Effectiveness of secondary post-traumatic periorbital reconstruction

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SUMMARY. In a 12-year period, 56 consecutive patients have undergone secondary periorbital reconstruction after trauma. To evaluate the overall results and the need for further correction, three diagnostic groups were formed. These were: malar bone (n = 16), midface (n = 16) and fronto-orbital fractures (n = 24). Also, in order to judge the reliability of the procedures used most frequently, all osteotomies of the zygoma (n = 32 in 30 patients), canthopexies (n = 26 in 19 patients) and corrections of the bony nasal skeleton (n = 26) were assessed as separate groups. After malar fractures, poor results were found in two cases while after midface fractures the results were quite satisfactory with only one poor result. The outcome after fronto-orbital fractures was also generally satisfactory. However, after a considerable number of later corrections there were still four poor results. Unfortunately, osteotomy of the zygoma left a rather high percentage of unsatisfactory results (19%), but canthopexies scored high and further corrections after secondary surgery of the nasal skeleton eliminated all but one poor result. It is concluded that 7% of our trauma patients undergo secondary and further periorbital corrections. The techniques have become routine. The final outcome was assessed as good in 60% and poor in 20% of patients.

INTRODUCTION

Seven years ago, a follow-up study on secondary post-traumatic periorbital surgery (SPPS) over a 6-year period was presented (Freihofer and van Damme, 1987). The number of cases discussed was rather small and a re-evaluation seemed appropriate, because in the meantime the number of patients had almost trebled. Also, earlier papers have generally dealt with isolated techniques, stopping short of integrating them into diagnostic groups and of following-up cases which have been treated less successfully. The purpose of this study was to:

- assess the overall treatment course
- judge the reliability of the procedures used most frequently
- evaluate the need for further surgery
- try also, to draw additional conclusions with respect to primary treatment.

PATIENTS AND METHODS

A total of 56 consecutive patients is presented of which 12 were female and 44 male, aged 3–54 years at the time of the accident (Table 1). They underwent secondary corrections between 1980 and 1991. 31 patients were primarily treated in our own department while 25 were referred to us after initial treatment elsewhere.

The delay between primary and secondary treatment varied from a few days to 25 years (Table 2) with a tendency to shorter delay for our own cases and patients seen in the second 6-year period.

For the purpose of this evaluation, three different groups of primary fractures were distinguished: 16 patients had sustained malar fractures, 16 fractures of the midface, in most cases including the maxilla, and 24 a fronto-orbital fracture, always including forehead and orbit but not necessarily nose and maxilla. Unilateral loss of vision was diagnosed on 15 occasions; in 1 patient with malar, in 6 with midfacial and 8 with fronto-orbital fractures.

Table 1 - Age at the time of accident/number of patients

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>No. of patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-10</td>
<td>2</td>
</tr>
<tr>
<td>11-20</td>
<td>14</td>
</tr>
<tr>
<td>21-30</td>
<td>19</td>
</tr>
<tr>
<td>31-40</td>
<td>11</td>
</tr>
<tr>
<td>41-50</td>
<td>6</td>
</tr>
<tr>
<td>&gt; 50</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td>56</td>
</tr>
</tbody>
</table>

Table 2 - Delay until secondary post-traumatic periorbital reconstruction

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>0–1 month</td>
<td>8</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>1–3 months</td>
<td>145%</td>
<td>20%</td>
<td>130%</td>
</tr>
<tr>
<td>3–6 months</td>
<td>5</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>6–12 months</td>
<td>5</td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td>1–2 years</td>
<td>855%</td>
<td>570%</td>
<td>470%</td>
</tr>
<tr>
<td>&gt; 2 years</td>
<td>4</td>
<td>5</td>
<td>5</td>
</tr>
</tbody>
</table>

In most cases reoperation was undertaken to improve aesthetics. A total of 168 corrections were performed secondarily, followed by 44 further procedures. The results were judged visually and diplopia was registered where appropriate. Results were rated as 'good' if patients and surgeon were satisfied that practically no deviation from normal could be detected, 'satisfactory' if a slight deformity was evident, but further correction did not seem to be necessary and 'poor', if it was considered so far from normal that it could not be overlooked and required further surgery. The majority of the patients were rated 'poor' before SPPS.

The outcome of the three groups of fractures will be discussed, together with the results of the techniques used most often. The latter, which includes osteotomy of the zygoma, canthopexy and corrections of the nasal skeleton will not be described in detail, as they had been reported elsewhere (Freihofer, 1986).

