Dermabrasion with an occlusive biosynthetic dressing increases rate of wound healing

Laura Jane Winter
Pacific University
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Abstract

Background: Deep dermal burns are initially difficult to evaluate. Some of these burns are able to heal spontaneously from the epidermal precursor cells found in hair follicles that were not destroyed by the injury. This type of healing is either slowed considerably or is unable to occur if the burn wound is covered with eschar or granulating surfaces. Leaving this necrotic tissue in place and covering the wound with a skin graft or occlusive dressing will create a closed fluid loculation that can then become infected and destroy viable epidermal cells thus converting a deep partial burn into a full thickness injury. Dermabrasion is a useful alternative to a more invasive and risky tangential excision. In a population with deep dermal partial-thickness (DDPT) burns, does dermabrasion with a biosynthetic wound dressing increase rate of wound healing?

Methods: Exhaustive search of available medical literature was conducted using Medline-OVID, CINAHL, Academic Search Premier, and Web of Science. The keywords dermabrasion, burns, and partial-thickness burns were used. Relevant articles were reviewed for studies analyzing patients with DDPT, DDPT combined with superficial partial thickness burns, DDPT combined with full thickness burns, and the use of dermabrasion with an occlusive biosynthetic dressing as a treatment method.

Results: Three studies met inclusion criteria and were included in this systematic review. Each study evaluated dermabrasion with a different biosynthetic wound dressing. One study reported a significantly reduced length of stay in an acute care setting, which lead to dramatic cost savings. Two studies evaluated occurrence of infection and reported nearly the same reduction in infection rates when dermabrasion and a biosynthetic dressing were used.

Conclusion: Based on the evidence found in the three reviewed studies, it is clear that additional research in the form of randomized control trials needs to be conducted to provide more conclusive evidence about how to treat deep dermal partial-thickness burns. The data presented by the three studies showed a decrease in length of hospital stay due to improved wound healing times, as well as decreased rate of infection. However, due to the limited sample size and the use of observational studies only, a strong recommendation for this treatment method in DDPT wounds cannot be made.

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The student author attests that this work is completely his/her original authorship and that no material in this work has been plagiarized, fabricated or incorrectly attributed.
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Laura J. Winter

A Clinical Graduate Project Submitted to the Faculty of the
School of Physician Assistant Studies
Pacific University
Hillsboro, OR
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Faculty Advisor: Saje Davis-Risen, PA-C, MS
Clinical Graduate Project Coordinator: Annjanette Sommers, PA-C, MS
Biography

Laura Winter graduated from the University of Oregon (Go Ducks!) with a BS in General Science and minor Chemistry. After completing her undergraduate degree, Laura moved to San Diego, CA where she worked in an administrative role for a small group of orthopedic surgeons for nearly 2 years. She then went on to EMT school and secured a position at a local ambulance company. Eventually, Laura moved back north to Portland, OR where she worked at the Knight Cancer Institute at Oregon Health & Science University for more than 4 years.
Abstract

**Background:** Deep dermal burns are initially difficult to evaluate. Some of these burns are able to heal spontaneously from the epidermal precursor cells found in hair follicles that were not destroyed by the injury. This type of healing is either slowed considerably or is unable to occur if the burn wound is covered with eschar or granulating surfaces. Leaving this necrotic tissue in place and covering the wound with a skin graft or occlusive dressing will create a closed fluid loculation that can then become infected and destroy viable epidermal cells thus converting a deep partial burn into a full thickness injury. Dermabrasion is a useful alternative to a more invasive and risky tangential excision. In a population with deep dermal partial-thickness (DDPT) burns, does dermabrasion with a biosynthetic wound dressing increase rate of wound healing?

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**Keywords:** dermabrasion, burn
Acknowledgements

To Kyle Dillon, Thank you for your endless love and support. You could not have come in to my life at a busier or crazier time but I could not imagine it any other way.

