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Computer aided planning and intraoperative navigation in cranio-maxillofacial distraction

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Introduction

Distraction of the facial skeletton in case of severe deformities needs detailed planning. In cranio-maxillofacial surgery advances in imaging techniques (spiral-CT, 3D-imaging) and associated technologies (stereolithographic models, CAD/CAM) have led to an improvement of preoperative planning. Stereolithographic models however do not fulfill the requirements for complex cranio-maxillofacial plastic and reconstructive procedures i.e. preoperative planning with virtual correction, intraoperative navigation and postoperative control.

Materials and Methods

On the base of a CT data set in our clinic an optical Navigation-System (Stryker-Leibinger) was used for preoperative planning, intraoperative navigation and postoperative control in complex cranio-maxillofacial distraction procedures (fig. 1). Bony and soft tissue contours were measured preoperatively, the surgical approach was marked and the distraction osteotomy and vectors virtually designed. Intraoperatively contours of preoperative planning were navigated.

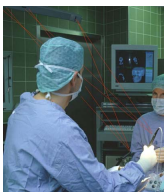

Fig. 1a: Frameless stereotaxy with infrared localization.

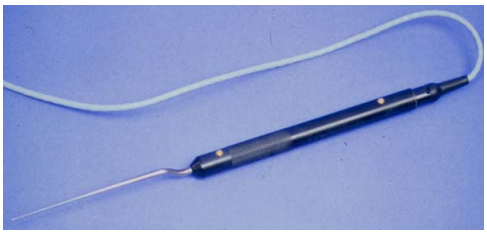

Fig. 1b: Surgical tool with infrared diods

Fig. 1c: Tracking frame

Fig. 1d,e: Non-invasive registration with an occlusal splint

Results

In 6 patients computer assisted distraction was performed. For mandibular distraction pre-operative planning was sufficient, intraoperative navigation dispensable. In midface distraction intraoperative navigation allowed guided osteotomies (fig. 2) and positioning of internal distraction devices according to the preplanned vectors (fig. 3).

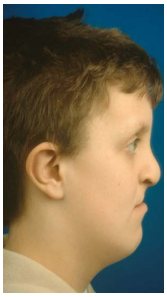

Fig. 2a: Midfacial hypoplasia due to cleft-lip-palate: preoperative view

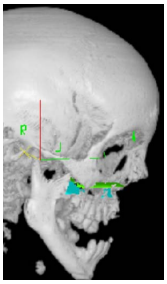

Fig. 2b: Osteotomy lines and tooth buts are marked preoperatively

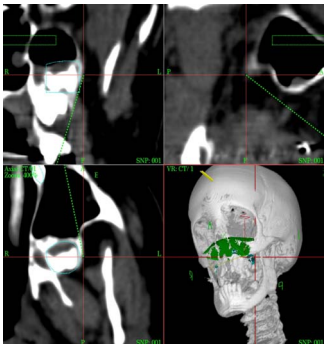

Fig. 2c: Monitor screen of intraoperative navigation: guided osteotomy saving hidden tooth buts

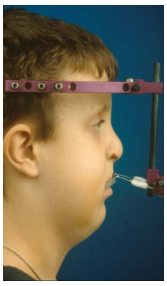

Fig. 2d: Postoperative clinical view

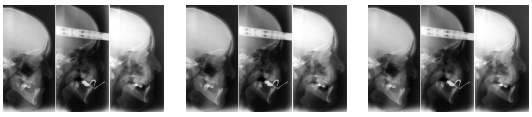

Fig. 2e-g: Radiological follow up

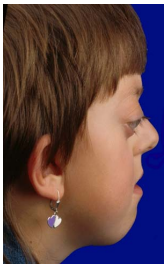

Fig. 3a,b: Crouzon's syndrom with midfacial hypoplasia: preoperative view

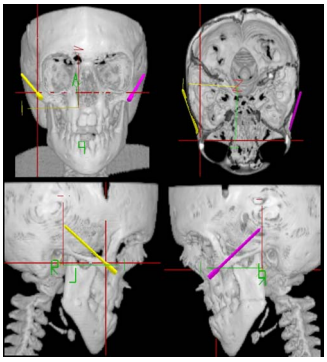

Fig. 3c: Virtual positioning of the distraction vectors

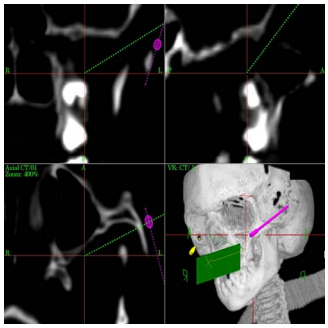

Fig. 3d: Intraoperative navigation: guided osteotomy in the Le-Fort-III level saving tooth buts

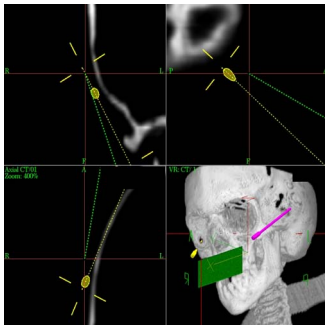

Fig. 3e: Intraoperative navigation: positioning of the distraction devices according to the preplanned vectors.

