

ABSTRACT BOOK



4<sup>th</sup> international

# Bernd-Spiessl-Symposium

for Innovative and Visionary Technologies in Cranio-Maxillofacial Surgery

Face and Identity | 3D-Planning and Navigation

June 5<sup>th</sup> – 7<sup>th</sup> 2008 | University Hospital Basel | Switzerland

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# Index

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Barth, Enno-Ludwig	7	Luebbers, Heinz-Theo	55, 57
Berndt, Dorothea	8	Müller, Andreas A.	26
Cattin, Philippe C.	9	Müller, Bert	27
Berg-Boerner, Britt-Isabelle	45	Muggenthaler, Frank	28
Deshpande, Dilip	10	Paulus, Gerhard W.	29
Deufilhard, Peter	11	Puelacher, Wolfgang	30
Drommer, Rainer B.	13	Roehling, Stefan	47
Freysinger, Wolfgang	14	Rotaru, Horatiu	31
Gahlert, Michael	47	Santler, Gert	32
Goetz, Martin	15	Schramm, Alexander	33
Grosjean, Maurice B.	48, 49	Schwartz, Friedrich Wilhelm	34
Reddy, Srinivas Gosla	16	Schwenzer-Zimmerer, Katja	35, 42
Haag-Wackernagel, Daniel	17	Singh, Salinder P.	36
Hirsch, Jan-Michael	19	Steinhäuser, Emil Walther	37
Jaeger, C. Raimund	20	Westermark, Anders	38
Jürgens, Philipp	21	Wiedmer, Martin	39
Kober, Cornelia	50, 52	Torpus, Jan-Lewe	39
Kovacs, Laszlo	23	Williger, Babett	58
Krol, Zdzislaw	53	Zachow, Stefan	40
Krenkel, Christian	24	Ziebart, Thomas	60
Kruse, Astrid	54	Zimmerer, Stefan	42



Abstracts

Oral presentations

Vorträge

## “Creating faces” – Use of computer-assisted surgery and 3D-photography in oral and maxillofacial reconstruction

*Enno-Ludwig Barth, Harald Essig, Sandra Terhorst, Martin Rücker and Nils-Claudius Gellrich, Hannover/ Germany*

Imaging plays a major role in planning and quality control of maxillofacial surgery. Besides visualizing the deformity via radiographic or photographic techniques, the information generated by visualizing technologies can be analyzed qualitatively and quantitatively, compared intra- and interindividually or even used to simulate via photomontage, segmentation and virtual modelling. Furthermore techniques of image fusion and 3D-photography contribute to quality control. We present our experiences with methods of visualization, segmentation, navigation, image fusion and 3D-photography in maxillofacial surgery.

In more than 200 patients preoperative planning, intraoperative navigation and postoperative evaluation by fusion of pre- and postoperative radiographic and / or 3D photographic images was done. Indications for surgical treatment were primary or secondary reconstruction after trauma, tumour resection or congenital deformity and orthognatic surgery.

Based on a CT or MRI data set, an optical navigation system was used for preoperative planning, intraoperative navigation and postoperative control. Pre- and postoperative 3D-photography was done with the FaceSCAN3D – system. There are many benefits of computer-assisted surgery in the treatment of cranio-maxillofacial patients: Image-guided treatment improves preoperative planning by visualization of the individual anatomy, intended reconstructive outcome and by objectification the effect of adjuvant therapy.

Furthermore intraoperative guidance makes reconstructive surgery more reliable, since reconstruction on the one hand was designed and performed precisely as virtually planned; on the other hand accuracy could be checked by intraoperative navigation. Moreover image fusion of pre- and postoperative data sets achieves precise evaluation of postsurgical outcomes. And 3D-photography allows a radiation-free follow up of soft tissue changes after bony cranio- and maxillofacial reconstruction.

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## Cone-beam CT as basic imaging diagnostic in implantology

*Dorothea Berndt, J-Thomas Lambrecht, Basel/ Switzerland*

The increasing amount of inserted dental implants is linked up to a steady rise in complications and failures of implants. False assessment of the available bone height and width is resulting in displeasing complications especially when there is nerv damage, lingual perforation with correlated bleedings and buccal recessions.

Therefore a necessarily planning is required. Up to the last few years, patients desiring implants were evaluated with panoramic, intraoral, of cephalometric radiographs, tomography or a combination of these methods. Aim of all these methods is to assess the bony anatomic structures for the potential implant sites. Nevertheless, accurate measurements were difficult to achieve, because of magnification and distortion produced of the panoramic view. Additionally CT has been recommended as a planning tool for implants. In this context, the x-ray dose rate is discussed.

The technology of cone beam CT is able to create good images where bone width and height, as well as special anatomical structures could be represented.

Compared to conventional CTs the dose is considerably less.

As a conclusion cone beam CT technology could be used as a basic imaging diagnostic as soon when three-dimensional images are necessary.

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## Navigation in Minimal Invasive Surgery

*Philippe Cattin, Basel/ Switzerland*

Due to its well known advantages over conventional interventions, minimally invasive surgery (MIS) is applied in a growing number of procedures. Minimally invasive surgery, however, requires considerable experience and pronounced skills from the surgeon. The main reasons lie in the almost complete loss of depth perception, the limited field-of-view, and the reduced dexterity. All these difficulties render the manipulation and exact placement of small objects such as needles, screws, or plates very difficult. Classical navigation techniques are often incapable of providing support in such situations as the augmentation of the scene with the necessary artificial markers is usually cumbersome and leads to increased invasiveness. In many cases their usage is even possible, as visual trackers need a line of sight and/or the dimension or function of such objects often does not allow marker attachment. While magnetic markers of small dimensions exist, the presence of metallic objects in their vicinity severely deteriorates their positioning accuracy.

In this talk we present a new approach relying solely on a standard monoscopic endoscope. This technique not only allows to augment the endoscopic image with navigation information but also to intra-operatively reconstruct the surgical scene in 3D. We furthermore show that surgical objects, such as needles and plates, can be tracked reliably in the endoscope's camera coordinate system. If in addition the endoscope itself is tracked, using a standard tracking device, these surgical objects can be navigated and accurately positioned under endoscopic interventions. This new development opens an entirely new field of "Navigated minimal invasive interventions" that shows great potential to improve the surgical outcome.

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## Maxillo facial implants

*Dilip Deshpande, Mumbai/ India*

Restoration of maxillo-facial defects has been challenging to restorative team. Each patient, whether he has acquired or congenital defects, presents different sets of problems.

The paper discusses using dental implants and a multi-disciplinary approach to rehabilitate these patients.

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## What is a Beautiful Face? - In Search for Criteria

*Peter Deuffhard, Berlin/ Germany*

Since the early nineties, the research group of the speaker has been working on patient-specific mathematical operation planning in computer assisted cranio-maxillo-facial surgery (CAS). In this context, the question asked in the title arises for each individual patient and plays a decisive role. The talk will try to illuminate the associated background in terms of the humanities: What can we mathematicians (including computer scientists) learn from disciplines like philosophy, psychology, anthropology, or evolution biology with regard to „beautiful faces“? With this question in mind, the author deliberately starts out as a mathematician and scientist in search for a deeper understanding of the phenomenon „beauty“-- meaning here, of course, not the beauty of an elegant mathematical proof or an efficient algorithm, but rather the sensually comprehensible beauty of faces. In the ideal case, a catalogue of criteria would come up, which could be taken as guidelines for CAS operation planning.

In the introductory part, the notorious beautiful faces from art are sampled in view of their use for CAS. As expected, the outcome is impressive, but only intuitive. Therefore, the rest of the talk will focus on scientific questions – encouraged by the fact that a „science of beauty“ has been increasingly growing in recent years. Quite a number of books on the topic begin with a statement of the kind: „No two faces are the same“. Is this statement true? A mathematician is trained to ask immediately: How many degrees of freedom are needed to describe a face? Where could beauty hide in this high-dimensional space? Among the first ones who have tried to capture beauty (and, of course, ugliness) quantitatively were painters like Leonardo da Vinci (simultaneously a mathematician!) or Albrecht Dürer. As an absolute must, the inevitable „golden ratio“ will arise and be discussed. Is it a code for beauty? Or is it rather the 7-divisor rule?

One of the central scientific questions in our context is: Does a concept of universal beauty exist, valid through all regions and times? The talk will address quite recent psychological-ethnological experiments that were done in order to shed light into this question. However, so much may be revealed in advance, the author will argue frankly that none of the experiments described in the literature has really convinced him. It seems obvious that all of them have quite clear weak points, either already in the design of the experiments or, at least, in their corresponding interpretations.

The next question addressed will be: Is there an evolutionary advantage of beauty? Already Charles Darwin asked: Why do male peacocks have these large, flamboyant tail feathers? Clearly, this feature makes them extremely visible and vulnerable to their predators and is an obstacle for any fast escape. Which kind of evolutionary sense could nevertheless lie behind this phenotype? For an explanation, Darwin added the mechanism of „sexual selection“ to be distinguished from his already established „natural selection“ on the basis of a survival of the fittest.