To my family: Thank you for helping me to succeed and for supporting me tirelessly through the years of ups and downs. I love each and every one of you.
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List of Abbreviations

DDPT.................................................................Deep dermal partial-thickness
FT...................................................................................................................Full thickness
SPT.................................................................Superficial partial-thickness
TBSA.................................................................Total body surface area
Dermabrasion with an occlusive biosynthetic dressing increases rate of wound healing

BACKGROUND

A major function of the skin is to act as a protective barrier and defense against infection. Burns destroy this protective barrier, leaving behind necrotic tissue and granulating surfaces that are warm, moist, and protein rich, ideal for bacteria and fungi colonization. Burns cause fluid and electrolyte losses, which in combination with proliferating microbe invasion, can lead to systemic infection. Therefore, it can be argued that burns should be excised before bacterial counts are high, which largely occurs within five to seven days of the injury. After that time, the rate of sepsis and graft failure increases.\textsuperscript{1, 2}

In order to better discuss the treatment of burns, it is important to understand the classification of burns as it relates to the pathophysiology. Thermal injury causes coagulative necrosis of the epidermis and underlying tissues, with the depth and extent of injury dependent upon the temperature to which the skin is exposed, specific heat of the causative agent, and duration of exposure. The area of injury can be divided into three zones—zone of coagulation, zone of stasis, and zone of hyperemia. The zone of coagulation is the necrotic area where tissue is irreversibly damaged. The zone of stasis is the area immediately adjacent to the necrotic tissue and has decreased tissue profusion. This zone is associated with vascular damage and vessel leakage. \textsuperscript{3} It is argued that the ultimate burn depth is dependent upon the zone of stasis. Since it is a principally
reversible area, there are various therapeutic strategies that would reverse progressive burn ischemia and prevent additional tissue loss. The final surrounding area is called the zone of hyperemia. This zone contains viable tissue from which the healing process begins and is typically not at risk for further necrosis.

The method of classifying burns as first, second, third, and fourth degree has been replaced by a new system reflecting the need for possible surgical intervention. The new designations for burn depth are superficial, superficial partial-thickness (SPT), deep dermal partial-thickness (DDPT), and full thickness (FT). Superficial burns involve only the epidermal layer while SPT involve the epidermis and part of the dermis. SPT burns form a blister between the dermal and epidermal layer. Both of these burn types heal spontaneously and scarring is unusual. DDPT burns reach deeper into the dermis and tend to damage hair follicles and glandular tissue. FT burns extend through all layers of the dermis and often involve the subcutaneous tissue below. If the skin does not regenerate either spontaneously or by wound closure within a few weeks time, morbidity and scarring will be severe.

Treatment methods for burns depend on characteristics and size of the wound. All treatments are aimed at rapid and painless healing. Superficial and SPT burns are managed by topical antimicrobials and scheduled dressing changes. Full thickness burns require excision and grafting because the whole dermis and base of the skin adnexae are destroyed, so the ability for spontaneous healing from the base of the wound is lost and can only occur from the edge of the wound. Hypertrophy and contracture are generally inevitable if the wound is not closed with a graft. DDPT burns are controversial in terms of both diagnostics and management. DDPT burns can heal
from epithelial elements surviving in the wound, but typically these burns form granulation tissue. The granulation tissue interferes with complete epithelial cover, which in turn delays healing and promotes scarring.\(^5\) Early debridement is commonly completed through escharectomy, which is an effective way of preventing granulation tissue formation, reducing risk of infection, and decreasing scar formation. However, escharectomy still carries a risk for infection, increased cost due to longer hospital stay, and higher blood loss, which has many clinicians considering an alternative like dermabrasion. What is the efficacy of dermabrasion paired with an occlusive biosynthetic dressing in managing deep dermal partial-thickness burns?

**METHODS**

A comprehensive literature search was conducted using Medline-OVID, Academic Search Premier, Web of Science, and CINAHL using the following keywords: dermabrasion, burns, and partial-thickness burns. The search was narrowed to include human studies and English language articles only. The bibliographies from the relevant literature were reviewed for additional pertinent articles.

