Realtime-navigated, customized correction of superior sulcus deformity and enophthalmos in anophthalmic patients using computer-assisted designed 3D titanium-meshes

Rana M / Essig H / Gladilin E / Zizelmann C / Schramm A / Gellrich NC / Kokemüller H / Wilde F
Medical School Hannover (Germany)

Project #: C-10-17R

Ablative surgery of the orbit is often associated with dramatic changes in facial geometry. Surgical intervention is often necessary to correct functional and aesthetical appearance in those patients who are anophthalmic, having an intact eyelid appearance together with an orbital prosthesis. This group of anophthalmic patients is known to have in 100% a combined problem of hypophthalmic, enophthalmic anophthalmos including a considerable functional and cosmetic deformity. The outcome of the surgical correction depends on the shape of orbital implants and their adequate placement. In the case of comparatively small rearrangements, the impact of implants on soft tissues can be estimated by surgeons on the basis of their experience. However, large deformities in complex cases (including large deformation of soft tissue or asymmetry) can be hardly predicted on the basis of simple empirical considerations. The purpose of this study is to investigate long-term effectiveness of a new procedure of inverse design of customized orbital titanium meshes. Anophthalmic patients with superior sulcus deformity or enophthalmos will be enrolled in this study. First, the appearance and projection of the orbital prosthesis together with the periorbital soft tissues are examined using 3D optical FaceScan. 3D photographs will be taken in all patients to compare the degree of superior sulcus deformity and, additionally, exophthalmometric value will be examined via Naugle exophthalmometer. Volume and structure of extraocular muscles, soft tissue and bony structure of the orbital walls will be examined using high resolution multi-slice tomographic scanning. After that a geometrical model of the patient's anatomy is generated from tomographic data. Afterwards, the orbital prosthesis is virtually relocated to a new position. Then, the desired correction of particular soft tissue regions is performed using virtual sculpturing tools. Next, the deformation of soft tissues and initial prosthesis boundaries are computed from the predefined displacements of relocated tissue regions with the help of the Finite Element Method. The differential volume between the initial and the designated position of the orbital prosthesis yields the sought implant shape which is required to effect the desired correction of soft tissue. During surgery the pre-planned position of the customized titanium meshes is guided by a navigation system. Until now, there are rare findings of scientific evidence and trials showing a predictable simulation using inverse finite element approach in correction of severe enophthalmos in anophthalmic patients with computer-assisted fabricated individual titanium meshes for reconstruction of orbital walls.