Surgical treatment of non-melanoma skin cancer of the head and neck: expanding reconstructive options
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Chapter 4

Full-thickness skin grafts and perichondrial cutaneous grafts following surgical removal of cutaneous neoplasms of the head and neck

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ABSTRACT

Objective/ hypothesis
To determine efficacy in terms of survival rate and cosmesis of “normal” full-thickness skin grafts (FTSGs) as compared to perichondrial cutaneous grafts (PCCGs) in facial reconstruction

Study Design
A chart review of all facial reconstructions using FTSGs and PCCGs between 1995 and 2005 was undertaken. The same surgeon treated all patients.

Material and Methods
A total of 121 skin grafts was included in this study (70 FTSGs and 51 PCCGs). All patients were examined on day five and day ten to assess the viability of the graft. For aesthetic evaluation, 70 photographs were available with a minimum follow-up of six months (42 FTSGs / 59% of total; 28 PCCGs / 54% of total). The photos were randomly shown to three raters, who had no previous knowledge about the graft being a FTSG or PCCG.

Results
The complete take rate of the FTSGs and of the PCCGs was respectively, 87% (nine failures) and 94% (three failures). This is no statistically significant difference ($p = 0.1857$).
The cosmetic outcome of PCCGs received a better overall score from the three raters. However, the aesthetic rating between PCCG and FTSG was of no statistical significant difference ($p = 0.06$).

Conclusions
Both FTSGs and PCCGs are viable options in facial reconstruction, with no statistical difference in survival and cosmesis. They are simple and one-stage procedures. The PCCG is a smooth graft, containing a few sebaceous glands, and possibly has less contraction.
INTRODUCTION
Surgical removal of cutaneous neoplasms of the head and neck, together with traumatic injuries, presents a variety of cutaneous defects, which require reconstruction. The ideal method of reconstruction aims at healing the defect with good cosmesis at little or no morbidity. Four categories of options are available: healing by secondary intention, primary closure, skin grafts, and local or regional flaps. Each reconstruction has its advantages and disadvantages to be weighed for each particular defect.

Skin grafts, if properly selected, can yield functional and aesthetically satisfying results with minimal risk of complication. Skin grafts can be categorized in full-thickness, split-thickness and composite grafts. Most grafts used for facial reconstruction are full-thickness. Split-thickness grafts have poor cosmesis and are used to resurface large areas only. Composite grafts normally consist of skin and cartilage and are mainly used in small full-thickness defects (measuring less than 10 mm) of the nose.

The full-thickness skin graft (FTSG) consists of epidermis and full-thickness dermis. Healing is initiated by plasma imbibition, a diffusion of nutrition from fluid in the recipient site. The vascular inosculation occurs during the first 24-8 h. After 48-72 h capillaries begin to grow into the graft to provide new circulation. By 4-7 days, a new blood supply has been established. Initially, the FTSG appears blanched; at 3-7 days a pink color develops, signaling neovascularization. After 4-6 weeks, the pink color begins to fade.

Given the technical simplicity and the general applicability of full-thickness skin grafts, they can be used almost anywhere, provided there is adequate vascularity of the recipient site. For optimal cosmesis the defect location, depth as well as graft donor site choice and delicate tissue handling are essential. Possible disadvantages of skin grafts are graft failure, graft contraction, poor color match, depressed contour, and donor-site morbidity. Total or partial failure rates of FTSGs as mentioned in the literature vary from 5 to 30%.

The perichondrial cutaneous graft (PCCG) is a variation on the theme of skin grafting. By definition, PCCG is a composite graft, consisting of epidermis, full-thickness dermis and perichondrium. The PCCG is most often harvested from the conchal bowl. The literature discusses several benefits of the PCCGs compared to FTSGs. Two large clinical studies encompassing 100 PCCGs and 406 PCCGs reported failure rates of 0% and 2%, respectively. Both studies showed excellent cosmetic outcomes with no contraction. In a comparative study using rabbits, PCCG also demonstrated a higher survival rate of 85% compared with skin grafts of 65%. In addition, the PCCG does seem to contract less with initial wound healing. It is suggested that the perichondrial plexus allows for quicker revascularization of the graft. In view of the positive benefits reported of PCCG, we performed a clinical study to determine survival rate and cosmesis of “normal” FTSGs compared with PCCGs.