All references gathered were evaluated for the following pertinent criteria: articles analyzing patients with DDPT, DDPT combined with SPT burns, DDPT combined with FT burns, and the use of dermabrasion with an occlusive biosynthetic dressing as a treatment method. Exclusion criteria included patients with superficial or full-thickness burns alone, studies that did not explicitly state dermabrasion was used as opposed to tangential excision (escharectomy) as a treatment method. Literature, where only the abstracts are available, are excluded, as well as articles published as letters to the
editor. Relevant articles were assessed for quality using the Grading of Recommendations, Assessment, Development and Evaluation (GRADE).

RESULTS

A total of sixty-three articles were found using Medline-OVID, Academic Search Premier, Web of Science, and CINAHL. References of relevant articles were reviewed, and an additional eight studies were identified. After inclusion and exclusion criteria were applied, the remaining articles were assessed to make certain the patient populations, interventions and measured outcomes were consistent with the goals of this review. At the conclusion of this exhaustive literature search and review, three articles remained. These articles included three cohort studies. At the time of this review, there were no randomized control trials (RCT) published. (See Table I)

Comparison of the Results of Operative and Conservative Treatment of Deep Dermal Partial-Thickness Scalds in Children

In Poland, Kazmierski et al conducted an observational trial comparing the results of operative and conservative treatment of deep dermal partial-thickness burns in a pediatric population. There were 114 children (74 boys and 40 girls) between the ages of 3 months and 18 years, treated at the burn center between 1999 and 2004 enrolled in this trial. The burns were classified as DDPT as well as mixed DDPT/SPT and DDPT/FT. Burns varied from 3% total body surface area (TBSA) to 40% TBSA. The treatment of five groups of study patients, divided further into sub-groups based on burn size, are evaluated for the following outcomes: total time of wound healing (days), total duration of patients’ hospitalization (days), total number of dressing changes, mean pH value of the wound, wound swab results, the appearance of clinical signs of wound infection, and
late assessment of the scar according to the modified Vancouver Scar Scale (mVSS).
mVSS assesses scars based on four variables: vascularity, height/thickness, pliability, and pigmentation. The mVSS score ranges from 0-13. The five treatment groups (A-E) consisted of: excision and grafting, mechanical dermabrasion, hydrocolloid dressings, enzymatic dressings, and hydrofibre with Ag respectively. For the purpose of this review, wound healing time, length of hospital stay, incidence of infection, and scar assessments were compared in operative treatment group (A) and dermabrasion group (B).

The extent of burn depth was determined on day five post-trauma. All burns recognized as DDPT, mixed DDPT/FT, or DDPT/SPT were included in the study. The area of full thickness burn was not larger than 3% of TBSA. When evaluating DDPT/SPT, superficial partial-thickness areas covered less than 50% of the burn. Group A and group B were prognostically different in that group A included DDPT and mixed DDPT/FT where group B included DDPT and mixed DDPT/SPT (See Table II: Summary of Findings). All groups received standard wound debridement as well as appropriate medical treatment before study entry at day five.

Group A underwent tangential excision with a dermatome, followed by split-thickness autologous skin graft (STASG) on the fifth day after trauma. The graft was then covered with a Jelonet dressing and gauze that was changed 4-6 days post operatively. Group B experienced controlled abrasion with rotating diamond stones to remove superficial necrosis. Following removal of at least 95% of superficial necrosis, the wound was covered with hydrocolloid dressing, which was changed every 2-4 days until healing was complete.
Twenty-five patients in group A received tangential excision and STASG. The mean total time of wound healing was 16 days (14-25 days). Partial graft rejection and the need for re-grafting was observed in four patients, including two DDPT burns of less than 10% TBSA and two DDPT burns over 20% TBSA. Graft rejection was caused by infection in all cases. Graft overgrowth was found in three patients, all wounds less than 20% TBSA. Melting wound graft was observed in two patients. Four cases of complications in healing donor sites were observed (two cases of infection, two cases of hypertrophic scarring). The mean mVSS was 4.6

