	0.31
Pressure	0.33	0.09
Silicone	0.54	0.02*

MVSS, Modified Vancouver Scar Scale.

\* $P < .05$ .

Despite evidence for the beneficial effect of silicone on hypertrophic scars, optimal timing of initiation and duration of silicone use has not yet been determined. Most studies investigating the effectiveness of silicone vary in study design regarding stage of scar maturation when silicone is initiated and the time duration for which silicone is applied. Observing the wide ranges of initiation for intervention in the present study at one burn center, we suspect clinical use of silicone is just as varied. Katz<sup>19</sup> applied silicone gel sheeting on fresh scars upon re-epithelialization and found 79% of patients did not develop hypertrophic scars, thus concluding that silicone gel is effective when applied early in the wound-healing process. In the same study, however, silicone was applied to chronic hypertrophic and keloid scars and improvement was noted in 56% of patients, suggesting silicone may have an effect later in the course of scar development as well.<sup>19</sup> The rate of change and absolute difference in scar outcome between the two groups was not compared. Our study supports earlier use of silicone for improved scar outcome. However, prospective investigation is needed to determine the optimal therapeutic time frame for silicone use in preventing or correcting hypertrophic scars.

Earlier silicone application was also related to improved pigmentation subscale score on the MVSS. Although the mechanism of how silicone might influence pigmentation is not well understood, other studies have shown trends toward more normalized pigmentation with silicone use as well.<sup>30-34</sup> Li-Tsang et al<sup>30</sup> showed improved pigmentation in terms of lightness and yellowness after 4 months of combined silicone/pressure therapy intervention as compared with a control group. Momeni et al<sup>31</sup> showed significantly reduced pigmentation MVSS scores in scars treated with silicone gel sheet compared with control sites. Pigmentation subscale results should be interpreted with caution as clear limitations have been demonstrated when using the Vancouver Scar Scale and modified versions of the scale.<sup>21,35-38</sup> Draaijers et al<sup>38</sup> concluded that a highly vascularized scar can mask pigmentation so it is possible that with the use of the MVSS in this study, the result may reflect the changes in vascularity reported rather than in pigmentation. In addition, given the nominal nature of the pigmentation subscale of the MVSS, a lower score may not represent the true cosmetic impact for the patient.

Evaluating specifically the vascularity subscale score of the MVSS, the present study indicates that not only early initiation of silicone but also early use of pressure therapy and implementation of facial exercises are related to improved vascularity scores. Decreased erythema of the scar is a sign of scar maturation.<sup>39</sup>



**Table 5.** Linear regression analysis of therapeutic interventions and MVSS subscale scores

	Pliability		Height		Pigmentation		Vascularity	
	B	p	B	p	B	P	B	P
Massage	-0.068	0.27	-0.001	0.69	0.048	0.62	0.002	0.46
Exercise	-0.027	0.71	-0.000	0.76	0.073	0.54	0.14	0.04*
Pressure	-0.012	0.84	-0.002	0.28	0.052	0.64	0.14	0.01*
Silicone	-0.077	0.27	0.000	0.88	0.21	0.04*	0.16	0.02*

MVSS, Modified Vancouver Scar Scale.  
 \*P < .05.

Our results support other studies that have found improved time to scar maturity with silicone application,<sup>40,41</sup> pressure therapy,<sup>14,39</sup> and combined silicone/pressure therapy.<sup>30,31</sup> No studies were found showing a correlation between exercise and diminished time to scar maturity. Even though they found no difference in erythema scores with silicone, Van der Wal et al<sup>28</sup> concluded that silicone can have a significant effect on burn scar maturation, based on significant findings of reduced pruritus in the first 3 to 6 months after silicone was applied. Van den Kerckhove et al<sup>14</sup> found pressure therapy delivered at a minimum of 15 mm Hg tended to accelerate scar maturation. In contrast, Chang et al<sup>42</sup> found no significant differences in scar maturation in patients wearing pressure garments compared with those not wearing pressure garments.

