Journal of Cranio-Maxillo-Facial Surgery 45 (2017) 485–490

Contents lists available at ScienceDirect

Journal of Cranio-Maxillo-Facial Surgery

journal homepage: www.jcmfs.com

Calculation of resected orbital wall areas in the treatment of endocrine orbitopathy

Matthias Krause [a], Heike Hümpfner-Hierl [a], Daniel Kruber [a], Ina Sterker [b], Thomas Hierl [a, *]

[a] Department of Oral & Maxillofacial Plastic Surgery (Head: Alexander Hemprich MD DDS PhD), Leipzig University, Liebigstr. 12, 04103 Leipzig, Germany
[b] Department of Ophthalmology, Leipzig University, Liebigstr. 12, 04103 Leipzig Germany

ARTICLE INFO

Article history:
Paper received 23 September 2016
Accepted 11 January 2017
Available online 25 January 2017

Keywords:
Endocrine orbitopathy
Decompression
Navigated surgery

ABSTRACT

Purpose: Orbital wall decompression is routinely used to treat proptosis in endocrine orbitopathy. Until now, however, there has been no investigation to measure the area/extent of the removed walls.
Materials and methods: The inner areas of 154 orbital walls (lateral, inferior, medial) which had been resected in 38 patients were measured using pre- and postsurgical computed tomographic data in Brainlab iPlan software. Furthermore the effect of concomitant centrolateral orbital rim advancement was calculated in 48 cases. Surgery was performed after preoperative planning using intraoperative navigation.
Results: The mean area of resected inferior and medial orbital walls lay at 6.7 cm^2 and 6.2 cm^2, while the area of the lateral orbital wall was 6.9 cm^2. Rotation-advancement of the lateral rim added an area of 1.8 cm^2 (~25% of the lateral orbital wall). Comparison of the pre- and postsurgical computed tomographic data showed excellent conformity of the presurgical planning and postsurgical results.
Conclusions: This investigation is a first step in analyzing the potential surgical effect of bony decompression surgery by stating the metric amount of orbital wall removal. Using these data, further studies will be performed in the future.

1. Introduction

Endocrine orbitopathy (EO) is the most frequent and important extrathyroidal sign of Graves' disease (Bartalena et al., 2008a, 2008b). Early restoration and maintenance of euthyroidism and immunosuppressive treatment is the first-line therapy during the active phase of disease, whereas rehabilitative surgery (orbital decompression by enlargement of the bony orbit and/or orbital fat resection, squint surgery, eyelid surgery) is postponed until a stable euthyroid and inactive stage of at least 6 months is reached (Bartalena et al., 2008a, 2008b, 2000; Bonara et al., 2008; Graham and Carter, 1999; Kamer et al., 2009; Mourits et al., 1990; Schaefer et al., 2003; Wulc et al., 1990; Kirsch et al., 2009; Zielinski et al., 1989).

Since 1911, when Dollinger first described surgical orbital decompression (Dollinger, 1911), many different techniques and approaches have been endorsed, including one-, two-, three-, and four-wall decompressions with or without orbital fat removal (Leong and White, 2010). Further surgical techniques include the advancement or lateral expansion of the laterocentral orbital frame (Gonzáles-Garcia et al., 2008; Tavassol et al., 2012; Tessier, 1969; Wolfe, 1979).

The primary goal of orbital decompression surgery is the reduction of proptosis. This is supposed to depend on the number of the removed orbital walls, the extent of their removal, and the anatomy of the bony orbit and periorbital spaces (Lee et al., 2003).

There are a few references that suggest that the reduction of proptosis is related proportionally to the number of removed walls, with about 2–3 mm per wall (Lee et al., 2003; Mourits et al., 2009). The anatomy of the orbital walls are well described (Holck and Ng, 2005), but until now there has been no investigation on the real metric extent of orbital wall decompression. The reasons for this are presumably the difficulties encountered in the measuring.

* Corresponding author.
E-mail addresses: KrauseMa@medizin.uni-leipzig.de (M. Krause), Heike.Huempfner-Hierl@medizin.uni-leipzig.de (H. Hümpfner-Hierl), danielkruber@gmx.de (D. Kruber), Ina.Sterker@medizin.uni-leipzig.de (I. Sterker), hiet@medizin.uni-leipzig.de (T. Hierl).

http://dx.doi.org/10.1016/j.jcms.2017.01.015
1010-5182/

Therefore the purpose of this study was to define the areas of the removed walls in orbital decompression for the first time. This seems to be a necessary prerequisite to improving the understanding of decompression surgery, to permit comparison between future investigations, and eventually to allow patient-specific surgical simulation. Furthermore, real measurements should be performed, as purely anatomical measurements of the orbital wall area in unaffected orbits will include regions not accessed during decompression surgery.