MATERIALS AND METHODS
A retrospective study of all facial reconstructions using FTSGs and PCCGs between 1995 and 2005 was undertaken. All patients were treated by one of the authors (H.D.V.). Grafts, applied in combination with a cartilage implant
or part of an elaborated reconstruction, for instance to provide lining to a forehead flap, were excluded.

**Evaluation methods**

All patients were examined on day five and day ten to assess the viability of the graft. The graft viability was scored as success, partial failure or total failure. Graft failure presented, if the graft turned dark five days postoperatively. In case of failure, patients were seen on a regular basis until healing by secondary intention was completed.

To assess graft cosmesis, photographs of patients with a minimum follow-up of six months were randomly shown to three raters (dermatologist /Mohs surgeon, ENT surgeon and naive scorer). These raters had no previous knowledge about the graft being a FTSG or PCCG. A photo series combined two to three close-ups from different angles and an overview from 1.2 meter.

A standard evaluation protocol was used to assess cosmesis. The outcomes measured in this protocol included; erythema (1= none, 2= pink, 3= red); texture match to adjacent skin (1= similar, 2 = not similar); color match to adjacent skin (1= similar, 2 = not similar); edge contour (1= blending to surrounding skin, 2= elevated or lower); teleangiectasia (percentage of graft surface area affected: 1= 0%, 2 = 1-25%, 3 = 26-75%, 4 = 76-100% ); inappropriate hair (percentage of graft surface area affected: 1= 0%, 2 = 1-25%, 3 = 26-75%, 4 = 76-100% ).

If possible, the size of the defect was measured retrospectively using ‘Image J program’ (www.rsweb.nih.gov/ij/) with the use of an iris-dependent calibration, which is possible because the diameter of the iris in adults has an constant size of 11.5 mm. These measurements were only possible if the iris was visible together with the defect.

**Technique**

To harvest a PCCG, local anesthesia (1% lidocaine with 1: 100 000 epinephrine) is injected around the chosen donor site. Care is taken not to hydrodissect the skin from the underlying perichondrium. The incision is made through the perichondrium down to the cartilage. The PCCG is carefully dissected off the cartilage. The glistering undersurface of the perichondial cutaneous graft contrasts with the dull denuded cartilage itself. (Figure 1)

The PCCG may be as large as the size of the conchal bowl, normal diameter 2.5 – 2 cm. Only rarely (4 of 51) PCCGs were harvested from the posterior surface of the ear. As in FTSG, the graft is placed in the recipient bed and trimmed to provide a precise fit. Multiple (‘pie-crusting’) cuts are made through the graft to release possible excess of serosanguinous fluids and prevent a too shiny aspect of the healed grafts in the long term. The grafts are secured with 5.0 or 6.0 vicryl rapide. A non-adherent compressive dressing is applied using sterile strips for five days.

The management of the donor site includes 4 to 6 4-mm punch removal of conchal bowl cartilage (Figure 2). This allows granulation tissue from the medial side of the ear to grow through the conchal cartilage. Depending on the size of the conchal defect the donor site takes 3-5 weeks to re-epithelialize. (Figure 3) The cosmetic result is generally excellent and no further repair is necessary.
In order to obtain the best possible skin color and texture match, FTSG were chosen from various donor sites including preauricular, postauricular, nasolabial fold, upper eyelids and supraclavicular skin. In the study period, all FTSGs were defatted as much as possible before placing on the recipient site. All FTSG donor sites were closed primarily in a linear fashion.

Statistics
The difference in success rate between PCCG and FTSG was tested by means of a two-sided Cochran-Armitage Trend Test. Inter-observer agreement on cosmetic results was expressed in terms of an intraclass correlation coefficient. Testing differences in cosmetic results, between observers, was performed with a linear mixed effects model.

