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INDICATIILE, STABILITATEA SI LIMITELE OSTEOTOMIILOR MAXILARE MULTISEGMENTARE – STUDII CLINICE SI EXPERIMENTALE

Teza de doctorat
pentru obtinerea titlului de doctor in stiinte medicale, domeniul medicina dentara

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CUPRINS

Cuvinte cheie: osteotomie maxilara multisegmentara, chirurgie ortognatica bimaxilara, acuratetea pozitionarii, flux sanguin osos, laser Doppler, proceduri aditionale, pierderea de sange

1. INTRODUCERE

Unul din scopurile acestui studiu a fost elaborarea indicatiilor pentru osteotomiile multisegmentare LeFort I. Exista doar putine studii care au investigat stabilitatea orizontala si verticala a osteotomiilor multisegmentare LeFort I [12, 13, 15, 22, 23]. Din acest motiv a fost conceput un studiu cuprinzand 60 de pacienti cu osteotomii LeFort I monosegmentare si 60 osteotomii trisegmentare. Doua studii au fost desfasurate pentru a investiga efectul diferitilor factori (segmentarea maxilarului, durata interventiei, experienta chirurgului) si a diferitelor proceduri aditionale (grefa de creasta iliaca, osteotomii aditionale sau ambele) asupra pierderii

de sange in osteotomiile bimaxilare. Un studiu exeprimental a fost efectuat pe oi adulte pentru a stabili limita expansiunii in osteotomiile multisegmentare.

2. ISTORIA OSTEOTOMIEI MULTISEGMENTARE LEFORT I

3. TEHNICA

Daca este planificata repozitionarea superioara, reductia peretelui maxilar posterior este procedura cea mai problematica. Protocolul autorului recomanda evitarea sectionarii arterei palatine descendente [56, 57, 58]. In functie de bresele osoase din siturile de osteotomie este necesara grefarea cu os local sau cu os din creasta iliaca.

4. INDICATIILE SEGMENTARII IN OSTEOTOMIILE LEFORT I

4.2. Material si metode

Toate cazurile cu trisegmentare maxilara din ultimii 3 ani au fost examinate privitor la 5 criterii diferite de indicatii.

4.3. Rezultate

1380 pacienti cu deformitati de dezvoltare craniofaciala au fost operati prin tehnica osteotomiei maxilare LeFort I cu sau fara repozitionare mandibulara intre 1/1999 si 12/2008. Segmentarea maxilarului in trei sau mai multe segmente a fost efectuata in 663 cazuri (41%). Discrepanta transversala, ocluzia deschisa, discrepanta intermaxilara a dimensiunii dentare, asimetria arcadei dentare maxilare si angulatia nefavorabila a incisivilor sunt criteriile pentru segmentare in osteotomiile LeFort I.

4.5. Concluzii

Pragul semnificatiei clinice trebuie sa fie fixat la 2 mm sau respectiv 5°. Osteotomiile maxilare multisegmentare sunt indicate cand doi sau mai multi parametri depasesc pragul significantei clinice.

5. ACURATETEA POZITIONARII MAXILARE IN CHIRURGIA BIMAXILARA

Cele mai importante diferente intre deplasarea planificata si realizata se regasesc in dimensiunea verticala [79]. In studiul prezent nu a fot identificata o diferenta semnificativa intre intruzia si extruzia maxilarului referitor la deviatiile standard ($F=0.41$, $p=0.52$) (Figura 5.4). Pentru avansarea maxuilarului (deplasarea orizontala observata) nu s-a determinat o corelatie semnificativa ($r=0.067$; $p=0.299$; $n=239$) cu diferenta intre deplasarea observata si planificata (Figura 5.5).

Sistemul modificat al pin-ului ofera posibilitatea de pozitionare cu acuratete a maxilarului anterior in chirurgia ortognatica, evitand erorile sistematice. Datorita mobilitatii articulatiei temporo-mandibulare (ATM), pozitionarea orizontala maxilarului este mai putin predictibila.

6. STABILITATEA OSTEOTOMIILOR MULTISEGMENTARE LEFORT I

6.2. Stabilitatea sagitala si verticala a osteotomiei LeFort I in osteotomiile bimaxilare: maxilarul mono- vs. trisegmentar

Scopul acestui studiu a fost investigarea efectului segmentarii asupra stabilitatii diferitlelor deplasari maxilare. Arpornmaeklong et al. au observat un grad semnificativ mai mare de recidiva verticala in grupul monosegmentar in cazul avansarii maxilarului fara proceduri mandibulare [22]. Decizia pentru segmentarea in procedurile LeFortI trebuie luata

in accord cu beneficiul ocluzal, deoarece nu va induce instabilitate suplimentara daca se face grefare osoasa corespunzatoare. Pentru avansari mai ample, cu repozitionare inferioara simultana, s-ar putea indica o procedura in doi timpi, cu distraction initial si osteotomie maxilara multisegmentara dupa 6 – 12 luni.

6.3. Stabilitatea transversala a osteotomiilor maxilare multisegmentare LeFort I

Scopul prezentului studiu retrospectiv a fost acela de a compara stabilitatea transversala dento-alveolara si scheletala a osteotomiilor multisegmentare LeFort I realizate prin 3 tehnici diferite: osteotomie palatinala unilaterala, osteotomie palatinala bilaterala dupa Turvey si osteotomie palatinala unilaterala cu imobilizarea boltii palatine cu placi biodegradabile [18].

