Posttraumatic orbital emphysema: incidence, topographic classification and possible pathophysiologic mechanisms. A retrospective study of 137 patients

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Objective. The aim of this study was to retrospectively evaluate the incidence of posttraumatic orbital emphysema (OE) and to propose a radiologic topographic classification as well as a possible pathophysiologic model.
Study Design. Orbital fine-cut (1 mm) computerized tomographic scan slices from 137 patients were used to assess the fracture's type, the presence and position of OE, and periorbital tissue herniation. The OE was categorized into the following 5 compartments: subcutaneous periorbital, peribulbar, retrobulbar extra- and intraconal, and pterygopalatine fossa.
Results. The incidence of OE was 61%. OE was more frequently associated with isolated medial wall (78%; $P < .001$) and combined medial wall/orbital floor (82%; $P < .01$) fractures. Palpable isolated subcutaneous eyelid emphysema was not related to fracture's type ($P = .85$).
Conclusions. OE suggested medial wall fractures alone or combined with orbital floor fractures. Pathophysiologically, according to the Poiseuille law, the difference in length between the ethmoid and sinusal infundibulii could explain the increased incidence of OE when the medial wall is involved. (Oral Surg Oral Med Oral Pathol Oral Radiol 2013;115:737-742)

Orbital emphysema (OE) is a recognized complication of orbital fractures involving any of the paranasal sinuses.[1,2] Concomitant conditions, such as mucosal tears and acute rise in intranasal pressure, are necessary to create a passage of air in the orbit. Orbital tissue further blocks the exit of air, creating a ball valve system.[1,3,4-6]

OE is generally a benign and self-limited condition lasting from 2 days to 2 weeks, though it has been linked to potentially sight-threatening conditions such as compressive optic neuropathy due to acute orbital compartment syndrome and orbital cellulitis.[2,6,13-18] The treatment possibilities of these specific sight-threatening conditions are well described elsewhere.[1,6,16,18]

Although earlier studies have shown a higher incidence of OE in medial wall fractures, none have studied this condition in systematic clinical and radiologic (fine-cut computerized tomographic [CT] scan) fashion.[21,22] To date, the higher proportion of nose bleeding and consecutive nose blowing linked to medial wall fractures has been the only explanation proposed for this supposed higher incidence.[1,3,4,7-11]

The aim of the present study was to evaluate the incidence of OE related to different types of pure orbital fractures, to propose a topographic classification based on fine-cut CT scan analysis regarding the different orbital compartments involved with OE, to analyze whether OE protects from tissue herniation with an "air bag" effect, and to propose a pathophysiologic model.

MATERIALS AND METHODS

Patients were selected from a database of facial trauma at the Hôpitaux Universitaires de Genève, Switzerland, over a 3-year period from 2008 to 2011. The procedure followed in this retrospective study was in accordance with the Helsinki Declaration of 1975, as revised in 2000, and was approved by our local Ethical Board. Only patients with pure orbital fractures (not associated with concomitant midfacial fractures) and available fine-cut CT scans (1 mm) were included. Age, sex, mechanism of injury, presence of palpable palpebral crepitation, and diplopia were retrieved from the patient's file.

CT scan acquisition

Imaging was performed with a 64-slice CT scanner (Siemens Sensation 64; 120 kV, 240 mAS, 2 × 32 detectors,

Statement of Clinical Relevance

Our findings showed that pure orbital fractures result in a high rate of orbital emphysema (OE). The higher incidence of OE in medial wall fractures could be explained by the difference in length between the ethmoid and sinusal infundibulii.