**Correction after fracture of the zygoma**

Of the 16 cases of malar fracture, 12 underwent osteotomy of the zygoma. In 9 reconstruction of orbital walls and in 4 additional contouring of the orbital rim was performed. Transplant materials were bone from the skull and iliac crest and also bank cartilage. A good result was obtained in 13 cases (80%).

However, a third operation in two patients and a fourth in one patient failed to improve the 2 'poor' results (Fig. 1). In one case diplopia persisted and in the other the aesthetic result was still not acceptable.

**Correction after fracture of the midface**

The multiple corrective procedures carried out on the 16 patients in this group are shown in Table 3. After
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A (Condition after repositioning of naso-orbito-malar fracture on the left in a 25-year-old patient. (A) An osteotomy of the malar bone, reconstruction of orbital walls, direct canthopexy and osteotomy of the nasal skeleton are planned. (B) Condition 10 days after operation. (C) Late result. The osteotomy of the zygoma is rated 'poor' because of residual diplopia and slight concomitant entrophtalmos, the canthopexy is judged 'satisfactory' because of vertical relapse and the nose as 'good'. There is also some ptosis.

<table>
<thead>
<tr>
<th>Table 4 – Therapy after fronto-orbital fracture</th>
<th>Secondary</th>
<th>Tertiary</th>
<th>Quaternary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reconstruction of forehead/frontal sinus</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reconstruction of base of skull</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Osteotomy zygoma</td>
<td>10</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Reconstruction of orbital wall</td>
<td>17</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>Shaping orbital rim</td>
<td>9</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Correction of nose</td>
<td>15</td>
<td>8</td>
<td>1</td>
</tr>
<tr>
<td>Canthopexy</td>
<td>17</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Dacryocystorhinostomy</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Le Fort I osteotomy</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scar correction</td>
<td>5</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Others</td>
<td></td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td>94</td>
<td>26</td>
<td>5</td>
</tr>
</tbody>
</table>

Fig. 3 – Condition after repositioning of naso-orbito-malar fracture on the left in a 25-year-old patient. (A) An osteotomy of the malar bone, reconstruction of orbital walls, direct canthopexy and osteotomy of the nasal skeleton are planned. (B) Condition 10 days after operation. (C) Late result. The osteotomy of the zygoma is rated 'poor' because of residual diplopia and slight concomitant entrophtalmos, the canthopexy is judged 'satisfactory' because of vertical relapse and the nose as 'good'. There is also some ptosis.

SPPS, the overall results were reasonably 'satisfactory' but were further improved by 5 corrections in 4 patients (Fig. 2), 4 of which were refinements to the nose (Fig. 3).

The residual 'poor' result was caused by scar contraction in the cheek which could not be adequately corrected.

**Correction after fronto-orbital fracture**

This was the largest and most heterogenous group of patients. The many different, and often extensive corrective procedures, are shown in Table 4. After having generally achieved little more than 'satisfactory' results with SPPS, a number of further reoperations took place in 14 of the 24 patients (Fig.

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Fig. 4 – Results after fronto-orbital fracture (24 patients).
4) and these considerably improved the mean result (Fig. 5).

In all 4 'poor' cases, the final opinion was reached following assessment of several different deformities, such as incorrect position of the eye or orbital prosthesis, increased intercanthal distance, unsatisfactory nasal contour and major soft tissue scarring. Each of these on their own may not have been judged 'poor' but contributed to the overall unsatisfactory appearance.

RESULT

Results after osteotomy of the zygoma

In all three diagnostic groups osteotomy of a displaced zygoma was the most frequent secondary procedure, being carried out 32 times in 30 patients. Additional significant reconstruction of the orbital walls was necessary in 25 cases, while concomitant remodelling of the orbital rim was needed 7 times.

The average outcome rated clearly above 'satisfactory', and further corrections improved the results only slightly, eliminating only one of the remaining 'poor' ones (Fig. 6). In none of these cases was further remobilization of the whole zygoma considered, only remodelling and improvement of orbital wall reconstructions (Fig. 7). In the 6 cases assessed as 'poor' (19%), 3 have residual diplopia, one with an additional contour defect while 3 others are aesthetically unsatisfactory.

Enophthalmos was evaluated postoperatively in 29 patients. In this group, there was found to be a relationship between the rating of the overall aesthetic

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Fig. 5 - 27-year-old patient, treated elsewhere for fractures of frontal bone, nose, both malar bones and maxilla. (A) Pre-operative condition before osteotomy of one zygoma, bone graft to the nose, double direct canthopexy and revision of the frontal sinus with drainage. (B) The result after secondary correction still being 'poor', further corrections of the nose, repetition of the canthopexies and correction of an epicanthal fold resulted in a 'satisfactory' result.