Another study by Van den Kerckhove et al<sup>15</sup> demonstrated that combination pressure and silicone therapy was most effective for Caucasian people with light hair. The majority of patients in our study were from ethnicities other than Caucasian, with most being from Hispanic background. Differences observed in the described scar characteristics with earlier interventions suggest some benefit of these scar management interventions to individuals with darker pigmented skin as well. However, only ethnicity and not true skin coloration could be determined from this review.

This study had some limitations. First, it was a retrospective chart review and therefore relies on documentation, which may be missing or incomplete. Many charts were excluded and the documentation of the time frames for intervention that were extracted only represent the first date on which the treatment was documented, which may have affected the ranges of scores. The intervention groups were not mutually exclusive. However, because our analyses did not make direct comparison across the groups this does not influence the validity of the study. Our burn facility provides free care to patients and the access to reconstructive surgery is not limited by third-payer parties. In addition, we

treat exclusively pediatric patients who are growing and typically demonstrate increased reconstructive needs. Combined, these factors may have resulted in inflated rates of reconstructive surgery, which may have biased the results. The MVSS is a subjective scar scale that has been shown to have poor or indeterminate reliability and validity<sup>22</sup> but was the primary clinical measure used during the period this study was conducted. No objective measure of scar outcome was used, nor was the patient's opinion and reports of itch and pain documented often enough to be included in the results.

This preliminary study provides information that can be used to direct future prospective studies evaluating optimal timing of noninvasive scar management interventions. Objective scar assessments should be used to make more reliable and valid determinations about scar outcome. Some currently available tools for the objective evaluation of the scar characteristics described by the Vancouver Scar Scale include: tristimulus reflectance colorimeter and narrowband spectrophotometer for color or pigmentation, ultrasound for scar thickness, and tonometry or Cutometer Skin Elastic Meter for pliability. A variety of other objective instruments to measure these and other scar characteristics are currently under investigation as well.<sup>43</sup> The unique aspects of the face may benefit from specific tools for facial scar and functional outcome. Using a tool designed to allow assessment of facial contours and expressions may be appropriate to use in combination with general scar assessment tools.<sup>44</sup> Finally, standard documentation within the burn rehabilitation community regarding facial outcome is also needed to allow for multicenter comparisons among a greater number of patients.

## CONCLUSION

Early initiation of silicone gel sheeting to the face is associated with an improved MVSS scar outcome score, specifically vascularity and pigmentation subscales. Improvement in vascularity is also seen with

early application of pressure therapy and facial exercises/ROM. Further prospective investigation on the optimal timing of noninvasive methods of scar management is needed to determine impact on facial scarring.

## ACKNOWLEDGMENT

Special thanks to the following people for their participation in reviewing charts for this study: Jamie Lewis, Arthur Chu SPT, and Kyleigh Short SPT. Thanks to Fred Molitor for his assistance with statistical analysis.

Informed consent was received for publication of the figures in this article.