Dermabrasion (group B) was used on 31 total patients. Mean total time of wound healing was 18 days (12-27 days). Wound infection was observed in three patients with a (when compared with group A, there is a relative risk of .42). Failure of wounds to spontaneously epithelize and therefore require skin grafting on the twelfth day was observed in six DDPT patients (four with wounds greater than 20%, two below 20%). The grafted area was 50% in two patients, and 10-20% of the initial wound the other four patients. Five of these patients healed by post burn day 21 without any complications. One patient got an infection, which complicated wound healing and required re-grafting prolonging total healing time to 27 days post trauma. Patients receiving dermabrasion and not requiring grating had a total wound healing time of 15 days (12-21 days). The mean mVSS was 2.6

The authors state that one limitation to their study was the inability to enroll a sufficient number of patients for an adequate statistical analysis. However, the authors believe that preliminary results based on clinical observation show a relationship can be made between TBSA of the DDPT burn and choice of treatment method.6
Use of Transcyte and dermabrasion to treat burns reduces length of stay in burns of all size and etiology

In the US, Amani et al. conducted a retrospective cohort study evaluating the use of transcyte after dermabrasion in DDPT patients. A review of all patient records receiving treatment at the author’s burn center between April 2002 and December 2002 was performed. One hundred and ten patients receiving dermabrasion and transcyte were identified. The group ranged in age from 2 months to 60 years of age, with a mean of 18.5 years. The burn size ranged from 1% TBSA to 60% TBSA. Patients were divided into the following groups: 0-19.9% TBSA, 20-39.9% TBSA, and 40-59.9% TBSA. There were 92 patients in the sample (84%) that fell into 0-19.9% TBSA range. A normative comparison with the American Burn Association Patient Registry data was made with the primary outcome of interest being length of hospital stay (LOS) and secondary outcome being cost (charges/day). There were 80% of the population reported in the registry that were in the 0-19.9% TBSA category.

Patients were taken to the operating room for definitive debridement prior to post-injury day seven. Burns were dermabraded and Transcyte was applied to the wound. If any part of the burn was determined to be full thickness, autograft was used for closure of the full thickness portion. Anticoat and Tegaderm were applied and removed 48 hours later. If no fluid collection was observed under the Transcyte, and it was well adhered to the wound, patients were sent home. If there was significant fluid collection, or if patients’ pain was not well controlled with oral analgesics, Anticoat was reapplied and patients remained in the hospital for an additional 48 hours until the dressing could be removed.
Patients with 0-19.9% TBSA burns had LOS of 6.1 days (p< 0.0001) compared to the average of 9 days as reported in the registry. When considering only patients with partial thickness burns who did not receive an autograft, the LOS drops further to 4.8 days (p< 0.0001). Patients with 20-39.9% TBSA burns had a mean LOS of 17.5 days compared to 25.5 days and patients with 40-59.9% TBSA burns had a mean LOS of 39.70 compared to 44.58, respectively. However, due to the small sample size in these populations, the numbers are not statistically significant.

Charges per day in 1993 dollars for patients with 0-19.9% TBSA burns were $2253 for registry patients compared to $1288 for the dermabasion treatment patients. In the 20-39.9% TBSA category, charges were $3067 for registry compared to $2221 for treatment patients and in the 40-59.9% TBSA category, charges were $3865 for registry patients and $3579 for treatment patients.

The authors theorize that by removing any tissue necrosis and potentially colonized layers of wound, the zone of coagulation is removed and possibly eliminates the zone of stasis. Limiting or eliminating the zone of stasis, transforms the unpredictable burn into a more predictable surgical wound. The authors conclude that the use of dermabrasion and Transcyte decreases LOS considerably and therefore, decreases the associated treatment cost in an acute care setting.

The Use of Hyalomatrix PA in the Treatment of Deep Partial-Thickness burns

In Italy, between February 2001 and September 2005, Gravante et al began using Hyalomatrix PA on their pediatric population with DDPT burns. The authors conducted a retrospective observational study with the primary outcome of avoiding escharectomy and skin grafting by using dermabrasion followed by Hyalomatrix PA. There were 300
pediatric patients treated using this method. Burns were evaluated by the same surgeon and determined to be DDPT based on the following clinical signs and symptoms: no pain and rose or pearly-white appearance without change of the color after applying pressure. Superficial partial-thickness and full-thickness burns were excluded.8