Fig. 6 - Results of osteotomy of the zygoma (32 sides)
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Fig. 7 - Condition after treatment in our own hospital of fractures of frontal bone, right malar bone, maxilla and mandible in an edentulous 53-year-old patient. (A) There is retroposition of the right zygoma and marked enophthalmos. (B) After remobilization - repositioning of the zygoma and reconstruction of the orbital walls enophthalmos is only partially corrected. The result is rated 'satisfactory'. (C) After further reconstruction of the walls and remodelling of the rim almost perfect symmetry has been obtained.

Table 5 - Postoperative enophthalmos in cases of osteotomy of the zygoma in relation to overall result. (N = 29 excluding cases with eye prosthesis)

<table>
<thead>
<tr>
<th>Rating of overall result</th>
<th>Total</th>
<th>Good</th>
<th>Satisfactory</th>
<th>Poor</th>
</tr>
</thead>
<tbody>
<tr>
<td>No enophthalmos</td>
<td>19</td>
<td>16</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Minimal enophthalmos</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Evident enophthalmos</td>
<td>6</td>
<td>1</td>
<td>1</td>
<td>4</td>
</tr>
</tbody>
</table>

result after correction of the malar bone and orbital walls and the position of the eyes (Table 5).

Results after repositioning of the medial canthus

In 19 patients canthal adjustment was carried out, in 7 cases bilaterally. Of these 26 canthi, 17 were repositioned directly and 9 indirectly. In contrast to the report of 1987 where no tertiary correction was required in the 5 cases, 3 of the second series of 14 patients required further revisional surgery. In all of them the direct technique was used and all poor results were eliminated (Fig. 8).

Two patients with a vertical asymmetry could only be rated 'satisfactory'. However, it seemed not to be absolutely necessary for the intercanthal distance to be below 36 mm, in order to be rated 'good' (Fig. 9).

Results after correction of the bony skeleton of the nose

The 26 secondary operations on the nose, 12 tertiary and 2 quaternary, illustrate the importance of this structure to the patient.

Nine patients underwent secondary reconstruction utilising a bone graft, 11 an osteotomy and 6 a combination of both. Simultaneous nasal tip surgery was unusual in secondary intervention. The mean result was 'satisfactory', after further corrections it

Fig. 8 - Results after reposition of the medial canthus (19 patients).
improved further (Fig. 10). The only remaining 'poor' result (4%) was in a patient who primarily sustained extremely severe fronto-orbito-maxillo-mandibular injuries. All aspects were improved to some extent, but the overall impression remained 'poor'.

It is interesting to note, that of the 40 cases with midface and fronto-orbital fractures, 6 underwent secondary Le Fort I osteotomy to improve occlusion. For one, bimaxillary osteotomies were planned on purely aesthetic grounds, the function being 'good'.

DISCUSSION

The distribution by sex and age of this series of patients is practically the same as for primary facial trauma in the Nijmegen area (van Beek, 1992). Apparently, there is no selection of specific groups who agree to undergo secondary surgery. We have re-operated upon many more of our own patients in recent years, while referrals have remained about the same (Table 2). The reason might be that we look

Fig. 9 – Fractures of one malar bone, the nose and the frontal bone treated elsewhere at age 21. (A, B) Exploration of infected frontal sinus with drainage, bone graft to the nose, bilateral direct canthopexies and unilateral dacryocystorhinostomy were needed secondarily. (C, D) After further minor nasal correction the result is rated 'good' in spite of an intercanthal distance of 38 mm.
After secondary correction  Further operations  Final result

Good 9 4 15
Satisfactory 12 1 10
Poor 5 3 1

Fig. 10 – Results after correction of nasal skeleton (26 patients).

more critically at the result after primary surgery, because our confidence in the potential for secondary improvement is increased. We are aware that evaluation without measurable criteria opens the door to bias. However, we feel that subjective factors are important, especially when discussing these issues with the patient. The series allows an estimate to be made of the necessity for secondary corrections. In the series of our department 1 out of 50 fractures of the zygoma, 1 out of 15 fractures of the midface and 1 out of 4 fronto-orbital fractures undergo such surgery. This substantiates clearly our earlier statement that the probability of SPPS increases with the severity of trauma (Freihofer, 1987). The same is true for further corrections. These ratios vary from clinic to clinic (Röthler and Walldhart, 1991; Ulrich et al., 1991; Weber et al., 1991) and cannot be compared directly. Some very similar ratios have been reported (Eickbohm et al., 1991; Krause et al., 1991), and also some considerably less favourable (Hürtel, 1991). The outstanding results of Gruss (1991) are not approached by anyone else.