## REFERENCES

1. Stubbs TK, James LE, Daugherty MB, et al. Psychosocial impact of childhood face burns: a multicenter, prospective, longitudinal study of 390 children and adolescents. *Burns* 2011;37:387-94.
2. Wiechman SA, Ptacek JT, Patterson DR, Gibran NS, Engrav LE, Heimbach DM. Rates, trends, and severity of depression after burn injuries. *J Burn Care Rehabil* 2001;22:417-24.
3. Pallua N, Künsebeck HW, Noah EM. Psychosocial adjustments 5 years after burn injury. *Burns* 2003;29:143-52.
4. Druery M, Brown TL, La H Brown T, Muller M. Long term functional outcomes and quality of life following severe burn injury. *Burns* 2005;31:692-5.
5. Vehmeyer-Heeman M, Nanhekhan L, Van den Kerckhove E, Boeckx JW. Initial reconstruction of sustained neck and facial burns. *J Burn Care Res* 2007;28:442-6.
6. Klein MB, Moore ML, Costa B, Engrav LH. Primer on the management of face burns at the University of Washington. *J Burn Care Rehabil* 2005;26:2-6.
7. Philp L, Umraw N, Cartotto R. Late outcomes after grafting of the severely burned face: a quality improvement initiative. *J Burn Care Res* 2012;33:46-56.
8. Greenhalgh DG, Hinchcliff K, Sen S, Palmieri T. A ten-year experience with pediatric face grafts. *J Burn Care Rehabil* 2013;34:576-84.
9. Ward RS, Reddy R, Lundy CH, Brockway C, Saffle JR, Schnebly WA. A technique for control of hypertrophic scarring in the central region of the face. *J Burn Care Rehabil* 1991;12:263-7.
10. Dougherty ME, Warden GD. A thirty-year review of oral appliances used to manage microstomia, 1972 to 2002. *J Burn Care Rehabil* 2003;24:418-31; discussion 410.
11. Staley M, Richard R, Billmire D, Warden G. Head/face/neck burns: therapist considerations for the pediatric patient. *J Burn Care Rehabil* 1997;18:164-71.
12. Groce A, Meyers-Paal R, Herndon DN, McCauley RL. Are your thoughts of facial pressure transparent? *J Burn Care Rehabil* 1999;20:478-81.
13. Parry I, Doyle B, Hurlin-Foley K, Palmieri T, Greenhalgh T. Does the first impression count? A survey of current practices and satisfaction with the use of transparent face masks in the treatment of facial scarring. *J Burn Care Rehabil* 2002;23:555.
14. Van den Kerckhove E, Stappaerts K, Fieuws S, et al. The assessment of erythema and thickness on burn related scars during pressure garment therapy as a preventive measure for hypertrophic scarring. *Burns* 2005;31:696-702.
15. Van den Kerckhove E, Boeckx W, Kochuyt A. Silicone patches as a supplement for pressure therapy to control hypertrophic scarring. *J Burn Care Rehabil* 1991;12:361-369.
16. Patiño O, Novick C, Merlo A, Benaim F. Massage in hypertrophic scars. *J Burn Care Rehabil* 1999;20:268-271; discussion 267.
17. Linares A, Caamaño GJ, Diaz R, Gonzalez FJ, Garcia-Peregrin E. Utilization of ketone bodies by chick brain and spinal cord during embryonic and postnatal development. *Neurochem Res* 1993;18:1107-12.
18. Leung PC, Margaret Ng. Pressure treatment for hypertrophic scars resulting from burns. *Burns* 1980;6:244-50.
19. Katz BE. Silicone gel sheeting in scar therapy. *Cutis* 1995;56:65-7.
20. Baryza MJ, Baryza GA. The Vancouver Scar Scale: an administration tool and its interrater reliability. *J Burn Care Rehabil* 1995;16:535-8.
21. Nedelec B, Shankowsky HA, Tredget EE. Rating the resolving hypertrophic scar: comparison of the Vancouver Scar Scale and scar volume. *J Burn Care Rehabil* 2000;21:205-12.
22. Tyack Z, Simons M, Spinks A, Wasiak J. A systematic review of the quality of burn scar rating scales for clinical and research use. *Burns* 2012;38:6-18.
23. Perkins K DR, Wallis K. Silicone gel: a new treatment for burn scars and contractures. *Burns* 1983;9:201-4.