Deplasarea inferioara postchirurgicala medie semnificativa statistic a molarului prim superior este probabil datorata recidivei transversale dupa "tippping" indus ortodontic sau chirurgical. Aceasta reprezinta o problema majora in cazurile de ocluzie deschisa. Grefarea osoasa adecvata produce o buna stabilitate pentru repozitionarea anterioara si inferioara a maxilarului. Expansiunea chirurgicala a maxilarului ofera rezultate stabile la nivelul bazei scheletice a maxilarului, dar rate inalte de recidiva la nivelul regiunii dento-alveolare. Expansiunea ortodontica preoperatorie este sursa principala de recidiva transversala. Diferitele tehnici chirurgicale de osteotomii (palatine, inclusiv imobilizarea cu placi resorbabile) nu au efect semnificativ asupra stabilitatii transversale. O procedura in 2 timpi cu expansiune maxilara rapida asistata chirurgical (SARME) si osteotomie LeFort I dupa circa 12 luni ar trebui preferata pentru tratamentul discrepantelor transversale mai mari sau egale cu 7 mm.

7. PIERDEREA DE SANGE IN OSTEOTOMIILE BIMAXILARE CU SEGMENTARE MAXILARA

Scopul urmatorului studiu a fost definirea factorilor care indica donarea preoperatorie de sange autolog in cazul pacientilor supusi interventiilor chirurgicale de osteotomii bimaxilare. Pierderea de sange se coreleaza semnificativ pozitiv cu durata operatiei. Segmentarea maxilarului nu duce la o pierdere semnificativ mai mare de sange, daca durata operatiei nu depaseste anumite limite. Procedurile aditionale cresc semnificativ pierderea intraoperatorie de sange in procedurile bimaxilare cu osteotomii multisegmentare LeFort I. Datorita ratei generale reduse de transfuzii sanguine observate in ambele studii, nu se pot face recomandari generale de donare preoperatorie de sange sau cross-matching in cazul osteotomiilor bimaxilare care includ osteotomii multisegmentare cu proceduri aditionale. La pacientii cu potential risc de transfuzie, cum ar fi: greutate corporala redusa, proceduri chirrugicale de durata lunga, valoare preoperatorie redusa a hemoglobinei trebuie luate in considerare donarea autoloaga de sange si administrarea de acid tranexamic, desmopresina sau aprotinina.

8. FLUXUL SANGUIN TISULAR IN OSTEOTOMIILE MULTISEGMENTARE LEFORT I

8.3.1. Tehnica cu microsfere

8.3.2. Laser Doppler flowmetria

8.5. Influenta expansiunii asupra fluxului sanguin osos intraoperator in osteotomiile multisegmentare maxilare – studiu experimental

Osteotomiile multisegmentare maxilare produc o reducere semnificativa a fluxului sanguin osos inspre segmentele dento-osoase. Deplasarile moderate ale maxilarului nu au o influenta semnificativa asupra perfuziei tisulare sanguine. Expansiunea transversala mai mare de 4 mm produce o reducere semnificativa suplimentara a fluxului sanguin osos maxilar.

Artera palatina descendenta (DPA) trebuie conservata pe cat posibil in osteotomiile maxilare multisegmentare. Flowmetria laser Doppler este o tehnica fezabila pentru monitorizarea segmentelor dento-osoase critice, de exemplu la pacienti cu despicaturi labio-maxilo-palatine sau cu interventii chirurgicale asupra palatului in antecedente.

9. CONCLUZII GENERALE

Osteotomia LeFort I multisegmentara este o interventie utila in chirurgia ortognatica moderna. Urmatoarele probleme tridimensionale pot fi considerate ca indicatii pentru segmentarea maxilara:

1. Discrepanta transversala la nivel dentar si scheletal. Spre deosebire de tratamentul ortodontic si de expansiunea maxilara rapida asistata chirurgical (SARME), este posibila obtinerea de expansiune mai ampla scheletala decat dentara (reducerea curbei maxilare a lui Wilson)
2. Ocluzia deschisa, in special cea anterioara si curba Spee excesiva.
3. Discrepante intermaxilare de dimensiune dentara, cu angulatia sau protruzia adecvata a incisivilor
4. Asimetria arcadei dentare maxilare.
5. Angulatia nefavorabila a incisivilor.

Osteotomiile maxilare multisegmentare devin o optiune chirurgicala daca 2 sau mai multi parametri depasesc urmatoarele praguri de semnificatie clinica: 2 mm de discrepanta transversala, deschidere de spatiu sau shift intre segmentele laterale; un overbite de 0 mm; un unghi al incisivului superior cu linia nasion-sella (U1-NSL) mai mare sau egal cu 107° sau mai mult si mai mic sau egal cu 97°, respectiv.

Comparativ cu osteotomiile LeFort I monosegmentare, procedurile multisegmentare nu produc mai putina stabilitate dentara sau scheletala in dimensiunea sagitala sau verticala. Diferitele tehnici de osteotomii palatinale (unilaterala, bilaterala si unilaterala cu imobilizarea boltii palatine cu placi resorbabile) nu au efect semnificativ asupra stabilitatii transversale. Expansiunea ortodontica preoperatorie este probabil principala sursa de recidiva transversala.