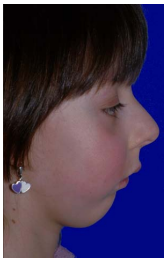

Fig. 3f,g: Postoperative clinical outcome after midface distraction

Fig. 3h,i: the pre and postoperative clinical comparison (Fig. 3h,i)

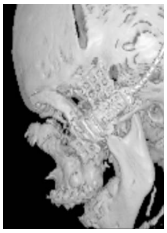

Fig. 3j,k: Radiological pre- and postoperative follow up: side view

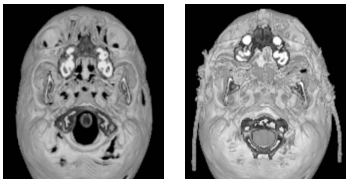

Fig. 3l,m: Radiological pre- and postoperative follow up: axial view

Discussion

With computer assisted CT evaluation demanding distraction procedures such as midface and mandible distractions in patients with craniofacial syndroms can be prezisely preplanned. Intraoperative the guided osteotomy prevents damaging of vital structures. Vectors and positioning of the internal distraction devices can be navigated according to the preoperative treatment plan. However further software developments are required to fulfill all demands for virtual distraction.

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Abbreviations

CT = Computed Tomgraphy
STN = Surgical Tool Navigator

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Poster Faksimile:

Computer aided planning and intraoperative navigation in cranio-maxillofacial distraction

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Introduction:

Distraction of the facial skeleton in case of severe deformities needs detailed planning. In cranio-maxillofacial surgery advances in imaging techniques (spiral-CT, 3D-imaging) and associated technologies (stereolithographic models, CAD/CAM) have led to an improvement of preoperative planning. Stereolithographic models however do not fulfill the requirements for complex cranio-maxillofacial plastic and reconstructive procedures i.e. preoperative planning with virtual correction, intraoperative navigation and postoperative control.

Materials and Methods:

On the base of a CT data set in our clinic an optical Navigation-System (Stryker-Leibinger) was used for preoperative planning, intraoperative navigation and postoperative control in complex cranio-maxillofacial distraction procedures (fig. 1).

Fig. 1: Infrared diode of the surgical tool (b) and the tracking frame (c) are detected by the camera (a) for intraoperative navigation. Non-invasive registration is performed with an occlusal splint (d,e).

Results:

In 6 patients computer assisted distraction was performed. For mandibular distraction preoperative planning was sufficient, intraoperative navigation dispensable. In midface distraction intraoperative navigation allowed guided osteotomies (fig. 2) and positioning of internal distraction devices according to the preplanned vectors (fig. 3).

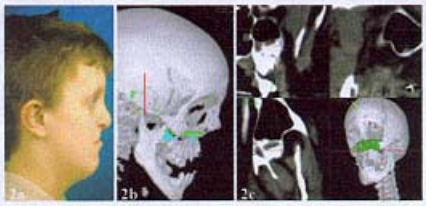

Fig. 2 a,b,c: Midfacial hypoplasia due to cleft-lip-palate (a); preoperative view: osteotomy lines and tooth buts are marked (b); intraoperative navigation allows a guided osteotomy according to the preoperative planning and indicates hidden tooth buts as seen on the monitor screen intraoperatively (c).

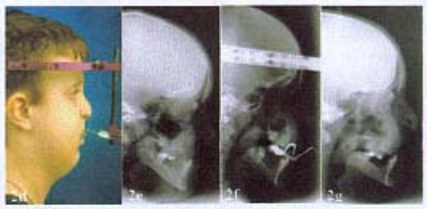

Fig. 2 d,e,f,g: The postoperative clinical view (d) and the radiological follow up is demonstrated (d,e,f,g).

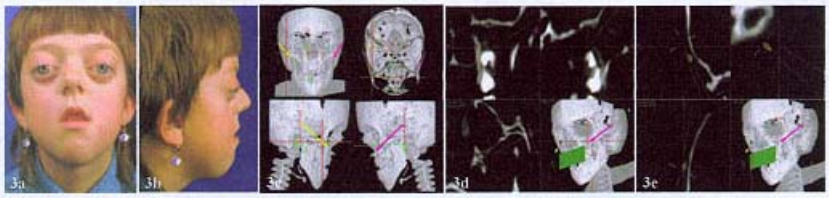

Fig. 3 a,b,c,d,e: Crouzon´s syndrom with midfacial hypoplasia; preoperative planning allows virtual positioning of the distraction vectors (c); intraoperative navigation achieves guided osteotomy in the Le-Fort-III level saving tooth buts (d) and positioning of the distraction devices according to the preplanned vectors (e).

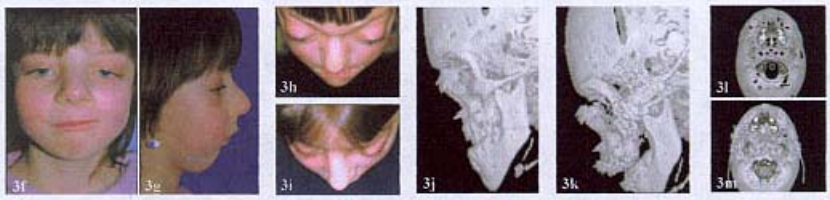

Fig. 3 f,g,h,i,j,k,l,m: Postoperative clinical outcome after midface distraction (f,g); the pre (h) and postoperative (i) clinical comparison and the radiological pre- (j,l) and postoperative (k,m) follow up demonstrate sufficient sagittal advancement and full orbital competence.

Discussion:

With computer assisted CT evaluation demanding distraction procedures such as midface and mandible distractions in patients with craniofacial syndroms can be precisely preplanned. Intraoperative the guided osteotomy prevents damaging of vital structures. Vectors and positioning of the internal distraction devices can be navigated according to the preoperative treatment plan. However further software developments are required to fulfill all demands for virtual distraction.