In the last part, the talk will screen several scientific hypotheses, such as the scheme of child-like characteristics, the averaging hypothesis, or the symmetry hypothesis. A closer look into details of these hypotheses will lead to surprises.

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### Facial Identity Loss after Severe Burns – Reconstructive Surgery and its Limitations

*Rainer B. Drommer, Heidelberg/ Germany*

In our culture, structural facial loss is a great burden for the affected person.

In the Asian world, such an incident can lead to exclusion from every kind of social and familial relationship.

Through our international Society for the Support of the Facially Handicapped, we have been allocated a young man from Indonesia.

During a civil war type attack on his house, he sustained severe burns in the areas of the neck, face and head that affected not only the facial soft-tissue, but the cartilage and bones as well.

The initial treatment was carried out in Indonesia over the course of one year.

The total, or almost total loss of the forehead tissue and bones, upper and lower eyelids, nose, upper and lower lips, and the ears were connected with cicatricial keloids.

A certain facial identity was achieved with the help of extended reconstruction and prosthetic procedures.

We will critically contrast the approach using autologous tissue with the newly identified possibilities of partial face transplantation.

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## Face and identity vs plannable identities

*Wolfgang Freysinger, Innsbruck/ Austria*

The central crucial question of life was and is: who am I? It can never be answered from outside, the answer lies within.

Historical vignette:

According to the current understanding - everyone is represented by his bodily appearance and the physical traces left in the world (sound, heat, magnetism, radiation, etc.) that was sacrosanct for human attempts of modifications. Man always tried to use objects / jewelry / colors for modifying the appearance of the body in order to comply with ideals of beauty. Even bodily modifications of the bony skull, the feet, the neck, earlobes and so forth, are known. But these are minor modifications.

Contemporary progress in medicine, science, technology and evolution of human and societal self-understanding and self-perception gives rise to some concerns regarding our identity. Since we now have the power to totally change our bodily appearance.

A simple experiment for everyone:

Based on a simple everyday question I will scratch out some aspects and leave them for further consideration. Assume you want to have all your hair removed, you decided to be bald-headed. Seriously, how long would it take you to see the hair-dresser? Answer for yourself and follow me further on. What if you had a disease that ends up in mutilating your bodily appearance? If you lost the face? What if you could not perceive other persons' faces? Or, conversely, what if you got a new nose or a new face?

And in 3rd millennium societies?

However, societal understanding is different to that: watching out, essentially a uniformity of faces and bodies, a general average, sort of an idealized dream, is pulling us towards a goal that cannot be achieved: A change of appearance does not imply a change of personality. Well - really?

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## The Strange Case of Michael Jackson or Enhancement of Face

*Martin Götz, Basel/ Switzerland*

One of the major issues in the current debate on biomedical ethics is ‚enhancement‘ which means to improve what is naturally given in a human being. Commonly, plastic surgery is mentioned in this context as a field in which enhancement is said to take place. Nevertheless, neither the definition of enhancement in general nor what it actually could mean in the specific case of plastic maxillofacial surgery are really clear.

The lecture shall contribute to the clarification of ‚enhancement‘ in plastic maxillofacial surgery by commenting on two examples or sources, the contemporary case of „Michael Jackson“ (as an international discourse, not an individual) and the Victorian novel by Robert Louis Stevenson „The Strange Case of Dr Jekyll and Mr Hyde“ (published in 1886).

As a result, enhancement of face should be restricted to the possible change of someone's identity, given the natural function of the face by which we define our personal identity in terms of the body.

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## Everybody needs a unique face for his/ her identity

*S Gosla Reddy, R Reddy, Hyderabad/ India*

### Introduction

Cleft lip and craniofacial cleft defects are the most psychologically devastating defects of the human body. This is because the face is the most prominent uncovered part of the body.

Treatment of cleft lip and craniofacial cleft defects needs an approach that while keeping in mind the cosmetic aims of surgery should also address the functional aspect of the defect.

### Evaluation

The evaluation should follow the development of the face. This is especially important because the knowledge of the development of various hard and soft tissue structures of the face will give an accurate description of the distorted anatomy. In cleft lip defects this is especially true in the insertions of various affected muscles. In craniofacial defects it is more important to understand the bony disjunction along developmental lines.

### Diagnosis

Diagnosis should be done based on the evaluation. This paper will talk in detail about the development of face and also the Tessier classification of craniofacial clefts which was done along the lines of development of face. Cleft lip defects are diagnosed according to a specially developed classification program by the authors' Institute. This diagnostic tool is also based on the development of the face.

### Repair

The repair of cleft defects appearing on the face requires complete understanding of the positioning of the hard and soft tissue structures surrounding the cleft. In cleft lip defects it the positioning of the muscles of the lip, the alveolus and the nasal structure. The author will detail a study of three different types of incisions used to repair cleft lip defects and two different types of incisions used to repair craniofacial cleft defects.

### Post Operative Outcome

The post-operative outcome measurement is done not only by an index which gives numerical scores based on various aspects of the lip and nose including that of scar formation, mismatch of white roll and vermillion, nasal ala collapse etc. but also measured on a quality of life index based on the patient's view of the surgical outcome and also the views of the patient's close family and friends.

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## The Biology of Attractiveness

*Daniel Haag-Wackernagel, Basel/ Switzerland*

Human nature is to a large extent universal. This includes beauty standards and the ways in which males and females interact. Evolutionary behavioral biology suggests that certain characteristics of the human face and body are important for mate preferences and are therefore subject to sexual selection. Current theoretical and empirical findings suggest that mate preferences are mainly cued on visual, vocal and chemical cues that reveal health including developmental health. Human beauty standards reflect our evolutionary distant and recent past and emphasize the role of health assessment in mate choice. Although beauty standards may vary between cultures and between times, the underlying selection pressures, which shaped the standards, seem to be the same.

Particular proportions of faces of women and particular proportions of waists and hips are only considered to be attractive because our ancestors with such preferences left more healthy offspring than the individuals in the population without preferences. Females value men's socioeconomic status, prestige and wealth and use these as indicators, more than male attractiveness. By contrast, men attach greater value to women's physical attractiveness, healthiness and youth that are linked with reproductive capacity.

Studies have demonstrated that assessments of attractiveness are sensitive to bodily symmetry in males and females. Symmetry of bilateral traits reflects stable embryonic development and genetic diversity in defense against diseases and a good physical performance. In spite of the general preference of symmetry slight facial asymmetry can improve the impression of attractiveness.

Studies have shown that computer-generated prototypical faces of females are more attractive than the single faces that have been used to generate them, but there are some individual faces that are more attractive than the prototypes. An evolutionary explanation is that female attractiveness should be the average because males should avoid mating with females who are at the extremes of a population. Extreme traits can signal pathological deviations. Facial attractiveness consists of a defined composition of sexually dimorphic features combined with small child patterns and expressive features. Adult female faces with artificial increase of small child patterns are more attractive than original faces. Females exhibit a preference for a male face on the masculine side of average during the fertile phase of their cycle but rate extreme male faces to be unattractive.

The consensus on which a female is considered to be good looking or not, is high in different cultures and seems to be universal.

Characteristics of attractiveness pertain to health and fertility suggesting that humans have evolved to view certain features as attractive because they were displayed by healthy and fertile individuals. The question remains how single features that are considered attractive relate to each other, and if they form a single ornament that signals mate quality. Individual differences in attractiveness judgments exist, as not all people find exactly the same person attractive. Additionally, adding an individual touch to ideal proportions, averageness and perfect symmetry can make an attractive person beautiful.

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## Good morning Sigmund Freud, what can I do for you

*Jan Hirsch, Uppsala/ Sweden*

Sigmund Freud (1856–1939) noted but neglected a swelling of the right posterior hard palate 1917 that eventually developed in to an extensive cancer 1923.

The aetiology was most likely smoking which he started early and never quit.

He consulted many therapists that performed 33 painful surgeries during 16 years and he had radiotherapy and a series radium capsule treatments. He had to live with constant pain and struggled with ill fitting dentures/obturators and progressing trismus. 1939 had been a difficult year for Freud. His terrible pain was relieved by topical painkillers and during a period of few months the skin over the right zygoma became gangrenous; eventually there was a perforation between the oral cavity and the skin.

Finally he died from an overdose of morphine administrated by a colleague on his request 1939.

Despite all suffering during these 16 years following his first operation 1923, he remained very productive, and never gave up.

We think the medical history of Sigmund Freud well raises many essential questions regarding diagnosis and treatment of oral cancer.

We believe that we could have done better with Sigmund Freud to day with the correct diagnosis, available technology in surgery, in radiotherapy and dental prosthodontics. Our facilities,our understanding of the needs of the patient, during and following treatment is an important factor.

However many questions are related to every new patient. When to treat, and not to treat, who gets what in health care? Surgery might be one option and planning and performing surgery will be discussed and ethical considerations. Which hospital, which doctor will be responsible, who decides the doctor, the patient, the budget or the politicians. With constantly new costly drugs in oncology marginally improving prognosis what can be justified to spend out of an already restricted budget?

What is done for the patient before treatment, during hospitalisation and after to improve the situation? When is the endpoint - who decides?

The question is raised if today's organisation of oral cancer care meets the varying emotional and existential needs of treatment teams, patients and spouses.