Fluxul sanguin osos in segmentele dento-osoase este redus semnificativ prin segmentarea in osteotomiile LeFort I. In mod special in cazurile cu dilatare maxilara, conservarea arterei palatine descendente trebuie pe cat posibil intreprinsa. Segmentele dento-osoase critice, cum ar fi de exemplu la pacienti cu despicaturi labio-maxilo-palatine sau cei cu operatii palatinale precedente, pot fi monitorizate prin laser Doppler flowmetrie.

Datorita ratei inalte de recidiva si a riscului crescut de sechele avasculare, pentru tratamentul discrepantelor transversale mai mari sau egale cu 7 mm trebuie efectuata o procedura in doi timpi, cu expansiunea maxilara rapida asistata chirurgical (SARME) si osteotomia LeFort I.

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Curriculum vitae

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Studii preuniversitare

1971 - 1975	Scoala primara in Stuttgart-Plieningen
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Studii

1984 – 1990	Facultatea de Medicina, Universitatea din Ulm
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08. Noiembrie 1990	Doctor in Medicina, Universitatea din Ulm
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Activitate profesionala

5/1994 – 10/1994	Medic rezident, cabinet privat de chirurgie maxiofaciala Dr. Werner Hillebrand, Biberach
Incepand cu 11/1994	Medic rezident, Departamentul de Chirurgie Orala si Maxilofaciala al Marienhospital Stuttgart (Seful Clinicii: Prof.Dr.Dr.Dr.K.Wangerin)
04. August 1998	Comisia germana de examinare in Chirurgie Orala si Maxilofaciala
1/1999	Director adjunct, Departamentul de Chirurgie Orala si Maxilofaciala
22.Octombrie 2001	Comisia germana de examinare in Chirurgia Plastica Faciala
9/2002	Nominalizare pentru examinator al Comitetului European de Chirurgie Orala si Maxilofaciala

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Apartenența la societăți științifice și profesionale

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Asociatia Europeana de Chirurgie Cranio-Maxilofaciala

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Reviewer

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Congresul European de Chirurgie Orala si Maxilofaciala, Bologna, 9/2008

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1st International Symposium on Distraction and Orthognathic Surgery, Stuttgart, 10/1997

2nd International Symposium on Distraction and Orthognathic Surgery, Stuttgart, 10/2000

3rd International Symposium on Distraction and Orthognathic Surgery, Stuttgart, 10/2003

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Lucrari comunicate / Conferinte

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Alveolar Reconstruction, Sindelfingen, 9/2004

Faculty and Live Operation Course

National Conference of the Indian Society of Oral and Maxillofacial Surgery Mangalore, India, 12/2003

Reconstruction of the lips and the chin, Symposium on Oncology and Reconstruction, Stuttgart, Germany 10/2005

Master Class Lecture: *The importance of incisor inclination in orthognathic surgery*, European Congress of Oral and Maxillofacial Surgery, Bologna, Italy, 9/2008

The vertical dimension in orthognathic surgery, European Congress of Oral and Maxillofacial Surgery, Bologna, Italy, 9/2008

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Three-dimensional stability of three-piece Le Fort I osteotomies, 5. Int. Symposium on Distraction and Orthognathic Surgery, Stuttgart, Germany, 10/2009

Winfried B. Kretschmer Stuttgart, 10.03.2010

Memoriu de activitate stiintifica

In timpul studiului medicinii la finele anilor ’80 mi-am inceput activitatea stiintifica experimentala in cadrul tezei de licenta. In mod interesant, si la acea vreme masurarea perfuziei tisulare constituia o tema importanta de cercetare. Aportul sanguin la nivelul cordului si al creierului am investigat-o astfel la miniporci in timpul reanimarii cardiovasculare cu adrenalina si noradrenalina cu ajutorul microsferelor radioactive (titlul tezei de licenta: *Aportul si cererea de oxigen a cordului si creierului in timpul reanimarii cardiovasculare cu adrenalina si noradrenalina*). Spre deosebire de laser Doppler, cu aceasta tehnica nu pot fi efectuate masuratori clinice. Dupa ce am intrat in departamentul de Chirurgie Orala si Maxilofaciala a spitalului Marienhospital din Stuttgart (Sef: Prof. Dr. K. Wangerin) in 1994, munca mea stiintfica s-a concentrat pe chirurgia ortognatica si distraction, datorita reputatiei internationale a profesorului meu in aceste domenii. Intre 1994 si 1998 am dezvoltat o tehnica de planificare a vectorului in cazurile de distraction vertical endooral. Aceasta tehnica a fost prezentata in cadrul congresului *1st International Symposium on Distraction and Orthognathic Surgery* (Stuttgart, Germania, 10/1997), al *International Course on Orthognathic Surgery and Distraction* (Helsinki, Finlanda, 2/1998) si a *Hands-on work shop on craniofacial distraction* (Roma, Italia, 4/98) si a fost publicata in cadrul cooperarii mele cu Universitatea de Medicina si Farmacie “Iuliu Hatieganu” din Cluj-Napoca, Romania (Gr. Băciut, M. Băciuț, K. Wangerin, W. Kretschmer, C. Dinu, H. Rotar, S. Bran, Ileana Mitre, *Selection of the distraction pattern in the deformed mandible,* Monduzzi Editore International Proceedings Division, vol. ISBN 88-7587-281-3, CD ISBN 88-7587-282-1, 2006, pp. 57 – 61, 2006). In 1999 am finalizat teza de licenta in medicina dentara (titlul: R*epozitionarea controlata tridimensional a mandibulei in procedurile bimaxilare cu placi de pozitionare si gutiere).* Acuratetea repozitionarii maxilarelor a fost investigata intr-un studiu retrospectiv pe 100 pacienti supusi chirurgiei bimaxilare de corectie a deformitatilor dentofaciale. Datorita diferentelor semnificative intre deplasarile verticale planificate si observate, aceasta tehnica cronofaga a fost inlocuita prin noul sistem cu pin, dezvoltat de autor in cooperare cu firma Medicon. Fiabilitatea noii tehnici a fost demonstrata recent intr-un studiu publicat in *British Journal of Oral and Maxillofacial Surgery* (2009; 47: 446 - 449). Dezvoltarea de noi aparate de distraction a jucat un rol important timp de multi ani in activitatea stiintifica din departament. In 2002 autorul a prezentat aparatul de expansiune a mandibulei la Verona. Primele cazuri de distraction maxilar transantral cu un nou aparat de distraction au fost prezentate la al *3rd International Symposium on Distraction and Orthognathic Surgery*