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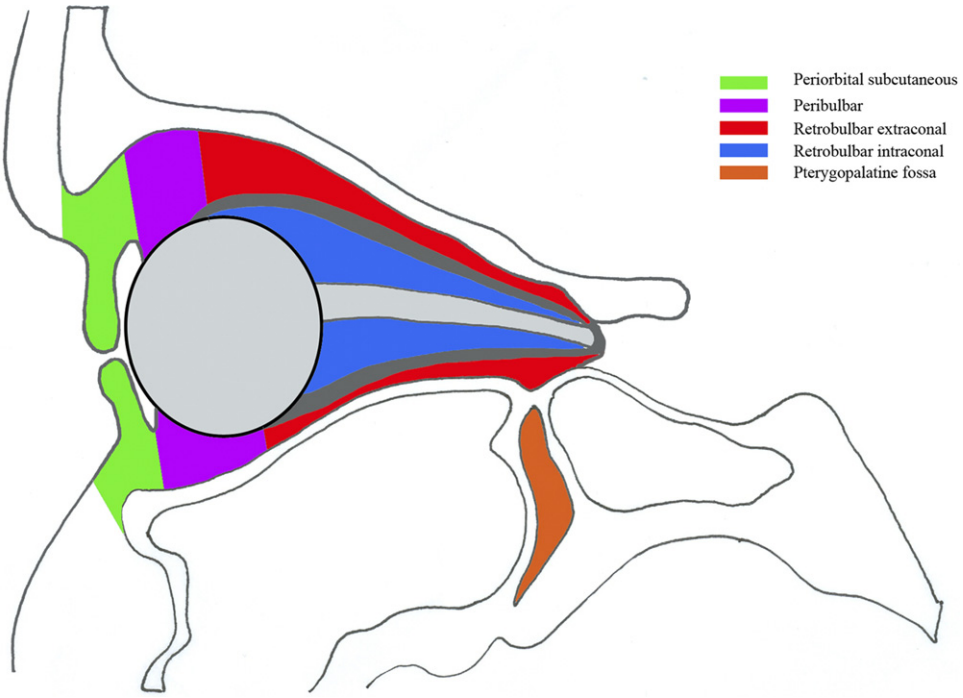

Fig. 1. Illustration of the 5 compartments used to topographically categorize orbital emphysema.

increment 0.7 mm, collimation 64 × 0.6, slice thickness 1 mm, matrix 512 × 512 pixels, gantry tilt 0°).

Computer image analysis

All CT scans were simultaneously reviewed in axial, coronal, and sagittal planes with the Osirix imaging software (version 3.8.1; www.osirix-viewer.com) running on Mac OS X 10.5 (Apple Computer, Cupertino, CA). The fracture type and the presence and location of emphysema were noted. Fractures were categorized as follows: floor, medial wall, roof, combined medial wall with roof and/or floor. The bony buttress between the inferior aspect of the ethmoidal cells and the maxillary sinus was used to delimit the floor and medial walls. Similarly, the bony septa between the frontal sinus and the superior aspect of the ethmoidal cells provided an anatomic separation between the orbital roof and the medial wall. We further categorized the site of orbital emphysema into 5 compartments. The compartment anterior to the orbital septum involving the palpebral region was defined as periorbital subcutaneous. The compartments posterior to the orbital septum were subdivided into peribulbar, retrobulbar (extra- and intraconal), and pterygopalatine fossa (Figure 1). Periorbital soft tissue herniation within or below the original position of the bone was also noted.

Statistical analysis

The largest study regarding OE incidence in orbital trauma found a proportion of 70% in medial wall fractures and 18% in floor fractures.[3] Precision calculation indicated that a sample size of a minimum of 37 patients with medial wall fractures and 73 patients with floor or roof fractures, for a total of 110 patients, was necessary.

Data were analyzed with the use of the statistical software R 2.10.1 (R Foundation for Statistical Computing, Vienna, Austria). Proportion of various fractures according to presence or absence of OE and its topographic location was examined with the use of bar plots. To examine the impact of fracture type on OE, we restricted our analysis to medial wall, floor, and roof fractures, excluding complex fractures, and used a logistic regression scheme. The effect of the fracture's location was estimated alone (univariate analysis) as well as adjusted for sex, age, and underlying mechanism. We also estimated the proportion of medial wall fractures compared with other subtypes of orbital fractures according to the number of compartments presenting OE (from 0 to 5). Finally, to determine if the importance of emphysema (i.e., amount of compartments involved) influenced herniation (possible protective effect of emphysema), logistic regression was used. The significance level was set at a P value of .05.

RESULTS

This retrospective study included 137 patients, with a mean age of 43.6 (SD 23.0) years. Sample characteristics are summarized in Table I. All patients presenting OE received 625 mg of amoxicillin and clavulanic acid prophylactically 3 times a day for 5 days. None of the patients presented posttraumatic orbital infection.