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## Mechanical properties of partially degraded, ex vivo resorbable implants

*C.R. Jaeger<sup>1</sup>, C. Landes<sup>2</sup>, Freiburg i. B., Frankfurt (Main)/ Germany*

Resorbable polymers increasingly find applications as biomedical materials for implants, e.g. as bone screws or osteosynthesis plates. Due to the degradation of the implant, a re-operation in order to remove the implant can be avoided. Furthermore, the change in the mechanical properties of the implant, i.e. the reduction of its stiffness can possibly stimulate the regeneration of the bone tissue due to decreased stress shielding.

The mechanical performance of the implant materials was evaluated in a three-point-bending arrangement. The experimental set-up was used to characterize the stiffness, bending strength and fatigue strength of original (non-degraded) polylactide-based osteosynthesis plates and fragments of partially degraded, ex-vivo implants.

In addition to the mechanical study of the implants, scanning electron microscope images of non-degraded and partially degraded implants are taken in order to assess the impact of the degradation on the surface morphology of the implants.

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## Preoperative planning and intra-operative navigation in corrective surgery for craniofacial deformities – Current concepts and future tasks

*Philipp Jürgens<sup>1,2</sup>, Kim Hyungmin<sup>3</sup>, Zdzislaw Krol<sup>2</sup>, Stefan Zimmerer<sup>2,4</sup>, Katja Schwenzer-Zimmerer<sup>1,2</sup>,*

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**Introduction:**

Accurate pre-operative planning of corrective surgery of deformities in the facial skeleton is essential for successful surgical treatment. Virtual 3D- models of the facial soft tissue and the underlying bony structures generated from CT- Scans are used to perform relocation planning and soft tissue prediction. Actually an all- in- one system, that allows operation planning, soft tissue prediction and intraoperative navigation is not available yet. So analysing the currently available systems and finding reasonable indications for each seems to be reasonable.

**Methods:**

In patients suffering from congenital or acquired (trauma or tumor) skeletal deformities corrective surgical interventions were planned using different planning and navigation systems: a commercially available system and a newly developed tool for computer-aided pre- operative planning and intra- operative navigation. both systems were based on CT- datasets of midface and mandible acquired in clinical routine. Presented will be 15 cases planned in orthognathic surgery without intraoperative navigation. One case of 2nd recurrence of a class III malokklusion, where navigation was performed to relocate the maxilla and to reposition the mandibular condyles into the fossa. A case of severe Cherubism is presented as an exaple for navigation guided surrgy of the orbital walls ans margins.

**Results:**

More than 20 cases was planned and partially navigated during surgery, using the available systems. Intraoperative navigation was exclusively used in complex cases such as craniofacial deformities, or severe posttraumatic facial asymmetries. Conventional orthognathic surgeries were planned using 3D-systems, but no navigation was performed during surgery.

**Conclusion:**

The tested systems all provide very accurate planning. We found out that 3D- planning and navigation has widespread indications in orthognathic as well as in reconstructive surgery. All system have unique advantages for different clinical situations.

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## Computer aided planning of the facial contour in the aesthetic and reconstructive surgery: Are soft tissue changes predictable?

*Laszlo Kovacs1, M Eder1, J Ludwig1, J Mitternacht2, H Pathok1, J Georgii3, R Westermann3, Munich/ Germany*

### Background

Especially in facial plastic surgery, surgeons are confronted with complex anatomical soft-tissue defects in daily routine of aesthetic and reconstructive surgery which often lead to functional impairment and aesthetic disfigurement of the patients face. Precise assessment of the facial contour changes during surgery would lead to a more objective preoperative planning and improve the possibility to predict soft tissue changes after surgery taking physical attributes of the human tissue into account. Three-dimensional (3-D) imaging is a prospering medical application offering the ability to objectively capture anatomical structures in different static body positions. The goal of this study is to present the application of 3-D imaging for objective facial assessment and the opportunities of computer aided planning systems for dynamic evaluation and simulation of facial soft tissue changes in aesthetic and reconstructive surgery.

### Materials and Methods

To assure objective quantification of facial contour changes a 3-D measurement system based on specific facial landmarks was developed and validated on different 3-D facial models captured using a white light surface scanner. The static assessment of soft tissue changes of varying facial expression was carried using our developed 3-D measurement system combined with a 3-D optical motion tracking system to evaluate the dynamic facial movement and displacement of facial soft tissue. Additionally, 3-D reconstructions of facial MR images were carried out to simulate the soft tissue deformation of the facial region applying the Finite Element Method taking mechanical properties of the facial anatomical region into account.

### Results

Using our developed 3-D measurement system for the facial region a precise static facial quantification is possible and leads to a better interpretation of facial contour changes. The combination with the optical motion analysis system allows a kinematical analysis of the facial movement but do not supply the surgeon with sufficient dynamic clinical data to predict soft tissue changes. To gain more specific results the need for a numerical simulation respecting biomechanical behaviour of the facial regions of interest is obvious. The Finite Element Method supplies the surgeon with the needed information.

**Conclusion:** The reconstruction of complex anatomical defects and minor soft tissue changes in facial plastic and reconstructive surgery actually do benefit from the existing static 3-D imaging systems. A supplementary dynamic assessment and simulation of facial contour deformation and the assessment of soft-tissue changes regarding elasticity and biomechanical behaviour represents a vast improvement on static 3-D imaging.

Although some studies regarding soft-tissue deformation do exist, the current state of the art of soft-tissue simulation in reconstructive and aesthetic facial surgery has to be estimated as preliminary only.

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### 3D-planning of asymmetries and the operative performance in patients

*Christian Krenkel, Triesnig, R; Singh, D; Enzinger, S, Salzburg/ Austria*

In orthognathic surgery both the patient as well as the surgeon want to reduce the risks of failure to a minimum: the surgeon wants to be prepared for any unexpected incidents during the operation, the patient declines any bad outcome concerning function and appearance.

With the 3 D - Orthognathic Surgery Simulator (3 D - OSS) a preoperative simulation can be performed planning both maxillar and mandibular osteotomies. The parameters displayed during planning are as follows: The occlusal relationship; the relationship on the Le Fort I osteotomy plain; the site of the condyle in the TMJ; the site of the sagittal split; the site of the mandibular angle; the site of the chin. The Face-O-Meter helps in fixing the exact centre of the upper jaw (inter-incisal point). It also allows to compare the line of the pupils of the eyes with the front upper tooth line. This Instrument is based on three sockets (small Kirschner wires with stops) in the frontal bone and can therefore be disconnected but also be replaced during the Le Fort I procedure. The measurement of the interincisal point is performed three dimensionally and allows perfect control of the intermediate wafer and helps to find a reproducible vertical position of the maxilla.

Failures of a wrong osteosynthesis of the maxilla can therefore be avoided.

But even if it became possible to predict every single step of the operation concerning hard tissue using this planning system, the surgeon still has to rely on his experience when it comes to the question of movement of soft tissue. And for that this all mechanical technique can be combined with modern computer-aided visualization using a morphing process of a common imaging software. The parameters of the 3 D-OSS-simulation can easily be entered in the software whereby the image of the outcome is rendered. So vice versa it is possible to correct the distances and angles again in the 3 D-OSS to see, what effect this would make to the hard tissue itself.

In combining mechanical and computer-aided techniques to plan orthognathic surgery the best and safest way for both the patient and the surgeon could be found to avoid failures during operation and minimize the discrepancy between the expectations of the patient and the actual results.

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### Facial Reconstruction using vascular free fibula grafts

*Samir Kumta, Mumbai/ India*

Various ways have been adopted for facial reconstruction. Free fibula grafts with 2-team approach achieving excellent results has been reported. The paper presents the same approach for rehabilitation of acquired and congenital defects.

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## Missing facial parts — statistically generated and automatically fabricated

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Mirroring of facial parts and rapid prototyping of prosthesis templates have been reported to be effective tools achieving more realistic facial prosthesis. However, mirroring is not applicable in central facial defects and the manufacturing of a template still needs the conventional transfer into the final facial prosthesis. We therefore aimed for a system to reconstruct any missing facial part by a statistical face model and to transfer the planning directly into a biocompatible, skin coloured facial prosthesis by rapid prototyping.

A statistical face model, derived from a dataset of two-hundred coloured 3D scans of faces, was developed to reconstruct the missing nose and cheek in a statistical meaningful way. The planning was merged with the cranial computed tomography of the patient to define the best positions for the prosthesis retaining implants. The prosthesis margins were defined and then the planning was manufactured out of biocompatible skin coloured polyamide powder by selective laser sintering.

The result showed a realistic shape. The over-contour allowed a cut down of the margins to optimize the marginal fitting. The retentive elements have been polymerised into the prosthesis on the patient by using dental composite. The presented prosthesis planning and manufacturing method showed good practicability and is a promising way to overcome the afore mentioned shortcomings.

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## High-resolution tomographic imaging of tissues and implants

*Bert Müller, Basel/ Switzerland*

The talk presents results of micro computed tomography with a spatial resolution down to the sub-cellular level. Several examples of human tissues, which are important for planning of surgical procedures and teaching purposes, demonstrate the power of this non-destructive method for post mortem tissue characterization.