A tendency is seen for earlier reoperation (Table 2). As in primary treatment, an attempt was made to do everything in one session Freihofer and van Damme, 1987). This aim could usually be realized except where tip refinements were sometimes delayed in cases of bone grafting to the nose. We did not come across any real incompatibility of techniques. In the first series we reported that we had not had to operate on an infected frontal sinus. In contrast to this, 6 had to be revised in the second series, one of them, primarily belonging to the first series, 11 years after primary treatment. Of these 6, only in one case is it known with certainty that a drain was inserted for a few weeks after the primary operation. After secondary surgery, all (except one, which was occluded by bone-grafting) were drained for 3 weeks. No further infection has so far been evident.

Diplopia was recorded as a reason for reoperation in 20% of the patients in our series. When one considers that residual diplopia is quoted in 2-8% of cases after primary treatment of malar fractures by other authors (Düker and Olivier, 1975; Schiffer and Austermann, 1977), this must be regarded as a relatively high percentage, indicating that functional reasons played a significant role in reoperations, although most zygoma in our series were corrected for aesthetic reasons. It should, however, be borne in mind that 15 patients (27%) had lost visual acuity in one eye due to the initial accident. Six patients with unilateral loss of vision among 16 with midface fractures is an extremely high percentage and suggests that the patients in this group had sustained exceptional trauma.

Correction of enophthalmos is an important part of treatment, because it has a considerable impact on the overall result. In one out of 4 cases, we did not succeed in compensating sufficiently. One other study reports comparable results in this respect (Rončević, 1983), and it is assumed that the main reason for this was inadequate overcorrection along the lines advocated by Kawamoto (1982). It must be recognized, however, that the amount of overcorrection needed is difficult to evaluate at the time of surgery, especially in cases with extreme enophthalmos. Figure 7 demonstrates that subsequent adjustment is still possible.

It was disappointing that a ‘good’ result, i.e. symmetry, was obtained in only 67% of zygomatic osteotomies. However, it has to be kept in mind that in 30% of normal faces, asymmetries in the zygomatic area of 4 mm or more may be found (Pape et al., 1977). We also acknowledge the importance of the zygomatic arch as a reference point (Gruss et al., 1990). We have nonetheless seen over- and undercorrections in this area independent of fixation techniques (Freihofer and Borstlap, 1989).

The results of canthopexy were a positive surprise, although 3 tertiary corrections were needed, in contrast to the earlier series. There was no significant difference between results obtained by direct and indirect techniques in these patients. However, a study on primary canthopexy from this department demonstrates that direct canthopexy is significantly more reliable and has a mean horizontal relapse rate of less than 2 mm. It concludes that the aim of treatment, at
the end of the operation, is an intercanthal distance of 33 mm after direct, and 31 mm after indirect canthopathy as an upper limit (Merkx et al., in press).

It is not surprising that the nasal bony skeleton required correction more frequently than the soft tissues, including the cartilages. However, the number of secondary bone grafts in cases treated primarily in our hospital was felt to be high. In the second 6-year period less (7/13) were needed than in the first (4/5). A difference between surgeons was evident, those more experienced choosing more readily to carry out a primary graft. Therefore, we feel that one should anticipate the need for primary grafting in order to avoid secondary procedures.

An interesting 'new' finding in the second series was upper eyelid ptosis in 40% of the fronto-orbital fractures after secondary correction and in one patient with trauma of the midface (Fig. 3). As it occurred predominantly in cases which had been primarily treated in our department, we wondered whether it was related to our technique, as a satisfactory alternative explanation could not be found.

CONCLUSIONS

Secondary post-traumatic periorbital reconstruction has become a standard treatment modality. Following a study of the patients in this series, it can be predicted that 7% of our patients sustaining periorbital injuries will require revisional surgery, usually for aesthetic reasons. After secondary surgery 40% of the patients are likely to have a good result, but another 40% will require further surgery. After this the results are assessed as 'good' in 60% and 'poor' only in 20%. Tertiary corrections after fracture of the zygoma and after secondary osteotomy of the zygoma, generally speaking, will not markedly improve the results. The further improvements by tertiary surgery after fracture of the midface are reasonable and after fronto-orbital injuries considerable. This is also true for improvements of the position of the inner canthus and both hard- and soft-tissue corrections of the nose.

In the future it will be necessary to address the problem of ptosis, which is not fully explained by this follow-up evaluation. The techniques used for secondary correction are well established and generally adequate. However, it seems justified to state, that with even more extended primary treatment a number of secondary corrections, especially after fractures of the zygoma and the nasal skeleton, could perhaps have been avoided.

References


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