Patient material
A hundred and twenty-one grafts (70 FTSGs and 51 PCCGs) were applied in 118 patients. Three patients had a FTSG twice and were considered individual cases. Overall only superficial defects were eligible for skin graft reconstruction. The patients who had FTSGs included 38 males and 32 females. Their ages ranged from 39 to 89 years (median age: 68 years). The patients who had PCCGs included 23 males and 28 females. Their ages ranged from 14 to 83 years (median age: 65 years).

The main etiology of the facial defect in both groups was excision of skin cancer. (PCCGs 73% and FTSGs 96%). Other indications were two traumatic disorders, 4 dermal nevi, 2 lentigo maligna, 1 hemangioma, 1 scar, 1 atypical fibroxanthoma and 1 chondrodermatitis on the anthelix.

As shown in Figures 4 and 5 the dominant side of reconstruction was the nasal unit in both groups; 50 nasal defects in FTSGs (71%) and 32 nasal defects in PCCGs (61%).
RESULTS

Table 1 summarizes the type of graft related to facial recipient site and patient characteristics. Analyzes of all the locations of reconstruction, using chi-square test, showed no significant difference between the two groups. ($p = 0.47$)

It can also be noted that FTSGs have been applied more often to the lower third of the nose then PCCGs (49% vs. 31%, $p = 0.09$). Table 2 depicts the relationship between nasal recipient site and FTSG donor site. It is specifically clear that FTSGs taken from the melolabial fold were applied to the lower third of the nose most frequently, the reason being the frequently occurring good match in number of sebaceous glands between FTSGs taken from melolabial fold, and surrounding recipient skin of the lower third of the nose.

In 26 patients the iris and the defect were visible in the same photo allowing for precise calibrated measurements using J-Image. The median sizes of the 15 FTSGs and of the 11 PCCGS were, 236 mm and 153 mm, respectively. Although defect sizes were measured in a small number of patients, clinically the defect size was rarely larger than 2\(\frac{1}{2}\) centimeters.

Table 3 summarizes the survival rate in relation to type of graft. The complete survival rate of the 70 FTSGs was 87%. There were nine failures (four partial and five total failures). Of the 51 PCCGs, 94% was successful. There were three failures (two partial and one total graft failure). Although PCCGs clinically seem to demonstrate better graft take, there was no statistical significant difference. (Table 3; trend test $p = 0.1857$)

Seventy photographs (28 PCCGs (54% of total) and 42 FTSGs (59% of total)) with a min-
Table 1. Type of grafts and patient characteristics.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Category</th>
<th>FTSG (n=70)</th>
<th>PCCG (n=51)</th>
<th>( p )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td>M</td>
<td>38</td>
<td>23</td>
<td>0.32¹</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>32</td>
<td>28</td>
<td></td>
</tr>
<tr>
<td>Location</td>
<td>Lower 1/3</td>
<td>34</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Nose</td>
<td>16</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Upper 2/3</td>
<td>16</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Eye</td>
<td>6</td>
<td>6</td>
<td>0.47¹</td>
</tr>
<tr>
<td></td>
<td>Ear</td>
<td>4</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Other</td>
<td>7</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Age (mean;SD)</td>
<td></td>
<td>67.2; 12.2</td>
<td>61.9; 18.1</td>
<td>0.10²</td>
</tr>
</tbody>
</table>

¹ chi-square (two-sided) testing all locations \( p=0.47 \); testing lower nose versus other locations \( p=0.09 \).
² t-test (Satterthwaite, two-sided)

Table 2. FTSG donor and recipient site.