In addition, the morphology of different kinds of tailored implants is quantified on the basis of the tomographic data and sophisticated algorithms. Finally, the characterization of the implant-tissue interface that is of prime importance for the success of implantation, is discussed to elucidate the necessity of monochromatic X-ray use.

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## The Neck Check: An evaluation of the aesthetic appearance of the neck

*Frank Muggenthaler, Freiburg/ Germany*

There are definite opinions about the individual perception of the human appearance. For those who try to make people look beautiful it is very important to have some orientation. Aesthetic plastic surgeons need this orientation because of their responsibility when they change the appearance of their patients.

It is very helpful to have objective criteria for finding the best way of treatment and measure the outcome.

Our perception of beautiful appearances depends on psychological reflexes, which are inherent in us. We have analysed all factors, which contribute to our aesthetic perception of a face and the neck and have created a test that translates our perception into a numerical value. We call this the NECK CHECK.

This procedure is based on the presumption that there are twentytwo criteria which are of importance for the aesthetics of the neck. They describe proportions or anatomical appearances of deep and superficial structures in the neck. All criteria can be rated in a clear and reproduceable manner.

For each criteria three possible results were defined which fell into the categories "bad", "neutral" and "good". To translate the judgement into a numerical value, "bad" equals no point, "intermediate" 1 point and "good" 2 points. The criteria are of different importance for the overall appearance of the neck. We have considered this by using the multipliers "less important" (1 point), "important" (2 points); "very important" (3 points), "extremely important" (4 points). The values of the criteria are multiplied by the values of their specific importances:

"criteria" x "importance" = "contribution to the aesthetic appearance of the neck"

With the calculations we obtain numerical values within a range between "0" and "100". The NECK CHECK demonstrates which factors influence the aesthetic appearance of the neck. It is a useful tool for face-and necklift surgery to find proper methods of treatment and analyze different surgical approaches in relative to their results.

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## Surgical correction of the facial profile

*Gerhard W Paulus, Munich/ Germany*

Looking to the history of arts we can realize that already artists of the ancient world knew details about the harmony of facial structures. Numerous sculptures created by Egyptian and Greek artists reveal beside a sense for beauty knowledges about rules and legitimacies to plan and get harmonious facial features. Vitruvius, an architect in ancient Rome was the first who published in his book "De architectura" guidelines to create sculptures especially the subdivision of the face into three equal parts. These rules became well known again when ancient literature was rediscovered during Renaissance due to Leonardo da Vinci's proportion studies and Albrecht Dürer's facial analysis.

At the facial profile the forehead, nose, chin and lips are the essential structures. The profile is mainly shaped by the bone, including the teeth behind the facial soft tissues. Most of the inharmonious facial profiles are due to over- or underdevelopment of the mandible, including the chin, the maxilla and the nose. Disharmony can occur in one, two or three dimensions.

There are several ways to correct unbalanced faces. Although indications are rare, augmentation or reduction of the forehead is possible with the help of osteotomies, osteotomies or implants; augmentation but mostly reduction of the nose are required very often as well as setback or advancement procedures of the mandible or the maxilla, reduction or advancement of the chin. Beside corrections in the anteroposterior plane vertical changes can also be performed.

Since the introduction of rigid bone fixation during mandibular osteotomies by Spiessl in Basel it became possible to combine simultaneously orthognathic surgery with rhinoplasties in a single operative procedure. The author has published this technique in 1986 and has gained experience in combined profile corrections in about 25 years. Beside the techniques of single corrections of the facial thirds, many sometimes tremendous changes of facial profiles in combined procedures will be demonstrated.

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## Reconstructive methods in hemifacial microsomia using 3-D planning

*Wolfgang Puelacher, Michael Rasse, Innsbruck/ Austria*

The wide spectrum of anomalies associated with hemifacial microsomia (HFM) has made systematic and inclusive classification difficult.

A nosologic system, in which each letter of the acronym O.M.E.N.S. indicates one of the five major manifestations of HFM; O for orbital distortion; M for mandibular hypoplasia; E for ear anomaly; N for nerve involvement; and S for soft tissue deficiency (Vento et al., 1991).

A positive association between mandibular hypoplasia and the severity of orbital, auricular, neural and soft tissue involvement cleft of lip and palate suggest an overlapping pathogenesis.

Reconstructive methods and 3-D planning including distraction-histogenesis, bone transplantation, fat transplantation, implantation of alloplastic materials and reconstruction of the auricle are discussed.

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## Cranioplasty – From ancient animal skulls to modern 3D custom made implants

*Horatiu Rotaru1, Lucia Hurubeanu1, Grigore Baciut1, Hans-Florian Zeilhofer2, Ralf Schumacher3, Alexandru Rotaru1, Mihaela Baciut1, C. Dinu1, S. Bran1, I. Moldovan1, H. Stan4, H. Chezan5, Cluj-Napoca/ Romania*

Cranial vault defects result from trauma, infection, tumor ablation or cerebral decompression procedures. They produce not only aesthetic but also functional alterations. Thus, the main purpose of a cranioplasty is not only cosmetic repair but also improving the neurological status.

Various materials have been used to fill defects in the cranial vault, such as metal, xenografts, autografts, and allografts. There are many clues that repairing of the skull defects is performed since the ancient time, evolving from using different metal plates through the use of animal or human bone to modern procedures of shaping acrylic or titanium plates by means of rapid prototyping technologies and three-dimensional modeling.

Passing by through the history of cranioplasty, we present the new era of three-dimensional reconstruction of the calvarial defects by using custom-made cranioplasty plates.

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## Symmetry as a major key to facial harmony

*Gert Santler, Graz/ Austria*

Beauty can be caused by a lot of different details, a look, a smile, the shape of the nose, the projection of the chin or the curve of the lips. Leonardo da Vinci already tried to develop some mathematical rules for aesthetic facial proportions. They all were based on a symmetrical based architecture.

Symmetrical faces appear to be more beautiful than asymmetries. Although absolute symmetry is found to be beautiful, the faces sometimes appear a little bit boring, whereas minimal nearly immeasurable asymmetries are able to enrich the impression by adding some kind of a special tension.

One of our main goals is to achieve the highest degree of symmetry. Already in children we are able to correct asymmetries caused by hemifacial microsomia or ankylosis. All these corrections have to be based on an intensive three-dimensional diagnosis and treatment planning. Whereas ankylosis cases will grow near to normal after reestablishing normal function, in hemifacial microsomia patients a lack of growth on the affected side will cause asymmetry again during the following growth periods even in distraction cases. Early functional treatment, surgery as late as possible with massive overcorrection will help to reduce the number of surgical interventions.

On the contrary in hemimandibular hypertrophy the increasing asymmetry should be stopped at a very early stage. Following definitive diagnosis by means of scintigraphy high condylectomy will stop the overgrowth. In most of the cases a definitive correction of symmetry has to follow in a second step.

After cessation of growth we find the best time to achieve definitive results. Three-dimensional planning by means of 3d-models in combination with intraoperative navigation in our hand has proved to give excellent results. In adults classical orthognathic procedures are preferred, allowing free three-dimensional movements without any limitations of distraction osteogenesis.

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## Virtual models in computer assisted maxillofacial surgery

*Alexander Schramm, Ulm/ Germany*

### **Purpose**

Correcting complex midface deformities remains a challenge firstly in the diagnostic evaluation of the deformity, secondly in setting up the therapeutic schedule and thirdly in the surgical correction itself. Until now, computer-assisted preoperative planning and surgery has not been practiced as part of the surgical routine in the field of facial deformities. Primary diagnostics are indispensable in assessing the mostly combined bony and soft tissue deformities. Advances in imaging techniques and associated technologies have led within the past years to improved preoperative planning for the craniomaxillofacial surgeon.

### **Methods & Materials**

Imaging, planning and navigation techniques in our clinical centers serve for computer assisted preoperative planning and computer assisted surgery. The patient's individual anatomy was assessed in multiplanar (axial, coronal, sagittal) and three-dimensional views. Virtual correction could be made by either moving segmented bony areas or mirroring of segments for simulation of ideal reconstruction or osteotomies. Intraoperative navigation was done using frameless stereotaxy. The virtual patient and the real patient were correlated with an individual registration system.

### **Results**

Over 300 reconstructive procedures of the facial skeleton have been performed the last 5 years using segmentation and mirroring techniques for the creation of virtual models. These were transferred for intraoperative guidance by navigational surgery or CAD-CAM templates. New software developments for automatic bone segmentation of standard CT data sets dramatically reduce the time period for preoperative planning in virtual facial reconstruction. Combining this tool with mirroring of segmented areas of the facial skeleton achieves instant virtual reconstruction of orbital and midface defects. The resulting virtual model is used for intraoperative navigation, guiding the reconstructive procedure to the desired result. In orthognathic surgery planning, the time for preoperative planning also could be reduced to one third compared to manual bone segmentation procedures.