(Stuttgart, Germania, 10/2003). Am fost invitat sa sustin conferinte in calitate de "invited lecturer" pe teme de distraction pediatric in Brazilia (*Scientific Meeting of the Division of Plastic Surgery*, Sao Paulo, 12/2000) si India (*National Conference of the Indian Society of Oral and Maxillofacial Surgery*, Mangalore, 12/2003). Acestea au reprezentat cu siguranta doua momente de varf ale carierei mele stiintifice. O cooperare apropiata cu departamentul de Chirurgie Orala si Maxilofaciala a Universitatii din Verona, Italia (Sef: Prof. Dr. P.F. Nocini) a condus gratie contributiei mele in interventie la primul distraction efectuat pe un lambou liber vascularizat de fibula. Cazul a fost prezentat in *Journal of Craniomaxillofacial Surgery* (2000; 28: 20 – 24). Pentru evaluarea calusului in distractionul mandibular, ultasonografia a fost utilizata foarte timpuriu in departamentul nostru. Un studiu pe aceasta tema a fost efectuat la Verona in cooperare cu clinica noastra si publicat in *Journal of Craniomaxillofacial Surgery* (2002; 30: 286 – 291). Pe parcursul anilor, osteotomiile multisegmentare LeFort I au devenit o componenta importanta a activitatii de rutina in chirurgia ortognatica. Am introdus aceasta tehnica in Clinica de Chirurgie Orala si Maxilofaciala a Universitatii de Medicina si Farmacie "Iuliu Hatieganu" din Cluj-Napoca in 2005. Hemoragia importanta si irigarea insuficienta sunt cele mai severe complicatii ale acestei proceduri. O chestiune importanta se punea in intrebarea de a folosi sau nu donarea autoloaga de sange preoparator. Lipsa datelor a condus la efectuarea a doua studii pe loturi mari de pacienti cu proceduri bimaxilare. S-a putut demonstra ca donarea autoloaga de sange nu poate fi recomandata in chirurgia bimaxilara, chiar daca este planificata segmentarea maxliarului si proceduri aditionale. Cele doua studii au fost publicate in *Journal of Oral and Maxillofacial Surgery* (2008; 66: 1399 – 1403) si *British Journal of Oral and Maxillofacial Surgery* (2010; 48: 276 - 280). Conlucrarea stransa si prietenia cu echipa Clinicii de Chirurige Orala si Maxilofaciala a Universitatii de Medicina si Farmacie "Iuliu Hatieganu" din Cluj-Napoca mi-au dat posibilitatea de a-mi continua activitatea stiintifica si in special experimentala in studii animale la USAMV Cluj-Napoca. Prapastia dintre procentul inalt de osteotomii maxilare multisegmentare din departamentul nostru si lipsa datelor privind aportul sanguin la maxilar dupa expansiunea transversala a generat ideea masurarii intraoperatorii a perfuziei maxilarului intr-un studiu animal. Studii anatomice ale craniilor diferitelor animale au sugerat utilizarea oii pentru osteotomiile multisegmentare LeFort I. Masurarea planificata a perfuziei maxilarului la diferite etape de expansiune graduala au exclus tehnica cu microsfere. In final, pentru studiul experimental a fost utilizata tehnica Laser Doppler. In acest fel s-a putut stabili prima recomandare pentru o limita a expansiunii maxilare bazate pe evidente (5 pana la 6 mm in regiunea molara). Rezultatele au fost publicate in *International Journal of Oral and Maxillofacial Surgery*