On post burn days 3-5, dermabrasion was performed and Hyalomatrix PA was placed on the wound. Dressings were changed every 7 days. Further dermabrasion could be performed on resistant necrotic residue. On post burn day 21, those without signs of spontaneous re-epithelialization underwent escharectomy and split thickness skin graft.8

A total of 183 patients (66%) underwent one dermabrasion, 67 patients (22.3%) underwent more than one, and 50 patients (16.7%) underwent escharectomy after two dermabrasions. The incidence of infection was 10% (30 patients) in the study group compared to 29.5% based on historical data from the author’s burn center.8

Two hundred fifty patients (83%) with DDPT burns avoided escharectomy and skin grafting and healed in a manner similar to superficial burn injuries. The biologic dressing reduced bacterial invasion, thereby reducing infection rates.8

**DISCUSSION**

While the primary outcomes for these three studies6-8 differed, there was some overlap when evaluating infection rate and length of hospital stay. Gravante et al8 compared the incidence of infection in their treatment group to historical data gathered by their burn center. The rate of infection was reduced to 10% from 29.5% when dermabrasion and Hyalomatrix PA was used. Similarly, Kazmierski et al6 reported a 58% relative risk reduction in wound infections when dermabrasion and a hydrocolloid dressing were used over escharectomy and split thickness skin graft. This data represents
that for every seven burn wounds treated with dermabrasion and hydrocolloid dressing, one wound is prevented from getting an infection.

Length of hospital stay was evaluated in each of the three studies\textsuperscript{6-8} of interest. Gravante et al\textsuperscript{8} reported a mean LOS of 20.84 days (2-63 days; SD 15). However, they do not correlate LOS with burn size or with treatment type (ie, one dermabrasion vs two dermabrasions vs escharectomy and skin grafting). Kazmierski et al\textsuperscript{6} measured length of stay as a surrogate endpoint to duration of wound healing as the patients were discharged home after their wounds had been determined to be healed. Length of hospital stay did not significantly change between the dermabrasion and hydrocolloid group from the excision and skin graft group. The sample size of these groups were quite small and it is unknown if the two groups were prognostically different. The primary outcome measured by Amani et al\textsuperscript{7} was length of hospital stay. They report use of dermabrasion and Transcyte significantly reduces length of hospital stay thereby reducing associated treatment cost. They theorize that by dermabrading a burn and removing the zone of coagulation and potentially eliminating the zone of stasis, they then take an unpredictable wound and transform it into a predictable surgical wound. While this article does compare study patients with similar burn size to American Burn Association Patient Registry data, it is unclear if the registry patients are similar in terms of age, location where they were treated, along with countless other variables.

Herndon et al\textsuperscript{1} reports that applying an occlusive biosynthetic dressing to a debrided wound reduces bacteria counts, limits fluid and protein loss, reduces pain and increases rate of epithelialization. Many of these types of dressings are applied immediately after debridement and left in place until healing is complete.\textsuperscript{9} This form of
dressing eliminates the need for daily dressing changes, which in turn reduces pain, and associated treatment cost. Advantages of dermabrasion\textsuperscript{10} include: decreased operating time, significantly reduced blood loss, and the risk of damaging the facial nerve is minimized. Therefore, use of dermabrasion with an occlusive biosynthetic dressing is a reasonable treatment choice in DDPT burns.

Despite all of these possible benefits, there is a lack of evidence in the limited studies presented to make a definitive conclusion about how to treat DDPT burns. According to the GRADE approach, the overall quality of evidence is very low due the small sample sizes utilized in each study (See Table I). Despite the poor quality of published articles specifically evaluating our clinical question, there is reasonable evidence to consider dermabrasion with a biologic or occlusive dressing as a treatment alternative for DDPT wounds.