### **Conclusion**

Computer-assisted preoperative planning and surgery techniques have improved operators confidence in facial reconstruction. Anatomical structures can be identified intraoperatively and preplanned reconstructions can be realized by means of navigation. Especially image fusion of pre- and postoperative data enables detailed evaluation of postsurgical outcomes. The first application studies with autosegmentation have now led the computer assisted cranio-maxillofacial reconstruction to clinical routine due to reduced planning time and even more by erasing the problems of pseudofoam in orbital wall reconstruction.

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## “Physicians are not merchants and medical treatments are not sales oriented products.” What’s the position of aesthetic surgery?

*Friedrich Wilhelm Schwartz, Hannover/ Germany*

At the 3rd Spiessl-Symposium, the position of aesthetic surgery in a health care system was discussed, which is influenced by a growing consumerism (Schwartz, 2007). The president of the German Medical Association Hoppe postulated 2007: “Physicians are not merchants and medicine is not a good”.

But are these positions realistic in a consumer society? A large part of aesthetic surgery is already embedded in an enhancement industry. The prevailing standards for adequate consumer information, transparency on benefits and risks as well as consumer protection (quality, reliability and warranty), which are already applied in the field of non-medical consumerism, should be minimum standards in the expanding market for aesthetic surgery.

In any kind of medical surgery - comparable to traditional medicine – the “consumer” has to be regarded as a person (with an individual biography, social environment and future perspectives). Therefore, the individual consultation between physician and patient has to remain the priority: Does the aesthetic surgery meet this criterion in quasi-commercial offers? According to the Stiftung Warentest, public hospitals offer consultation in the majority of cases. In the private hospitals, medical advice is mostly provided, but in some cases also very fragmentary.

Beim 3. Spiessl-Symposium wurde nach der Position der ästhetischen Chirurgie in einem vom wachsenden Konsumerismus geprägten Gesundheitswesen gefragt (Schwartz, 2007). Der Präsidenten der deutschen Ärzteschaft Hoppe fordert 2007: „Ärzte sind keine Kaufleute und die Medizin keine Ware“.

Aber sind dies in einer Konsumgesellschaft realistische Positionen? Weite Bereiche der ästhetischen Chirurgie sind längst eingebettet in eine Enhancement-Industrie. Die in den nichtmedizinischen Konsum- und Warenbereichen geltenden Maßstäbe für angemessene Konsumenteninformation, Transparenz von Nutzen und Risiken sowie Konsumentenschutz (Qualität, Zuverlässigkeit und Gewährleistung) sollten auch die Mindestmaßstäbe der expandierenden ästhetischen Chirurgie sein.

Bei jedweden medizinischen Eingriffen ist der „Verbraucher“ wie in der klassischen Medizin auch als Person (mit individueller Biographie, sozialem Umfeld und Zukunftserwartungen) zu begreifen. Daher muss die individuelle Beratung zwischen Arzt und Patient im Mittelpunkt bleiben. Leistet das die ästhetische Chirurgie in quasi-gewerblichen Angeboten? Laut Stiftung Warentest (Mai 2008) ist dies in öffentlichen deutschen Krankenhäusern überwiegend der Fall. Bei privaten Klinikbetreibern wird eine Beratung mehrheitlich, z. T. aber auch erheblich lückenhaft durchgeführt.

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## Face, Speech and Identity

*Schwenzer-Zimmerer, Katja 1,2 , Susanne Codoni 2, Basel/ Switzerland*

In the western culture the individual and the recognition of its identity plays an important role inside the society. The physical representation of the personal identity is strictly depending on two key structures of communication: the face and the speech. Physical impairments concerning the „normal“ out-looking and the ability of „normal“ verbal communication lead to severe stigmatism of the affected person.

This can mainly concern the self recognition, especially in juvenile and adult persons with inborn or acquired malformations or defects, but can also represent the estimation of others which is often resulting in false-categories of handicap or neurological retardation in normal intelligent children caused by speech impairment or facial deformities.

In this presentation strategies in the treatment of different cranio-maxillo-facial diseases are shown to preserve, reconstruct or built up form and function of the communication organs to reach patients' full social integration.

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## Catch them young and avoid surgery

*Salinder P Singh, Chandigarh/ India*

When a jaw discrepancy is present in growing children, the ideal solution is to treat it by modifying growth, so that the skeletal discrepancy disappears. The most appropriate time for growth modification is during mixed dentition, prior to puberty.

Incidence of Class III malocclusion in India is about 3% of the total population as compared to that of Japan 35-57% and 8% in the United States. Class III malocclusion may be the result of a) maxillary retrusion, b) mandibular prognathism or a combination of both. It may be functional or skeletal.

Early identification and correct diagnosis and treatment planning can resolve many of the class III malocclusion with orthopedic/orthodontic modalities. Growing children may benefit from orthopedic modalities during active growth phase by means of maxillary protraction, chin cap and orthodontics. However, one of the most difficult tasks for the orthodontists is decision making in borderline cases. While appliances succeed in resolving the malocclusion in many cases, they may be less successful or outright failures in other circumstances. Therefore, selecting the right approach for any growing patient remains the key to success.

This clinical presentation illustrates the orthodontic management of select Class III malocclusions which were successfully managed with different modalities, without resorting to the surgical modality.

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## Profile Measurement with the Zero-Meridian Line According to Gonzalez Ulloa

*Emil Walter Steinhäuser, Erlangen/ Germany*

Gonzalez Ulloa, a Mexican Plastic Surgeon, described in the 60ties of the last century a method for measuring the human facial profile, which could be easily applied and utilized for the diagnosis and correction of the different facial structures. His method consists basically in the application of two lines, a horizontal line which corresponds with the Frankfort Horizontal Line and a vertical one which is dropped from the soft tissue Nasion perpendicular to the Frankfort Line.

This vertical line was called by Gonzalez Ulloa the Zero-Meridian Line in relation to the cartographic division of the globe into longitudinal meridians. In a well balanced and harmonic profile the facial soft tissue structures, except the nose should be at or just a few degrees posterior to the Zero-Meridian.

Gonzalez Ulloa could prove this statement while taking many examples from famous paintings and sculptures from the Ancient World to the present. He also demonstrated in several publications excellent clinical examples for the practical use of his method.

We also could show in a follow-up investigation of cases with autorotation of the mandible that the esthetic assessment of the lower facial profile is easier and more accurate with this rather simple technique compared with other methods of profile evaluations.

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## Another face

*Anders Westermarck, Stockholm/ Sweden*

To what extent are our lives shaped by the looks we were born with? This is a highly relevant question in a world so focused on physical appearance.

In this presentation you will meet some young men and women who were born with severely disfigured facial appearances, and who have undergone multiple surgical procedures to improve on the facial aesthetics. Deep interviews with these patients reveal thoughts that may seem distant from what we, as surgeons, might consider first priorities.

Meeting these patients is a truly humbling experience. You might find that things are not always what they seem to be.

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## Augmented Reality (AR) as a tool for innovation

*M Wiedmer and JL Torpus, Basel/ Switzerland*

Scientists deal with research, an open and unsettled, uncertain, risky, emergent and pluridisciplinary process. At the beginning of the process the problem definition and the outcome is never fully identified. Nevertheless scientists know implicitly or explicitly how to manage this paradox of innovation. Hence the core question is: How do scientists conceive possible futures to achieve novelty?

The presentation describes findings in design sciences based on a phenomenological approach and the observation of designerly and artistically ways of knowledge in the making. Our showcase is the AR-technology based research project „LifeClipper2“. We present the investigation of three different principles: a) technology as material: a describable and initial condition for novelty, b) technology as a tool for ideas: a shift in 3D-planning and communication c) technology as a tool for investigations and observations – a human centred and scenario based approach.

The design research project lifeClipper2 investigates the applicability of immersive outdoor Augmented Reality for architecture visualisation, tourism and game. The decisions that lead to experimental settings are often ignored in research because they are difficult to defend. lifeClipper2 uses scenario and experiment design as a heuristic method focusing on user experience.

Within these complex possible future application terrains we observe people's unconscious behaviour and response. a) The scenario “Playground” is an unrestrained inquiry into the virtual optical system of AR. By means of playing with the commonly applied parameters for texture, projection surface, spatial depth and masking functions we look for new potentials and the language of the medium itself. b) The focus of the scenario “Archiviz” is the evaluation of the potential of the medium AR for urban planning, in comparison with the conventional medium of architectural plans. Structures, stylistic devices and tools used in the development process of architecture get transferred to the medium of AR in order to explore their possible use, replacement or extension. c) The definition of limiting conditions, the development of a questionnaire and the ultimate entourage of implementation transform the scenario into an experimental setting wherein different user groups get evaluated.

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### 3D model based planning in surgery of the head

*Stefan Zachow, Berlin/ Germany*

There is an increasing demand for computerized 3D models of individual anatomy and surgical planning systems based on such models that provide assistance to a surgeon in all stages of therapy. A method for accurate, high quality geometric reconstruction of individual anatomy from medical image data will be presented as well as the generation of statistically averaged anatomy and its use for computer assisted surgery planning. Applications of model based therapy planning in CMF and ENT surgery will be demonstrated. In the end, the transfer of model based surgery planning into the operating theatre will be shortly addressed.