(2010; 39: 282 - 286). Tehnica Laser Doppler a fost utilizata de asemenea intr-un studiu clinic al fluxului sanguin osos in timpul osteotomiilor LeFort I multisegmentare. Fluxul sanguin osos nu mai fusese masurat in niciun studiu prealabil. Rezultatele au aratat ca deplasarile maxilare moderate nu provoaca reducerea suplimentara de flux sanguin in segmentele dento-osoase. Lucrarea a fost publicata in *Oral Surgery Oral Medicine Oral Pathology Oral Radiology and Endodontology* (2009; 108: 178 – 183). Stabilitatea pe termen lung este unul din cei mai importanti factori in chirurgia ortognatica. In literatura nu exista decat putine date referitor la stabilitatea osteotomiilor multisegmentare. In plus, o noua tehnica de stabilizare transversala a boltii palatine cu o placuta biodegradabila a fost introdusa in Clinica de Chirurgie Orala si Maxilofaciala a spitalului Marienhospital din Stuttgart. Din acest motiv au fost conduse doua studii asupra stabilitatii osteotomiilor maxilare multisegmentare. Au fost comparate stabilitatea verticala si sagitala a osteotomiilor uni- si multisegmentare in cadrul procedurilor bimaxilare. Nu au fost gasite diferente semnificative intre cele doua grupuri. Rezultatele au fost prezentate la o conferinta invitata la *European Congress of Oral and Maxillofacial Surgery* (Bologna, Italia, 9/2008) si publicate in *Journal of Oral and Maxillofacial Surgery* (2010; 68: 372 – 380). A fost o mare onoare pentru mine sa fiu nominalizat ca membru in comitetul stiintific la acest congres si sa tin un masterclass la acest congres ("*The importance of incisor inclination in orthognathic surgery*"). In al doilea studiu au fost investigate trei tehnici diferite de expansiune maxilara. Stablizarea boltii palatine cu o placa resorbabila a prezentat o tendinta mai mica de recidiva. Nu au fost observate diferente semnificative intre grupuri. Datele au fost prezentate la al *5th International Symposium on Distraction and Orthognathic Surgery* (Stuttgart, 10/2009). Recent, articolul respectiv a fost acceptat spre publicare in *Journal of Oral and Maxillofacial Surgery*. In 2009, am fost nominalizat ca reviewer la aceasta revista. Cooperarea europeana este unul din domeniile mele favorite. A fost stabilita o cooperare stransa cu Universitatile din Cluj-Napoca si Verona. Aceste cooperari includ si schimburile de medici. Organizarea de manifestari stiintifice internationale este importanta pentru schimburile stiintifice. Am fost membru in comitetul de organizare a 5 conferinte internationale in Stuttgart.

Winfried B. Kretschmer Stuttgart, 10.03.2010

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INDICATIONS, STABILITY AND LIMITS OF MULTISEGMENTAL MAXILLARY OSTEOTOMIES – CLINICAL AND EXPERIMENTAL STUDIES

PhD Thesis
for the title of doctor in medical sciences, domain dental medicine

Scientific conductor:
PROF. DR. DR. GRIGORE BĂCIUŢ

PhD candidate:
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CONTENTS

Keywords: multisegmental maxillary osteotomy, bimaxillary orthognathic surgery, accuracy of positioning, bone blood flow, laser Doppler, additional procedures, blood loss

1. INTRODUCTION

One of the purposes of this work was to elaborate the different indications for multisegmental LeFort I osteotomies. Only few studies have investigated the horizontal and the vertical stability of segmental LeFort I osteotomies [12, 13, 15, 22, 23]. Therefore, a study with 60 single-piece and 60 three-piece LeFort I osteotomies was designed. Two studies were run to investigate the effect of different factors (segmentation of the maxilla, operating time, experience of the surgeon) and different additional procedures (iliac crest graft, additional osteotomies or both) on blood loss in bimaxillary osteotomies. An experimental study was carried out on adult sheep in order to establish another limit – the limit of expansion in multisegmental osteotomies.

2. HISTORY OF MULTISEGMENTAL LEFORT I OSTEOTOMY

3. TECHNIQUE

If superior repositioning is planned, reduction of the distal maxillary wall is the most demanding procedure. The author`s policy is to avoid transection of the descending palatine artery (DPA) [56, 57, 58]. Depending on the bony gaps at the osteotomy sites, grafting with local bone or iliac crest is necessary.

4. INDICATIONS FOR MAXILLARY SEGMENTATION IN LEFORT I OSTEOTOMIES

4.2. Material and methods

All the cases with a three-piece maxilla within the last three years of this ten-year period were examined for five different indications.

4.3. Results

1380 patients with developmental craniofacial deformities received LeFort I maxillary osteotomies with or without mandibular repositioning from 1/1999 to 12/2008. Segmentation of the maxilla into three or more pieces was done in 663 cases (41%). Transverse discrepancies, open bite, intermaxillary tooth size discrepancies, asymmetry of the maxillary dental arch and unfavourable incisor inclination are possible criteria for segmentation in LeFort I osteotomies. The threshold for clinical significance should be set at 2 mm or 5°, respectively. Multipiece maxillary osteotomies are indicated, when two or more parameters exceed the threshold for clinical significance.

5. ACCURACY OF MAXILLARY POSITIONING IN BIMAXILLARY SURGERY

The most important differences between planned and achieved movements are found in the vertical dimension [79]. In the present study, no significant difference could be found between intrusion and extrusion of the maxilla with respect to the standard deviations ($F = 0.41$, $p = 0.52$) (Figure 5.4). For the advancement of the maxilla (observed horizontal movement) no significant correlation ($r = 0.067$; $p = 0.299$; $n = 239$) with the difference between observed and planned vertical movement was found (Figure 5.5). The modified pin system provides accurate vertical positioning of the anterior maxilla in orthognathic surgery without systematic errors. Due to the mobility of the temporomandibular joint (TMJ), horizonal maxillary repositioning is less predictable.

6. STABILITY OF MULTISEGMENTAL LEFORT I OSTEOTOMIES

6.2. Sagittal and vertical stability of LeFort I osteotomy in bimaxillary osteotomies: single-piece vs. three-piece maxilla

The purpose of this study was to investigate the effect of segmentation on the stability of different maxillary movements. Arpornmaeklong et al. observed significantly more vertical relapse in the single-piece group, when advancing the maxilla without mandibular procedures [22]. The decision for segmentation in LeFort I procedures should be taken according to the occlusal benefits, as it will not induce significant instability, when appropriate bone grafting is done. For larger advancements with simultaneous inferior repositioning, a two-step procedure with distraction first and multi-piece maxillary osteotomy after six to twelve months might be indicated.