24. Mustoe TA, Cooter RD, Gold MH, et al.; International Advisory Panel on Scar Management. International clinical recommendations on scar management. *Plast Reconstr Surg* 2002;110:560-71.
25. Ahn ST, Monafó WW, Mustoe TA. Topical silicone gel for the prevention and treatment of hypertrophic scar. *Arch Surg* 1991;126:499-504.
26. Carney SA, Cason CG, Gowar JP, et al. Cica-Care gel sheeting in the management of hypertrophic scarring. *Burns* 1994;20:163-7.
27. Cruz-Korchin NI. Effectiveness of silicone sheets in the prevention of hypertrophic breast scars. *Ann Plast Surg* 1996;37:345-8.
28. van der Wal MB, van Zuijlen PP, van de Ven P, Middelkoop E. Topical silicone gel versus placebo in promoting the maturation of burn scars: a randomized controlled trial. *Plast Reconstr Surg* 2010;126:524-31.
29. Mercer NS. Silicone gel in the treatment of keloid scars. *Br J Plast Surg* 1989;42:83-7.
30. Li-Tsang CW, Zheng YP, Lau JC. A randomized clinical trial to study the effect of silicone gel dressing and pressure therapy on posttraumatic hypertrophic scars. *J Burn Care Res* 2010;31:448-57.
31. Momeni M, Hafezi F, Rahbar H, Karimi H. Effects of silicone gel on burn scars. *Burns* 2009;35:70-4.
32. Gold MH. Topical silicone gel sheeting in the treatment of hypertrophic scars and keloids. A dermatologic experience. *J Dermatol Surg Oncol* 1993;19:912-6.
33. Gibbons M, Zuker R, Brown M, Candlish S, Snider L, Zimmer P. Experience with silastic gel sheeting in pediatric scarring. *J Burn Care Rehabil* 1994;15:69-73.
34. Chan KY, Lau CL, Adeeb SM, Somasundaram S, Nasir-Zahari M. A randomized, placebo-controlled, double-blind, prospective clinical trial of silicone gel in prevention of hypertrophic scar development in median sternotomy wound. *Plast Reconstr Surg*. 2005;116:1013-20; discussion 1021-2.
35. Tyack ZF, Pegg S, Ziviani J. Postburn dyspigmentation: its assessment, management, and relationship to scarring—a review of the literature. *J Burn Care Rehabil* 1997;18:435-40.
36. Forbes-Duchart L, Marshall S, Strock A, Cooper JE. Determination of inter-rater reliability in pediatric burn scar assessment using a modified version of the Vancouver Scar Scale. *J Burn Care Res* 2007;28:460-7.
37. Durani P, McGrouther DA, Ferguson MW. Current scales for assessing human scarring: a review. *J Plast Reconstr Aesthet Surg* 2009;62:713-20.
38. Draaijers LJ, Tempelman FR, Botman YA, Kreis RW, Middelkoop E, van Zuijlen PP. Colour evaluation in scars: tristimulus colorimeter, narrow-band simple reflectance meter or subjective evaluation? *Burns* 2004;30:103-7.
39. Jensen LL PP. Postburn scar contractures: histology and effects of pressure treatment. *J Burn Care Rehabil* 1984;5:119-23.

40. Chernoff WG, Cramer H, Su-Huang S. The efficacy of topical silicone gel elastomers in the treatment of hypertrophic scars, keloid scars, and post-laser exfoliation erythema. *Aesthetic Plast Surg* 2007;31:495–500.
41. Rhee SH, Koh SH, Lee DW, Park BY, Kim YO. Aesthetic effect of silicone gel on surgical scars in Asians. *J Craniofac Surg* 2010;21:706–10.
42. Chang P, Laubenthal KN, Lewis RW 2nd, Rosenquist MD, Lindley-Smith P, Kealey GP. Prospective, randomized study of the efficacy of pressure garment therapy in patients with burns. *J Burn Care Rehabil* 1995;16:473–5.
43. Verhaegen PD, van der Wal MB, Middelkoop E, van Zuijlen PP. Objective scar assessment tools: a clinimetric appraisal. *Plast Reconstr Surg* 2011;127:1561–70.
44. Fraulin FO, Illmayer SJ, Tredget EE. Assessment of cosmetic and functional results of conservative versus surgical management of facial burns. *J Burn Care Rehabil* 1996;17:19–29.