Today anatomical atlases consist of single representative shapes of particular anatomical structures. Combining several geometric 3D models to an averaged 3D model not only provides a mean shape but also information on statistical variations – a new type of anatomy. Statistical 3D shape models can be clustered according to different aspects, like age, gender, ethnicity, etc., for any analysis of interest. 3D shape models of anatomical structures are even more valuable. They can be employed in auto-matic segmentation, i.e. geometric reconstruction, of individual anatomy from medical image data by providing a priori knowledge about an organ's typical shape (3, 4). Furthermore, 3D shape models provide very useful means for surgical reconstruction of missing, malformed or destroyed anatomical structures. Using statistical shape models, averaged anatomical structures can be adjusted within their range of normal shape variation. That way, statistical shape models can be adapted to individual, yet available anatomical landmarks, interpolating pathological regions in-between (5-7).

Model based planning has become an increasing relevance in surgery. In cranio-maxillofacial surgery, for instance, model surgery, i.e. surgery planning on life-size facsimiles of individual skull models, is often performed in complex cases where bone segments have to be mobilized and relocated. Though superior for practical preparation, such models are rather expensive and cannot be reused for the planning of different therapeutic concepts. Moreover, aesthetic results concerning facial soft tissues cannot be assessed that way. Computer assisted planning has no limitations on repeatability, and due to the possibility to include mechanical simulations of tissue deformation it yields additional insight for a functional and aesthetic assessment of preoperatively planned strategies (8). Model based surgery planning has advantages in many cases. Implants can be fitted to geometric models with regard to shape, size and position, and can be individually prefabricated. Statistical analysis of anatomical shapes also allow for semi-customized manufacturing, where implants can be chosen from a set of statistically relevant shapes or sizes according to the respective anatomy. Other applications in model based surgery planning are for instance: The assessment of rhinosurgery with respect to breathing(9), the assessment of middle-ear implantology with respect to sound propagation(10), the assessment of a surgical reconstruction of the bony orbit with respect to the correct position of the eye-ball, and many others.

Model based planning of surgery is useful and important for strategic thinking, mental preparation, quality assurance, and patient information. However, the transfer of a planning to the surgical site often remains an open question. Registration and 3D localization (navigation) techniques allow for a match between a model based planning and the patient. However, during the course of an operation planning data and reality may diverge due to heavy modifications of the anatomy (resection, deformation, etc.). Techniques are required to overlay planning data with image data in a perceivable manner, and to update changes according to intraoperatively acquired image data or positional information from navigation systems.

(References: <http://www.zib.de/visual/medical/projects>)

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## Nice to have or must have? „Im“Possible Techniques in daily use – Vision and real requirements

*Stefan Zimmerer and Katja Schwenzer-Zimmerer, Basel/ Switzerland*

Today a lot of techniques exist to provide the planning and execution of surgery, but what is really necessary in daily routine? Which tools are really helpful in the treatment of patients? Is it really necessary, to use all available tools like 3D-visualisation, Rapid-prototyping Models, Virtual reality, interdisciplinary teams, operative workflow, intraoperative imaging, like CT, MRI, ultrasound or even x-rays, endoscopy, laser technique, microscopic view, navigation with or without intraoperative update? Where is the borderline between a must have and a nice to have? During the last decades the development in surgery, grew up extremely, lots of techniques entered daily routine. Today surgeon's skills are no longer enough in the western world, because a lot of techniques were easily implemented into daily routine. But the question is where do we have to draw the borderline between necessity and surgeons toys. This presentation gives an idea to answer these questions.

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## Abstracts

## Poster presentations

## Poster

## Individualized Approach in Tumour Surgery

*Britt-Isabelle Berg-Boerner<sup>1,2</sup>, Cornelia Kober<sup>1,3</sup>, Zdzislaw Krol<sup>1</sup>, Carlos Buitrago-Tellez<sup>4</sup>, Karl Scheffler<sup>5</sup>, Ernst W Radü<sup>6</sup>, Philipp Jürgens<sup>1,2</sup>, Stefan Zimmerer<sup>1,7</sup> and Katja Schwenzer-Zimmerer<sup>1,2</sup>, Basel/ Switzerland*

**Introduction:**In the diagnostic and treatment planning concerning head and neck tumours, the amount and quality of radiological diagnostic can vary. Besides access to radiological equipment, experience of interpreting radiologist and surgeon using the information for therapy decisions, are determining factors for complex interventions. We demonstrate the application of advanced 3D visualization and virtual modelling in a recurrent squamous cell carcinoma which grew along the N. infraorbitalis up to the skull base.**Method:**A patient (83years, female) suffering from a cutaneous squamous cell carcinoma in the region of the N. infraorbitalis right side who had five times surgical interventions at another hospital came to our unit because of persisting pain. The initial CT scan raised the suspicion of a tumour recurrence up to the skull base. A navigated biopsy confirmed the suspicion. Due to dynamic imaging, it was possible to track the eye movement in the horizontal and vertical plane and show an infiltration of the tumour in the extraocular eye muscles. The patient asked for a second opinion and therefore was the surgical intervention delayed. An additional CT scan before the navigated surgical intervention showed a fast growth of the tumour. An exenteratio orbitae was not avoidable. The surgical margins were free of tumour tissue.**Results and Conclusion:**The additional 3D information enabled stepwise removal of this complex tumour. Adhesion due to the tumour and infiltration of the tumour into the extraocular eye muscles as well as the tumour growth along the N. infraorbitals were well visible. The 3D modelling and navigation allowed precise 3D orientation therefore operation time could be reduced.

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## Evaluation of the osseointegration of zirconia dental implants with a new rough surface. A histological and histomorphometrical study in mini pig

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### Background

Tooth replacement with dental implants in partially and completely edentulous patients has become a well documented and scientifically accepted treatment modality. The most often used implant material is titanium. Nowadays the patient's aesthetic demands have increased. Therefore the use of zirconia implants has become an attractive alternative to titanium because of the material's tooth like colour.

### Purpose

Clinical investigations and experimental studies have shown superior results for titanium implants with the sandblasted large grit acid-etched surface (SLA). As direct bone to implant contact is regarded as one of the key parameters for successful osseointegration the objective of the present study was to investigate this attribute for zirconia implants with a new rough surface topography in comparison to Ti-SLA implants in a histological and histomorphometrical study.

### Material and Methods

The incisor 2 and 3 were extracted from both sides of the maxillae of 15 adult miniature pigs. After a healing period of at least 6 months the animals received a total of 30 implants in the maxilla using a randomized scheme with both types of implants present in one animal.

Cylindrical zirconia implants 4.1 mm in diameter and 10.0 mm in length were produced by using a new low pressure injection molding technique. After that the implants were acid etched. Ti-SLA implants of the exact shape served as controls.

After 4, 8 and 12 weeks the animals were euthanized and 8, 10 and 10 implants, respectively, were removed with the surrounding bone, fixed and embedded in MMA. 2 implants were lost due to insufficient integration. Serial sections in a bucco palatal plane (initial thickness 200µm) were obtained and stained with Toluidine blue. Histomorphometrical analyses of contact radiographs from the unstained sections were evaluated with respect to peri-implant bone density and bone interface contact (BIC) ratio. Statistical analysis of the data was done using Student's t-test.

### Results

Both materials showed direct osseous integration. Zirconia implants revealed mean peri-implant bone density values of 42.3% at 4 weeks, 52.6% at 8 weeks, and 54.6% at 12 weeks of healing, whereas Ti-SLA implants demonstrated mean values of 29%, 44.1% and 51.6% at corresponding time intervals. Concerning BIC ratio the mean values for zirconia ranged between 27.1% and 51.9% and for Ti-SLA between 23.5% and 58.5%. No significant difference between both materials could be observed at any given time point.

### Conclusion

The histological and histomorphometrical results clearly indicate that zirconia implants have at least the same capacity for osseous integration as the titanium implants from the control group.

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## Face reconstruction after gunshot injury: living with a new identity

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### Background and purpose

Severe gunshot injuries to the face create complex, composite defects. We report the results of the treatment of three patients, where the cooperation of the operative management and psychological therapy could optimize the facial form and function and the social integration.

### Methods

The three patients were treated as follows: (1) initial operative treatment, (2) preparative operative treatment, (3) definitive reconstruction with vascularized tissue, (3) esthetic and prosthetic refinement and (4) continuous psychological care during the whole treatment by psychological reassessment, supporting conversation and coping strategies.

### Results

All three severe facial injuries were the results of gunshots. One patient suffers from a frontal cerebral syndrome and is blind. After each operative intervention, which contributed to the reconstruction of the face, there was an improvement of the psychological condition in terms of improved self-esteem and general confidence. The outcome of the operative treatment of each patient added significantly to the fact that they were later able to open up within the familial environment. One of the patients had a long period of reclusiveness. After a certain time, he was able to spend some time outside of the house for activities such as walking and he made new contacts, which enormously increased his quality of life. The other two patients could integrate fast into society and restart work or re-education.

### Conclusion

The operative treatment of severe facial trauma requires early tissue debridement with bony repair and covering of the defect. Free tissue transfer techniques allow reconstruction of the bony framework and overlying tissues. Multiple secondary procedures are frequently required for optimal esthetic restoration. Importantly, attendant psychological therapy can considerably improve the patient's self esteem and integration into society.