2. Material and methods

From 2010 to 2015, a total of 38 patients with endocrine orbitopathy were treated by bony decompression surgery and were retrospectively evaluated. Of the patients, 34 underwent operation bilaterally and four patients unilaterally, resulting in 72 operated orbits (150 orbital walls). The mean age was 51.6 ± 9.3 years (range 31–76 years), and the group consisted of 25 women and 13 men. Ten patients (26.3%) had dysthyroid optic neuropathy. Surgical procedures included uni- or bilateral one-, two-, and three-wall decompression with or without advancement of the laterocentral orbital rim (lateral rim advancement [LARA]) according to Gonzales-Garcia et al. (Gonzáles-Garcia et al., 2008). LARA was performed as the standard procedure in 25 cases. It increases the depth of the orbit in the lateral aspect and moves the lateral canthal ligament anteriorly. This leads to an instant esthetic improvement of proptosis (it changes Hertel values even without globe movements) and diminishes lateral skin retraction caused by lateral canthal tension. LARA leaves the orbital rim as a circular structure intact and prevents lateral skin retractions that might result in cases in which the lateral orbital rim is removed. During decompression surgery, the temporary removal of the lateroorbital rim eases the access to the lateral and inferior orbital walls and prevents excessive retraction and pressure on the orbital contents.

In 13 patients, the lateral orbital rim was not changed due to the following reasons: unilateral decompression (n = 4); isolated massive enlargement of the rectus medialis muscles (n = 1); mild proptosis with only bilateral lateral wall decompression (n = 1); and endocrine orbitopathy without major exopthalmus but ophthalmologic symptoms (n = 7).

Table 1 shows the relevant patient data. In the first three cases, surgery was performed via bicoronal open access, and in all subsequent cases a transconjunctival incision with lateral canthotomy was performed. In cases of LARA, a small secondary upper eyelid crease incision was added to permit the osteotomy of the superiormedial orbital rim lateral to the supraorbital foramen. In LARA, the upper and lower osteotomy cuts on the orbital rim served as a hinge to rotate the lateral aspect anteriorly using two microplates. After defining the desired advancement, a third microplate was inserted at the lateral aspect of the orbital rim to the zygomatic bone to prevent backward rotation. Furthermore, milled bone chips gathered during decompression were inserted in the superior and inferior gaps to stabilize the advancement/rotation. No lateral expansion of the orbital frame was performed with LARA. Orbital wall removal was performed using piezosurgical instruments, rongeurs, or forceps (Hierl et al., 2016). All patients underwent planning preoperatively in iPlan Brainlab software (Brainlab, Feldkirchen, Germany), and the Brainlab navigation system was used intraoperatively to control the amount of decompression and rim advancement. Preoperatively, the resection borders were planned as described below.

2.1. Lateral orbital wall

For cranial and posterior borders, the skull base contour was interpolated into orbit with removal of sharp cortical edges. The anterior border was drawn 4–5 mm posterior and parallel to the anterior border of the lateral orbital rim; and the inferior border was defined as follows: anteriorly the turning point between lateral and inferior wall, in the posterior region the inferior orbital fissure.

2.2. Inferior orbital wall

Anterior border: 3–4 mm posterior and parallel to the anterior border of the infraorbital rim; Posterior border: turning point between inferior wall and pterygopalatine fossa; medial border: upturning between inferior and medial wall (inferomedial strut); lateral border: anteriorly the turning point between lateral and inferior wall, in the posterior region the inferior orbital fissure.

The area of the inferior orbital fissure was not included in area calculation.

2.3. Medial wall

Anterior border: 3–4 mm posterior to the lacrimal fossa parallel to the medial orbital rim; posterior border: vertical line 4–5 mm anterior to the optic canal; inferior border: turning point to inferior wall (inferomedial strut); superior border: line parallel to skull base (2–3 mm caudal of skull base).

2.4. LARA

Superior extension: midorbital plane lateral to supraorbital foramen; inferior extension: midorbital plane (cranial-lateral to infraorbital foramen).

Fig. 1 shows a typical preoperative planning situation with display of resection borders, LARA osteotomy and LARA advancement (light blue and yellow, respectively). The optic and infraorbital nerves are colored red. All other markings resemble the planned resection borders.

All patients underwent pre- and postsurgical computed tomography (CT) scans, the findings from which were used for this analysis (0.4–1 mm contiguous slicing, bone windowing).

When measuring the area of the removed walls, several problems were encountered. Simply measuring the area of the orbital walls would have been possible, but this would be an anatomic

Table 1
Distribution of examined orbital walls.

	Unilateral			Bilateral without LARA			Bilateral with LARA		
	Patients	Orbits	Walls	Patients	Orbits	Walls	Patients	Orbits	Walls
1 wall (lateral)				1	2	2	3	6	6
2 walls (inferior + lateral)	2	2	4	3	6	12	20	40	80
2 walls (inferior + medial)				1	2	4			
3 walls (lateral + inferior + medial)	2	2	6	4	8	24	2	4	12
Orbital walls: 150	Lateral = 70		Inferior = 64		Medial = 16				

LARA, lateral rim advancement.