<table>
<thead>
<tr>
<th>Donorsite</th>
<th>Post-auricular</th>
<th>Pre-auricular</th>
<th>Melolab. fold</th>
<th>Supraclav.</th>
<th>Upper eyelid</th>
<th>Other</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recipient site</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lower 1/3 nose</td>
<td>3</td>
<td>6</td>
<td>22</td>
<td>2</td>
<td>1</td>
<td>34</td>
<td></td>
</tr>
<tr>
<td>Upper 2/3 nose</td>
<td>10</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td></td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>Periorbital</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td>5</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Ear</td>
<td>2</td>
<td></td>
<td></td>
<td>1</td>
<td></td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Forehead</td>
<td>1</td>
<td></td>
<td></td>
<td>2</td>
<td></td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>17</td>
<td>11</td>
<td>25</td>
<td>10</td>
<td>5</td>
<td>2</td>
<td>70</td>
</tr>
</tbody>
</table>
imum follow-up of 6 months were available for evaluation. The total photographic assessment scores from the three independent raters had an average measure intraclass correlation of 0.77 (95% CI 0.65 – 0.85). Assessments of the ENT-surgeon and dermatologist were most in agreement (weighted kappa = 0.46 (95% CI 0.31-0.61)). Further analysis showed no significant difference ($p= 0.207$) between the three raters. Figure 6, 7 and 8 show examples of excellent, mediocre and poor cosmetic outcomes.

Although the cosmetic outcome of PCCGs received a better overall score from the three raters, the difference between PCCG and FTSG was not significantly different. ($p = 0.06$). The results of the raters are shown in Table 4.

**Table 3. Success rates of FTSGs and PCCG, no significant difference (P > 0.3).**

<table>
<thead>
<tr>
<th>Type of graft</th>
<th>FTSG</th>
<th>PCCG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Success</td>
<td>61</td>
<td>48</td>
</tr>
<tr>
<td>Partial success</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Failure</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>70</td>
<td>51</td>
</tr>
</tbody>
</table>

Cochran-Armitage Trend Test: $p = 0.1857$

In the reconstructive decision-making process many factors must be taken into consideration. This includes the level of certainty of local tumor control, patients' health status (smoking, diabetes, vascular disease, multiple skin cancers) as well as patient wishes such as reconstructive burden and aesthetic result. The defect size, depth and location as well as skin status (thickness, relative excess) and the possible availability of a matching donor site must also guide the choice between secondary intention healing, skin graft or local or regional flap closure. In the study period (1995-2005), 965 facial skin cancer defects were reconstructed by the senior author (H.D.V.). In 47% the nose was affected. FTSGs and PCCGs were the mainstay of reconstruction in 121 cases (13%). Local and regional flaps were applied in 353 (37%) and 190 (20%) of the cases. The remaining 30% were treated by secondary intention healing or primary closure.

This clinical study was performed to compare the effectiveness of two types of skin grafts namely FTSGs and PCCGs. Survival rates and cosmetic appearance were used as measure of outcome.

Graft failure is defined by a dark black color of the graft surface in the first 5-7 days after surgery. This may signify total graft loss or only partial failure. In the first few days it is hard to determine whether one deals with superficial epidermolysis only or full-thickness
Figure 6. Cosmetic outcome of skin grafting on the nose characterized as excellent: good texture match to adjacent skin, slightly different color. A PGCG was used.

Figure 7. Cosmetic outcome of skin grafting on the nose characterized as mediocre: some hypo pigmentation and texture loss. A FTSG was used.

Figure 8. Cosmetic outcome of skin grafting on the nose characterized as poor: poor texture match, hypo pigmentation and contraction. A FTSG was used.

Table 4. Photographic assessment of FTSG and PCCG, cosmetic outcome was graded by summing the assessment scores.

<table>
<thead>
<tr>
<th>Raters</th>
<th>FTSG, 42</th>
<th>PCCG, 28</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>Clinical outcome</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Excellent</td>
<td>29 (%)</td>
<td>29</td>
</tr>
<tr>
<td>Good</td>
<td>48</td>
<td>40</td>
</tr>
<tr>
<td>Fair</td>
<td>21</td>
<td>26</td>
</tr>
<tr>
<td>Poor</td>
<td>2</td>
<td>5</td>
</tr>
</tbody>
</table>

6-7 = excellent; 8-9 = good; 10-12 = fair; > 12 = poor.
No significant difference in cosmesis between FTSG and PCCG ($p = 0.06$)
A= dermatologist, B= ENT surgeon and C= naïve scorer.
graft necrosis. Usually the graft is left to heal by secondary intention and no action is taken. Epidermolysis will usually heal with no significant scarring but can lead to loss of skin color and texture. Full-graft failure is obvious when the eschar is cast off from the wound bed. This can lead to induration and contracture.