6.3. Transverse stability of multisegmental LeFort I maxillary osteotomies

The aim of the following retrospective study was to compare the transverse dento-alveolar and skeletal stability of multi-piece LeFort I osteotomies with three different techniques: unilateral palatal osteotomy, bilateral palatal osteotomy according to Turvey and unilateral palatal osteotomy with stabilization of the palatal vault with biodegradable plates [18].

The statistically significant mean postsurgical inferior movement of the upper first molar is probably due to transverse relapse after orthodontically or surgically induced tipping, which is a major problem in open bite cases. Adequate bone grafting provides good stability in anterior and inferior repositioning of the maxilla. Surgical expansion of the maxilla provides stable results at the maxillary skeletal base, but high relapse rates in the dento-alveolar area. Preoperative orthodontic expansion is a main source of transverse relapse. Different surgical techniques of palatal osteotomies, including fixation of the palatal vault with resorbable plates, have no significant effect on transverse stability. A two-step procedure with surgically assisted rapid maxillary expansion (SARME) and LeFort I osteotomy after about 12 months should be preferred to manage transverse discrepancies of 7 mm and more.

7. BLOOD LOSS IN BIMAXILLARY OSTEOTOMIES WITH MAXILLARY SEGMENTATION

The purpose of the following studies was to define factors indicating autologous blood donation in patients undergoing bimaxillary osteotomies. Blood loss correlates significantly positively with operating time. Segmentation of the maxilla does not lead to a significantly higher blood loss, as long as operating time does not exceed certain limits. Surgical education is no risk for the patient in terms of blood loss. Additional procedures raise blood loss significantly in bimaxillary procedures with multisegmental LeFort I osteotomies. Due to the overall low transfusion rate observed in both studies, no general recommendation for preoperative blood donation or cross-matching can be given in cases with bimaxillary osteotomies including mutisegmental osteotomies and additional procedures. In patients with a potential transfusion risk, as low body weight, long surgical procedure or low preoperative hemoglobin value, autologous blood donation and administration of tranexamic acid, desmopressin or aprotinin should be considered.

8. BLOOD SUPPLY IN MULTISEGMENTAL LEFORT I OSTEOTOMIES

8.3.1. Microsphere technique

8.3.2. Laser Doppler flowmetry

8.5. The influence of expansion on intraoperative bone blood flow in multisegmental maxillary osteotomies – an experimental study

Multisegmental maxillary osteotomies lead to a significant reduction of bone blood flow to the dento-osseous segments. Moderate movements of the maxilla have no significant influence on the blood supply. Transverse expansion of more than 4 mm results in further significant reduction of maxillary bone blood flow. The descending palatine artery (DPA) should be preserved in multisegmental maxillary osteotomies whenever possible. Laser Doppler flowmetry is a feasible technique for monitoring of critical dento-osseous segments, e.g. in patients with cleft palate or previous palatal surgery.

9. GENERAL CONCLUSIONS

Multipiece LeFort I osteotomy is a useful tool in modern orthognathic surgery. The following three-dimensional problems can be considered indications for maxillary segmentation:

6. Transverse discrepancies at the dental and the skeletal level. In contrast to orthodontic treatment and surgically assisted rapid maxillary expansion (SARME), it is possible to achieve more skeletal than dental expansion (decrease of the maxillary curve of Wilson)
7. Apertognathia with emphasis on anterior open bite and an excessive curve of Spee.
8. Intermaxillary tooth size discrepancies with adequate incisor inclination or protrusion.
9. Asymmetry of the maxillary dental arch.
10. Unfavourable incisor inclination.

Multipiece maxillary osteotomies are a surgical option, when two or more parameters exceed the following thresholds for clinical significance: 2mm of transverse expansion, space opening or shift between the lateral segments; an overbite of 0 mm; an angle of upper incisor to nasion-sella line (U1-NSL) of 107° or more and 97° or less, respectively.

Compared to single-piece LeFort I osteotomies, multisegmental procedures do not show less skeletal or dental stability in the sagittal and vertical dimension. Different surgical techniques of palatal osteotomies (unilateral, bilateral and unilateral with fixation of the

palatal vault with resorbable plates) have no significant effect on transverse stability. Preoperative orthodontic expansion is probably the main source of transverse relapse.

Bone blood flow (BBF) to the dento-osseous segments is reduced significantly by segmentation in LeFort I osteotomies. Particularly in cases with maxillary widening, preservation of the descending palatine artery (DPA) should be attempted whenever possible. Critical dento-osseous segments, e.g. in patients with cleft palate or previous palatal surgery, can be monitored by Laser Doppler flowmetry.

Due to the high relapse rates and the enhanced risk of avascular sequelae, a two-step procedure with surgically assisted rapid maxillary expansion (SARME) and LeFort I osteotomy should be preferred to manage transverse discrepancies of 7 mm and more.