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## Gangrenous diseases of the oral cavity cause extensive tissue defects: necrotizing gingivostomatitis and noma disease

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### Background and purpose

Necrotizing gingivostomatitis and noma disease can cause considerable tissue defects in the face. Necrotizing gingivostomatitis occurs rather in industrialized countries in patients with a somehow compromised immune system due to infectious diseases such as HIV and hepatitis or smoking and vitamin deficiency. Noma occurs primarily among children in less developed countries and is associated with malnutrition and infectious and systemic diseases. They have both in common that the cause is multifactorial and that the causative organisms are most often borrelia, fusiform bacteria and treponema.

### Methods

A 42.4 year old patient positive for HIV and hepatitis B and C presented herself with an acute gangrenous infection of 3x5 cm at the chin that communicated with the oral cavity. Her denture showed a general severe periodontal destruction and caries. Importantly, the red of the lips was intact. The management consisted of conservative treatment of the acute phase by use of local disinfectants, antibiotics (amoxicillin and clavulanic acid, followed by clindamycin), debridement, extraction of affected teeth and stabilization of the patient by correction of fluid imbalance, electrolytes, vitamins and parenteral nutrition. The surgical correction aimed at the removal of scar tissue, improvement of the function of the mouth and reconstruction of the disfigured facial part. The functional and esthetical reconstruction was realized by a combination of a sliding flap and skin relieve by Burrow's triangles.

### Results

After the initial operation, the patient developed scar tissue formation with incomplete lip closure, difficulties with food intake and articulation and a cosmetic unfavorable result in the course of the treatment. After the second operation, which was carried out 13 days later, wound healing was without complications. Six months postoperative, the flap had healed completely and the function of the mouth improved markedly.

### Conclusions

We show that it is possible to encounter noma-like disease in western countries. Progressive non healing necrotizing gingivostomatitis can be associated with malnutrition, compromised immune deficiency and infectious diseases such as HIV and hepatitis. In such patients, a relevant immunodeficiency must be looked for. The therapy should be integral and should include treatment of the carious denture, debridement and covering of the wound, therapy of underlying systemic diseases and improvement of the immune function and nutrition.

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## Significant visualization of ocular dynamics – a multidisciplinary approach

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### Introduction

Whereas 3D-reconstruction based on CT or MRI has already been widely accepted as giving insight to individual patient's anatomy, dynamic radiological monitoring of functional disorders is still in its early beginning. This work refers to a multidisciplinary project dedicated to the evaluation of the functionality of the human organ of vision with focus on the extra ocular muscles and the optic nerve.

### Methods

For radiological imaging of the orbital cavity with special focus on the ocular soft tissue, MRI proved to be the appropriate means. The project is hierarchically structured with regard to the application which means that three different visualization strategies are followed: Firstly, high resolution 3D-reconstruction of the orbital structures, further near real time oculodynamic MRI (od-MRI) standing for "2D-over time", finally full 4D-visualization, namely "time dependent + 3D". In the contrary to od-MRI, the 4D-approach has not yet been realized in real-time.

### Results and Outlook

Highly refined 3D-reconstruction of the orbital structures frequently provided valuable diagnosis support in clinical cases. The od-MRI has already been applied in the clinical setting (high myope, strabismus, palsy and paralysis, tumors, periorbital fat oedema). The improved visualization techniques developed within the project increased the borders of tissue contrast and thus facilitated identification of sclera, periost and muscle structures. The full 4D-approach has been successfully applied for visualization of the eye movements of a control subject. It was rated as very promising. The next step will be application to clinical cases. Both approaches stimulated new ophthalmologic research. Further reduction of MRI acquisition time for the 4D-approach and automatization of data processing are subject of intensive actual research.

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## Visualization of new bone formation in rapid maxillary expansion

*C. Kober, C. Landes, A. Preiss, Y. Lu, A. Parvin, G. Al-Hakim, P. Young, R. Sader, Hamburg, Frankfurt (Main)/ Germany*

By now 30 pre- and postoperative Computertomographies were assembled and analyzed. Inclusion and exclusion criteria were maintained. Three dimensional reconstructions were successful in all cases: 3D-surface reconstructions were performed partially with Amira, Mercury Computer Systems, Berlin, Germany, and with ScanIP, Simpleware Ltd, Exeter, UK. Celsius V-Serie Computer, Siemens-Fujitsu, Frankfurt, Germany, was used to meet the required hardware standard equipped with an nVidia Quadro FX4500 graphics board. The automatic registration produced satisfactory results after some initial fine-tuning and the superposition by means of isosurfaces provided reliable insight. The segmentation of the CT-data enabled detailed 3D-reconstructions of the anatomical shape appropriate for quantitative measurements of the bone movements.

Direct volume rendering permitted complete information regarding the patients' anatomy.

New bone formation could be clearly differentiated from preexistent bone also in parasagittal osteotomies. Bone formation was non-uniform along the osteotomy lines, but approximately symmetric. The more symmetrical the osteotomy was performed, the easier the bone formation could be judged as symmetrical. Higher patient age from our results so far, was not associated with slower or absent bone formation.

The preliminary results indicate that multidimensional insight into the bone formation after surgically assisted maxillary expansion can be attained. Skeletal changes however now must be studied with more detail. Non-uniform bone formation as analyzed yet cannot give clear indication whether bone anchored or tooth anchored distraction devices have less vestibular remodeling. The next step will be isolation of the maxillae to permit better isolated visualization of the maxilla.

As a first result, differences of the patterns of the newly formed bones in the surgical gap could be stated depending on the applied device as well as surgical technique. It is expected that the analysis of the other data sets will provide further insight in the influence of the applied device and surgical technique.

Differentiation (by direct volume rendering) and quantitative (by an own approach) evaluation of local bone density, vestibular bone loss and tooth anchorage will be monitored. Actual results show significant changes in vestibular bone quality for the pre- and post-operative situation. Additionally, pre- and postoperative bone quality of the skull base will be compared.

By concise evaluation and systematic comparison of the cases within the study, locally specified insight to changes during therapy with regard to bone quantity and quality as well as tooth anchorage is expected which will directly influence improved distractor placement, stability, and design.

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## Patient-specific virtual anatomical models and model-guided therapy in the CMF- and neurosurgery

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### Introduction

To effectively manage the whole computer-assisted cranio-maxillofacial treatment pipeline, from the 3D-data acquisition to the post-operative surgery outcome validation, one needs a wide spectrum of algorithmic approaches. Our efforts in the development of strategy for realization of the treatment goals is focused on the generation of the virtual patient-specific anatomical models, which can be used in the surgery planning and simulation, during the intraoperative navigation as well as for the surgical outcome validation.

### Materials and methods

We divide the applied methodology into two parts. At the first stage segmentation, registration, measurement and visualization modules constitute actually the main pool of the heterogeneous software engineering tools, which enables the surgeon to create a virtual patient-specific anatomical model of the region of interest. Based on this model the surgeon can simulate and plan different treatment approaches as well as carry out quantitative measurements to identify the optimal surgical procedure. At the second stage, the prepared virtual patient model including the numerically defined treatment goals is used by the navigation system in the operation theatre. In the scheme below the virtual model for the patient with the skull base tumor (sphenoid wing meningioma), the input data and different model instances are presented.

### Results

The whole data processing pipeline has been applied to plan the surgical treatment in more than 10 CMF and neurosurgical cases. We will present three clinical cases, which illustrate the different instances of the generated virtual patient models and the application of such models for the surgery planning and the intraoperative navigation. These three cases being mostly representative for the performed surgeries are:

Case 1: Sphenoid wing meningioma

Case 2: Wooden stick injury in the craniofacial area

Case 3: Surgical treatment of the Pfeiffer syndrome

### Conclusions

Due to the applied methodology enabling advanced diagnostics and treatment planning the surgeon can safely remove tumors once thought to be „unresectable“ (like the meningioma case) or foreign body in the complex emergency case (stick injury). The presented model-guided therapy brings strong added value to the surgical practice by allowing more precise planning and performing of the surgical procedure, as well as by reducing intra-operative time. The damage to the healthy tissues and the risk of related complications can be also substantially reduced.

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## Micro-CT – an approach towards virtual reality

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Micro-Ct offers informations concerning the 3D bone architecture, bone density, bony quality and can therefore provide additional information about ethology of bone diseases.

Within the scope of a poster presentation, several pathologies will be presented by micro-ct as a computerbased form of visualization in order to provide an approach towards virtual reality.

This form of presentation enables a changed approach of several pathologies like salivary gland stones, dental fractures or different kinds of bone diseases.

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## When to utilize which Registration Concept for Surgical Navigation in Cranio-Maxillofacial Surgery

*Heinz-Theo Luebbers(1), Peter Messmer (2), Joachim A Obwegeser (1), R A Zwahlen (1); Ron Kikinis (3), Klaus W Graetz (1) F Matthews (2,3)*

### Background

Surgical navigation requires registration of the pre-operative image dataset with the patient in the operation theatre. The key element to all surgical navigation is the correct registration of the image dataset to the patient. Precise registration is crucial as it has direct repercussion onto the precision of all subsequent navigation tasks (Eggers et al., 2006).