In the literature, multiple studies report survival rates of FTSGs ranging from 70% to 95%. These rates are comparable to our survival rate of FTSG of 86%. For PCCG, clinical studies report survival rates of 98-100%. Given the possible variations in the criteria used for success, this may be considered level par with our survival rate of 94%.

Whether the perichondrial plexus allows for quicker revascularization by formation of anastomoses between graft and host vessels (inoculation) remains to be debated. One may also state that the dermal plexus of skin grafts also allows for inoculation and that the imbibition phase is easier if there is no barrier like the perichondrium. There is only one comparative study between PCCGs and FTSGs. This study using rabbits showed grafts survival rates of 65% for FTSG and 85% for PCCG.

Possibly, the PCCGs showed less contraction compared to FTSGs. It is suggested that while fibroblasts play an essential role in wound contracture, the perichondrium is an additional layer harnessing the contraction wound forces. Contraction of skin grafts was not the subject of this study. However, the suggested limited contraction of PCCGs induced us to apply PCCGs more frequently in eyelid reconstruction (Figure 5). However, the PCCGs, seem to demonstrate some bulging of the graft in the early postoperative period; whether this is initial contraction or just edema fading over time is not clear.

With regard to the cosmetic outcome in the literature of grafts, only 1 study used criteria to assess the cosmetic outcome of grafts. This specific study showed an 80% successful aesthetic result of FTSGs. In most studies the cosmetic outcome was only judged by the surgeon himself and so a biased judgment was created. In our study the grafts were systematically assessed by three independent raters who did not know the origin of the graft. All raters scored a 70-80% excellent to good cosmetic outcome for both types of grafts. No significant difference in cosmesis was found between the photographic assessment of FTSGs and PCCGs in our study. The postoperative skin color of grafts is of major influence on the clinical outcome because it clearly distinguishes grafts from the surrounding skin. If skin color of grafts would have been the only factor to be evaluated, statistical analysis again showed no significant difference between FTSGs and PCCGs. However, photographic assessment may be inferior to live assessment.

If we are ever to unveil the truth about the value of FTSGs and PCCGs, a prospective randomized study would be ideal. Is it ethically sound to apply a graft assigned by the study protocol when clinical experience suggests that another skin graft characteristic seems to better match the donor site? This probably leads to an inevitable tension between the surgeon committed to the individual patient here and now, and the clinical researcher whose focus is the benefit of future patients in the larger community.

Our goal was to explore and compare our results of PCCGs and FTSGs and draw tentative conclusions if possible. Given the statistical
outcome, these grafts reasonably matched for clinically important factors such as location of the defect, age and gender of the receiver, etiology of the facial defect. All patients were operated upon by one surgeon. Although the data about depth of the defect and graft size were limited, clinically both groups do seem compatible.

Given the limitations of our study we propose that both FTSGs and PCCGs are viable options in facial reconstruction, with no difference in survival and cosmesis.

A great benefit of skin grafting is its simplicity and one-stage procedure. Searching for the best possible match between donor site and defect as well as delicate tissue handling and good postoperative care is fundamental. The PCCG is an alternative smooth graft, containing few sebaceous glands. The simplicity of the conchal bowl donor site management by secondary intention may be an advantage. However, the underlying cartilage will not be available anymore for future reconstruction.

CONCLUSIONS
Both FTSGs and PCCGs are viable options in facial reconstruction, with no statistical difference in survival and cosmesis. They are simple and one-stage procedures. The PCCG may be seen as an addition to our armamentarium in our search for optimal reconstructive results.

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