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Curriculum vitae

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Personal Data

Name:	Winfried Kretschmer, M.D., D.D.S.
Date of birth:	02. March 1965
Place of birth:	Crailsheim

School

1971 - 1975	primary school in Stuttgart-Plieningen
1975 – 1984	grammar-school Hohenheim, Stuttgart

Studies

1984 – 1990	Medical School, University of Ulm
1990 – 1994	Dental School, University of Ulm

Academic degrees

08. November 1990	Doctor of Medicine, University of Ulm
29. June 1999	Doctor of Dental Medicine, University of Kiel

Professional career

5/1994 – 10/1994	resident, private office for OMF surgery
	Dr. Werner Hillebrand, Biberach
Since 11/1994	resident, Dept. of Oral and Maxillofacial surgery
	Marienhospital Stuttgart (Head: Prof.Dr.Dr.Dr.K.Wangerin)
04. August 1998	German Board Exam, Oral and Maxillofacial Surgery
1/1999	Deputy Director, Dept. of Oral and Maxillofacial Surgery
22. October 2001	German Board Exam, facial plastic surgery
9/2002	Nomination as examiner of the
	European Board of Oral and Maxillofacial Surgery

Publications

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Memberships

German Society of Oral and Maxillofacial Surgery

European Association of Cranio-Maxillofacial Surgery

International Association of Oral and Maxillofacial Surgeons

Reviewer

Journal of Oral and Maxillofacial Surgery

Scientific Committee

European Congress of Oral and Maxillofacial Surgery, Bologna, 9/2008

Organization Committee

1st International Symposium on Distraction and Orthognathic Surgery, Stuttgart, 10/1997

2nd International Symposium on Distraction and Orthognathic Surgery, Stuttgart, 10/2000

3rd International Symposium on Distraction and Orthognathic Surgery, Stuttgart, 10/2003

Symposium on Oncology and Reconstruction, Stuttgart, Germany, 10/2005

4th International Symposium on Distraction and Orthognathic Surgery, Stuttgart, 7/2006

5th International Symposium on Distraction and Orthognathic Surgery, Stuttgart, 10/2009

Invited lectures / Conferences

Planning in orthognathic surgery, International Course on Orthognathic Surgery and Distraction, Helsinki, Finland, 2/1998

The direction of mandibular distraction,

Secondary corrections after distraction, Hands-on work shop on craniofacial distraction,Rome, Italy, 4/98

Faculty, Master Course on Advanced Implantology, Verona, Italy, 7/2001

Simultaneous Le Fort III osteotomy in bimaxillary surgery with severe midfacial hypoplasia – a routine procedure?, International Symposium on Orthognathic Surgery, Udine, Italy 10/2001

Orthognathic Surgery – The Stuttgart Philosophy, Median Distraction of the mandible School of Verona, 10/2002

Bone Distraction in Children, Scientific Meeting of the Division of Plastic Surgery, Sao Paulo, Brazil, 12/2000

Transantral Maxillary Distraction, 3rd International Symposium on Distraction and Orthognathic Surgery, Stuttgart, Germany, 10/2003

Alveolar Reconstruction, Sindelfingen, 9/2004

Faculty and Live Operation Course, National Conference of the Indian Society of Oral and Maxillofacial Surgery Mangalore, India, 12/2003

Reconstruction of the lips and the chin, Symposium on Oncology and Reconstruction, Stuttgart, Germany 10/2005

Master Class Lecture: *The importance of incisor inclination in orthognathic surgery*, European Congress of Oral and Maxillofacial Surgery, Bologna, Italy, 9/2008

The vertical dimension in orthognathic surgery, European Congress of Oral and Maxillofacial Surgery, Bologna, Italy, 9/2008

Planning in orthognathic surgery and distraction: counter clockwise surgery, Three-dimensional stability of three-piece Le Fort I osteotomies , 5th International Symposium on Distraction and Orthognathic Surgery, Stuttgart, Germany, 10/2009

Winfried B. Kretschmer Stuttgart, 10.03.2010

Resume of scientific activity

During the medical studies in the late 80's I started the first experimental work for the medical thesis. Interestingly, measurement of perfusion was already a main topic at that time. Blood supply of heart and brain were investigated in mini-pigs during cardiovascular reanimation with adrenaline and noradrenaline with radioactive microspheres (title of the thesis: *Oxygen supply and demand of heart and brain during cardiovascular reanimation with adrenaline and noradrenaline*). In contrast to the laser Doppler, clinical measurements are not possible with this technique. Having entered the department of Oral and Maxillofacial Surgery at the Marienhospital Stuttgart (Head: Prof. K. Wangerin) in 1994, my scientific work was focussed on orthognathic surgery and distraction due to the worldwide reputation of my teacher in these fields. Between 1994 and 1998, I developed a technique for vector planning in enoral vertical distraction cases. This technique was presented during the *1st International Symposium on Distraction and Orthognathic Surgery* (Stuttgart, Germany, 10/1997), the *International Course on Orthognathic Surgery and Distraction* (Helsinki, Finland, 2/1998) and the *Hands-on work shop on craniofacial distraction* (Rome, Italy, 4/98). Subsequent to my cooperation with the Department of Oral and Maxillofacial Surgery at the "Iuliu Hatieganu" University of Medicine and Pharmacy Cluj-Napoca, Romania (Head: Prof. Dr. Grigore Baciut) the work was extended and also published (Gr. Băciut, M. Băciuț, K. Wangerin, W. Kretschmer, C. Dinu, H. Rotar, S. Bran, Ileana Mitre, *Selection of the distraction pattern in the deformed mandible,* Monduzzi Editore International Proceedings Division, vol. ISBN 88-7587-281-3, CD ISBN 88-7587-282-1, 2006, pp. 57 – 61, 2006. In 1999, the thesis in dental medicine was finished (title: *Threedimensionally controlled repositioning of the maxilla in bimaxillary procedures with positioning plates and splints*). In a retrospective study on 100 subjects undergoing bimaxillary surgery for correction of dentofacial deformities, accuracy of maxillary repositioning was investigated. Because of the significant differences between planned and observed vertical movements, this time consuming technique has been replaced by the new pin system, developed by the author in collaboration with the Medicon company. The reliability of the new technique has recently been shown in a study, published in the *British Journal of Oral and Maxillofacial Surgery* (2009; 47: 446 - 449). For many years, the development of new distraction devices played an important role in the scientific work of our department. In 2002, I presented the device for widening of the mandible in Verona. During the *3rd International Symposium on Distraction and Orthognathic Surgery* (Stuttgart, Germany, 10/2003), I showed the first cases of