Various marker and marker-free registration techniques are available (Schramm et al., 2001), each bearing an individual level of precision and clinical practicability. In this study the precision of four different registration methods in a maxillofacial surgical setting is analyzed. The results are judged on base of eight years of clinical experience with surgical navigation in the cranio-maxillofacial field.

### Materials and methods

A synthetic human skull model was registered with its CT-dataset using (a) a dentally mounted occlusal splint, (b) the laser surface scan, (c) facial bone implants and (d) a combination of dental splint and orbital bone implants. The target registration error was computed for 170 landmarks spread over the viscerocranium and neurocranium in ten repeats using the VectorVision 2 navigation system. Statistical and graphical analyses were performed overall and subdivided by anatomical regions.

### Results

An average precision of 1mm was found for the periorbital region irrespective of the registration method (range 0.6 to 1.1mm). Beyond the mid-face, precision linearly decreases with the distance from the polygon of the reference markers. The addition of two orbital bone markers to the splint carried fiducials significantly improved precision from 1.3mm to 0.8mm ( $p < 0.001$ ) on the viscerocranium and 2.3mm to 1.2mm ( $p < 0.001$ ) on the neurocranium.

### Conclusions

The use of five fiducials implanted into the bone provides highest accuracy over all areas of the skull. An occlusal splint alone yields good precision for navigation until surgery affects areas beyond the mid-face. The precision can be increased by combining it with just two bone implants inserted on the lateral orbital rim of each side.

Precision of the laser surface scanning is overestimated in this study due to the lack of realistic soft tissue simulation in the synthetic model. From clinical experience the method can be utilized if precision below 2mm is not an issue and no acute swelling is present.

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## The 3D-MD system in the Department of Cranio-Maxillofacial Surgery at the University of Zurich. Precision and accuracy

*L Medinger<sup>1</sup>, Heinz.Theo Luebbbers<sup>1</sup>, F Matthews<sup>2</sup>, Klaus W Grätz<sup>1</sup>, Zurich/ Switzerland, Boston/ USA*

**Aim**

The aim of this study was to perform a measurement capability analysis of the 3dMD system by evaluating the precision and accuracy of the system in capturing a mannequin head in various positions and to determine the impact of various sources of error.

**Methods**

Our study sample consisted of a mannequin head pre-labeled with 41 standard surface landmarks. The mannequin head was measured with caliper and 3D-Full-face photos captures using the 3dMD system in various head rotations (-30° to +30°), and head positions. Landmarks were digitized on the computer screen with and without zooming on the screen and difference between positions of landmarks compared on the different images captured.

**Results**

**Precision:** The operator error (repeated measures of the same image) was within 0.1mm whereas the capture error (difference between repeated captures of the same scene) was within 0.11mm.

**Accuracy/bias:** The system turned out to be highly accurate to manual anthropometry without significant difference between the measurements performed and with a bias calculated of only 0.024mm.

**Registration error:** No significant differences between various placements of the imaged object could be observed.

**Conclusion**

This investigation confirmed the reproducibility, accuracy and validity of the 3dMD method in recording facial morphology, with a variability less than that of the manual measurements.

From the clinical view the 3dMD system is able to display fast capture times and images, is reliable in archiving and storing data and easy to use.

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## Individualized concept in a polytrauma case with severe head and brain injury

*Babett Williger<sup>1,2</sup>, Stefan Zimmerer<sup>1,3</sup>, Katja Schwenzer-Zimmerer<sup>1,2</sup>, Basel/ Switzerland*

### Introduction

In a complex polytrauma case various disciplines are involved. The goal is to find fast a complete diagnosis of the injured after clinical examination and radiological diagnostic. The next step is to coordinate the operative therapy necessary in one intervention, if possible. The individual case may ask for a variation of this plan.

### Method

We present a complex trauma case of a patient (33 y, male) who has been hit by several metal pipes (50 – 70 kg each) at a reconstruction sight from 4 – 5 m height. He has been found unconscious with spontaneous breathing. When the ambulance arrived circulation was stable and the GCS was 6. The patient was intubated and transported to the University Hospital Basel.

At the trauma room, the patient was strongly bleeding out of the mouth and moderate out of nose and ear with a stabile cardiac situation. The maxilla was mobile and an anisocoria (left>right) was documented. The pupil reaction was decelerated. A CT scan confirmed following diagnosis: open trauma of the brain and skull, pan facial fractures with sagittal split of the maxilla, thorax trauma, instable pelvic fracture type c, blunt abdominal trauma, vertebra process fractures of the thoracic and lumbar spine.

The patient was transferred immediately to the operation theatre. The intervention was preformed with an interdisciplinary team: maxillofacial surgeons, neurosurgeons and general surgeons. Parts of the operation were: haemostasis of the maxilla, craniotomy, removal of the fractured frontal bone fragments and the supraorbital rim, reconstruction of the sinus, evacuation of the subdural haematoma, a ventricle drain and a dura plastic. Major blood loss (~1.5 l) due to bleeding from the maxilla region and a further blood loss out of the mesenteric vein lead to volume loss coagulopathy. Further operation in the head and neck area was not possible because of the cardio-pulmonary situation. The patient's bone was saved and stored in a cooler.

(7 days later) in a second operation the patient's midface was reconstructed and the frontal bone and the supraorbital rim were re-implanted.

In a second operation after stabilisation of the patient's situation the midface was reconstructed, the frontal bone and the supraorbital rim were reimplanted.

### Results and Discussion

The patient recovered completely. Since his hair covers the scars on his head the operation leaves little external signs. The situation of this patient asked for an adapted treatment plan with an interdisciplinary operation in two steps. In complex cases "gold standards" and therapy concepts shouldn't be seen as dogmas because each patient needs an individual adapted therapy concept.

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## Anti-proliferative effects of bisphosphonates on different cell types

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### Introduction

Bisphosphonate therapy has been incorporated in the standard management of patients with metastasising breast cancer, metastasising prostate cancer and multiple myeloma-related bony disease. Although their efficacy in reducing skeletal related events is important in the supportive management of the myeloma patient, post-marketing experience with this class of agents, particularly the more potent intravenous agents pamidronate and zoledronic acid, have raised cautionary notes regarding the potential side effects of these agents. One important side effect is an osteonecrosis of the jaw associated with bisphosphonate use. Therefore aim of our study was to investigate the viability of different cell types (HUVEC, osteoblasts, etc.) in vitro after bisphosphonates treatment.

### Methods

After isolation and characterization, the following cell types were investigated: human umbilical venous cells (HUVEC), osteoblasts, fibroblasts and tumor cell line (PCI30). To investigate the vitality of the cells we used the MTT test and other migration test like scratch wound assay.

### Results

Osteoblast, fibroblast and specially HUVEC show a significant reduction of the vitality after bisphosphonate therapy. Interestingly, tumor cell line (PCI30) shows only marginal effects after bisphosphonate therapy.

Discussion: Bisphosphonates influence not only the turn over of the bone. We could find interesting data that also the neovascularization is impaired after bisphosphonate therapy.

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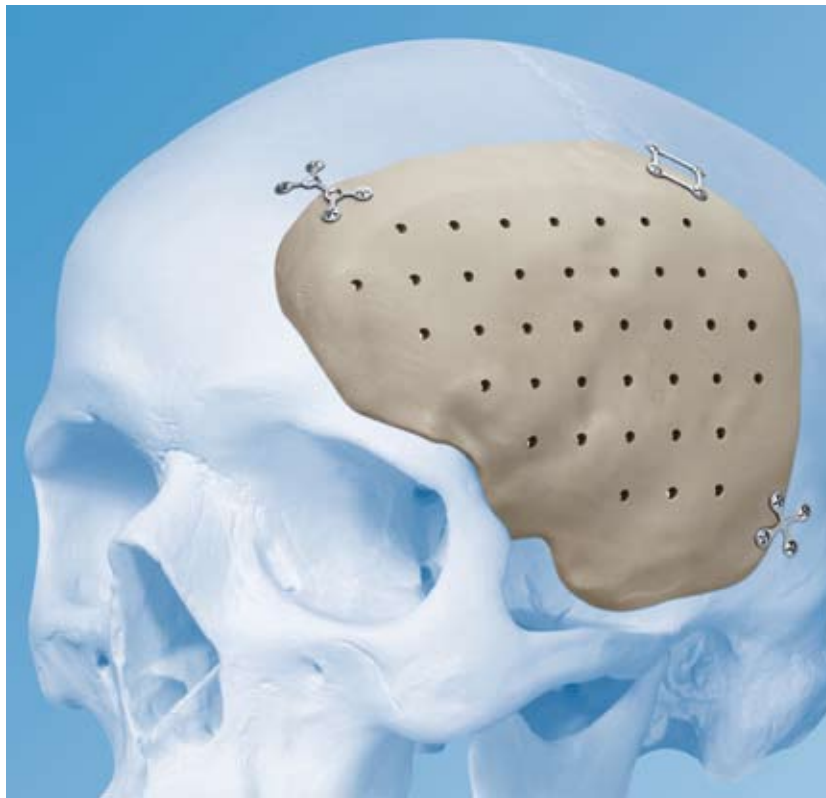
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