**CONCLUSION**

Based on the evidence found in the three reviewed studies, it is clear that additional research in the form of randomized control trials or larger observational studies should be conducted to provide more conclusive evidence about how to treat deep dermal partial-thickness burns. The data presented by the three studies reviewed showed a decrease in length of hospital stay due to improved wound healing times, as well as decreased rate of infection. However, due to the limited sample size and the use of observational studies only, we cannot make a strong recommendation for this treatment method in DDPT wounds.
References


Table I: Quality Assessment

<table>
<thead>
<tr>
<th>Quality Assessment</th>
<th>Downgrade Criteria</th>
<th>Quality</th>
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</thead>
<tbody>
<tr>
<td>Design</td>
<td>Limitations</td>
<td>Indirectness</td>
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<tr>
<td>Kazmierski et al (citation)</td>
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<td>Not serious</td>
</tr>
<tr>
<td>Gravante et al (citation)</td>
<td>Cohort</td>
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</tr>
<tr>
<td>Amani et al (citation)</td>
<td>Cohort</td>
<td>Not serious</td>
</tr>
</tbody>
</table>

(a) Small sample size
### Table II. Summary of Findings

<table>
<thead>
<tr>
<th>Study</th>
<th>Treatment (total)</th>
<th>Placebo or no treatment (total)</th>
<th>Length of stay (mean days)</th>
<th>Rate of healing (days)</th>
<th>Infection rate</th>
<th>Cost (charges/day)</th>
<th>Scar quality (mVSS)</th>
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<td>24% b</td>
<td>N/A</td>
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<td>2 c</td>
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<td>&gt;20% * a</td>
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<td>N/A</td>
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<td></td>
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<td>Gravante et al</td>
<td>300</td>
<td>N/A</td>
<td>20.84 (2-63, SD 15)</td>
<td></td>
<td></td>
<td>N/A</td>
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<tr>
<td>Amani et al</td>
<td>0-19.9% * a</td>
<td>92</td>
<td>0-19.9% * a</td>
<td>6 b</td>
<td>25.5% b</td>
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<td>39.70 c</td>
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(a) % Total Body Surface Area  
(b) Control group  
(c) Intervention group

### Table III. Summary of Studies

<table>
<thead>
<tr>
<th>Study</th>
<th>Year</th>
<th>Study Design</th>
<th>Patient/population</th>
<th>Intervention</th>
<th>Comparison</th>
<th>Outcome(s)</th>
</tr>
</thead>
</table>
| Kazmierski et al | 2007 | Cohort       | Children (3 months to 18 years old) with DDPT, DDPT/SPT, DDPT/FT                  | B. Mechanical dermabrasion with hydrocolloid dressing  
C. Hydrocolloid dressing  
D. Enzymatic dressing  
E. Hydrofibre with Ag | A. Excision and grafting (standard of care)                                                                 | 1. Increased wound healing days (18 mean days in intervention group compared to 16 mean days in control group)  
2. Decreased infection rate (10% in intervention group compared to 24% in control group)  
3. Improved appearance of scars after 6 months based on Vancouver Scar Scale (mVSS 2 in intervention group vs. mVSS 4 in control group) |
| Amani et al    | 2006 | Cohort       | All consecutive patients with DDPT from April 2002 to Dec 2002. Age range 2 months to 60 years. | Dembr abrasion with Transcyte  
Normative comparison with American Burn Association Patient Registry data |                                                                                               | 1. Patients sustaining 0-19.9% TBSA burns had LOS 6.1 days compared to 9 days reported by the registry  
2. Estimated savings in 1993 dollars is 43% when comparing 0-19.9% TBSA study patients with registry patients. Estimated savings was 28% in 20-39.9% TBSA burn and 7% in 40-59.9% TBSA burn when comparing study with registry patients.  
3. Charges per day in 1993 dollars is $2163 for study patients and $2638 for registry patients  
4. Decreased infection rate (10% in study population compared to 29.5% based on historical data collected at the same burn center) |
| Gravante et al | 2007 | Cohort       | All pediatric patients with DDPT between Feb 2001 and Sept 2005 treated at S. Eugenio Hospital Burn Center. Age range 1 year old to 16 years old. | Dembr abrasion with Hyaalomatrix PA  
None |                                                                                               | 1. Total of 66% (183 patients) needed only one dermabrasion treatment  
2. 22.3% (67 patients) needed more than one dermabrasion treatment  
3. 16.7% (50 patients) needed escharectomy and skin grafting after 2 dembr abrasions |