transantral maxillary distraction with a new device. The invited lectures on pediatric distraction in Brazil (*Scientific Meeting of the Division of Plastic Surgery*, Sao Paulo, 12/2000) and India (*National Conference of the Indian Society of Oral and Maxillofacial Surgery*, Mangalore, 12/2003) were certainly two highlights of my scientific career. A close collaboration with the department of Oral and Maxillofacial of the University of Verona, Italy (Head: Prof. PF Nocini), led to the first distraction of a free vascularised fibular flap with my assistance in the operation theatre. The case was reported in the *Journal of Craniomaxillofacial Surgery* (2000; 28: 20 – 24). For the evaluation of the callus in mandibular distraction, ultrasound was used very early in our department. A study on this topic was run in Verona in collaboration with our clinic and published in the *Journal of Craniomaxillofacial Surgery* (2002; 30: 286 – 291). Over the years, multipiece Le Fort I osteotomies have become an important part of the daily work in orthognathic surgery. I have introduced this technique in the Clinic for Cranio-Maxillofacial Surgery of the University of Cluj-Napoca in 2005. Major bleeding and vascular impairment are the most severe complications of the latter procedure. An important question was, whether to use autologous blood donation prior to surgery, or not. The lack of data led to two studies with large samples of bimaxillary procedures. It could be shown, that autologous blood donation cannot be recommended for bimaxillary procedures, even when segmentation of the maxilla and additional procedures are planned. The two studies were published in the *Journal of Oral and Maxillofacial Surgery* (2008; 66: 1399 – 1403) and the *British Journal of Oral and Maxillofacial Surgery* (2010; 48: 276 - 280).

The close collaboration and friendship with the staff of the Clinic for Cranio-Maxillofacial Surgery of the University of Cluj-Napoca gave me the possibility to do experimental work and especially animal studies at the Veterinarian Clinic of Cluj-Napoca. The gap between the high percentage of multipiece maxillary osteotomies in our department and the lack of data regarding the blood supply of the maxilla after transverse expansion led to the idea of intraoperative measurement of the maxillary perfusion in an animal study. Anatomical studies of the skulls of different animals suggested the use of sheep for multipiece Le Fort I osteotomies. The planned measurement of maxillary perfusion with different steps of widening excluded the microsphere technique. Finally, the laser Doppler technique was used for the experimental study. Thus, the first evidence based recommendation for a limit of maxillary widening (5 to 6 mm in the molar region) could be given. The results were published in the *International Journal of Oral and Maxillofacial Surgery* (2010; 39: 282 - 286). The laser Doppler technique was also used for a clinical study on maxillary bone blood

flow during multipiece Le Fort I osteotomies. Bone blood flow of the maxilla had not been measured before in any study. The results have shown, that moderate maxillary movements does not provoke further reduction of blood flow to the dento-osseous segments. The work was published in *Oral Surgery Oral Medicine Oral Pathology Oral Radiology and Endodontology* (2009; 108: 178 – 183). Long term stability is one of the most important factors in orthognathic surgery. Little data can be found in the literature concerning stability of multisegmental maxillary osteotomies. Additionally, a new technique for transverse stabilization of the palatal vault with a biodegradable plate was introduced at the Clinic of Oral and Maxillofacial Surgery of the Marienhospital Stuttgart. Therefore, two studies on stability of multipiece maxillary osteotomies have been run. Vertical and sagital stability of one-piece and three-piece Le Fort I osteotomies in bimaxillary procedures were compared. No significant difference was found between the two groups. The results were presented in an invited lecture at the *European Congress of Oral and Maxillofacial Surgery* (Bologna, Italy, 9/2008) and published in the *Journal of Oral and Maxillofacial Surgery* (2010; 68: 372 – 380). It was a great honour to be nominated member of the scientific committee of the same congress and to give a masterclass lecture there (*The importance of incisor inclination in orthognathic surgery*). Three different techniques for maxillary widening were investigated in the second study. Stabilization of the palatal vault with a resorbable plate showed a tendency for less relapse. Significant differences were not seen between the groups. The data was presented at the *5th International Symposium on Distraction and Orthognathic Surgery* (Stuttgart, 10/2009). Recently, the respective article was accepted for publication in the *Journal of Oral and Maxillofacial Surgery*. In 2009, I have been nominated as reviewer for the same journal. European collaboration is one of my favourite topics. A close collaboration with the Universities of Cluj-Napoca and Verona has been established. These collaborations include the exchange of physicians. The organization of international meetings is important for the scientific exchange. I was member of the organization committee of five international conferences in Stuttgart.

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