

Fixed Complete Dentures (i.e. Hybrids)

1. **AK** G DE Vico 1, M Bonino, D Spinelli, R Schiavetti, G Sannino, A Pozzi, L Ottria Rationale for tilted implants: FEA considerations and clinical reports Oral Implantol (Rome) . 2011 Jul;4(3-4):23-33.
2. **TV** Jensen OT, Adams MW, Cottam JR, Parel SM, Phillips WR 3rd. The all on 4 shelf: mandible. J Oral Maxillofac Surg. 2011 Jan;69(1):175-81.
3. **DL** Jensen OT, Adams MW, Cottam JR, Parel SM, Phillips WR 3rd. The All-on-4 shelf: maxilla. J Oral Maxillofac Surg. 2010 Oct;68(10):2520-7.
4. **CM** Peñarrocha-Oltra D, Covani U, Peñarrocha M, Peñarrocha-Diago M. Immediate versus conventional loading with fixed full-arch prostheses in mandibles with failing dentition: a prospective controlled study. Int J Oral Maxillofac Implants. 2015 Mar-Apr;30(2):427-34
5. **VX** Maló P, de Araújo Nobre M, Lopes A, Ferro A, Botto J. The All-on-4 treatment concept for the rehabilitation of the completely edentulous mandible: A longitudinal study with 10 to 18 years of follow-up. Clin Implant Dent Relat Res. 2019 Aug;21(4):565-577.
6. **RH** Maló P, de Araújo Nobre M, Lopes A, Ferro A, Nunes M. The All-on-4 concept for full-arch rehabilitation of the edentulous maxillae: A longitudinal study with 5-13 years of follow-up. Clin Implant Dent Relat Res. 2019 Aug;21(4):538-549.
7. **NL** Maló P, Lopes A, de Araújo Nobre M, Ferro A. Immediate function dental implants inserted with less than 30N·cm of torque in full-arch maxillary rehabilitations using the All-on-4 concept: retrospective study. Int J Oral Maxillofac Surg. 2018 Aug;47(8):1079-1085.
8. **MS** Khayat PG, Arnal HM, Tourbah BI, Sennerby L. Clinical outcome of dental implants placed with high insertion torques (up to 176 Ncm). Clin Implant Dent Relat Res 2013;15:227–33
9. **AK** Stephen M Parel 1, William R Phillips A risk assessment treatment planning protocol for the four implant immediately loaded maxilla: preliminary findings J Prosthet Dent . 2011 Dec;106(6):359-66.
10. **TV** Francesco Pieri 1, Nicolò Nicoli Aldini, Milena Fini, Claudio Marchetti, Giuseppe Corinaldesi Immediate fixed implant rehabilitation of the atrophic edentulous maxilla after bilateral sinus floor augmentation: a 12-month pilot study Clin Implant Dent Relat Res . 2012 May;14 Suppl 1:e67-82.
11. **DL** Papaspyridakos P, Bordin TB, Natto ZS Double Full-Arch Fixed Implant-Supported Prostheses: Outcome and Complications after a Mean Follow-up of 5 year. Journal of Prosthodontics 28 (2019) 387–39

Transsinus, Zygomatic and Pterygoid implants

12. **CM** Ole T Jensen 1, Jared Cottam, Jason Ringeman, Mark Adams Trans-sinus dental implants, bone morphogenetic protein 2, and immediate function for all-on-4 treatment of severe maxillary atrophy J Oral Maxillofac Surg . 2012 Jan;70(1):141-8.
13. **VX** Aparicio, C., Manresa, C., Francisco, K., Claros, P., Alánde, J., González-Martín, O., & Albrektsson, T. (2014). Zygomatic implants: Indications, techniques and outcomes, and the zygomatic success code. Periodontology 2000, 66, 41–58
14. **RH** Funda Goker 1, Emma Grecchi 1, Massimo Del Fabbro 1 2, Francesco Grecchi 2 Clinical outcome of 302 zygomatic implants in 110 patients with a follow-up between 6 months and 7 years Clin Implant Dent Relat Res. 2020 Jun;22(3):415-423.
15. **NL** Luc Vrielinck 1, Catalina Moreno-Rabie 2 3, Wim Coucke 4, Reinhilde Jacobs 2 3 5, Constantinus Politis Retrospective cohort assessment of survival and complications of zygomatic implants in atrophic maxillae Clin Oral Implants Res . 2023 Feb;34(2):148-156.
16. **MS** Miguel Peñarrocha 1, Celia Carrillo, Araceli Boronat, Maria Peñarrocha Retrospective study of 68 implants placed in the pterygomaxillary region using drills and osteotomes. Int J Oral Maxillofac Implants 2009 Jul-Aug;24(4):720-6.
17. **AK** Rodríguez X, Méndez V, Vela X, et al: Modified surgical protocol for placing implants in the pterygomaxillary region: clinical and study of 454 implants. Int J Oral Maxillofac Implant 2012;27:1547-155

Topic: tilted implants

Authors: G DE Vico 1, M Bonino, D Spinelli, R Schiavetti, G Sannino, A Pozzi, L

Title: Rationale for tilted implants: FEA considerations and clinical reports

Source: Oral Implantol (Rome) . 2011 Jul;4(3-4):23-33

DOI: NA

Reviewer: Amber Kreko

Type: review

Keywords: titled implants, FEA, immediate loading, full fixed rehabilitation

Purpose: To describe the clinical and biomechanical rationale for tilting implants and to evaluate the long term prognosis of immediately loaded full fixed prostheses for the treatment of edentulous patients with extreme bone atrophy rehabilitated with both axial and tilted implants.

Rationale for tilted Implants: fea considerations:

- Biomechanical rationale –
 - o reduction of cantilever length for better load distribution
 - o optimized AP spread.
 - o Improved cortical anchorage and primary stability
 - o No negative effect on load distribution

Material and methods:

- Prospective 3 year clinical study on 35 patients with 140 implants.
- Guided surgery was done and Nobel Active implants placed – 70 axial and 70 tilted and fixed partial prostheses immediately loaded.
- Two distal tilted implants were placed near the emergence of the nerve or parallel to the anterior sinus wall with 30 degrees angulation relative to the occlusal plane.
- Marginal bone loss, overall bone loss, prostheses stability, implant stability, and patient satisfaction were assessed

Results:

- 100% cumulative survival rate
- Mean marginal bone remodeling was 0.66mm for the axial implants and 0.77 for the tilted ones.
- No failure of abutments and prosthesis and no other biological complications were found.
- Esthetics, phonetics, and mastication were considered excellent by 100% of patients.

Conclusions: This new surgical technique may reduce patient morbidity and extend the indications for immediate loading full fixed rehabilitations.

Topic: All on 4 bone reduction

Authors: Jensen, Ole T et al

Title: The all on 4 shelf: mandible

Source: J Oral Maxillofac Surg. 2011 Jan;69(1):175-81.

DOI:10.1016/j.joms.2010.06.207

Reviewer: Tam Vu

Type: Review

Keywords: alveolar bone reduction, shelf, dental implants, prosthetic, nerve

Purpose:

Discussion:

All on 4 shelf: vertical bone reduction to create flat alveolar ridge for prosthetic restoration

- Functions:
 - Establishes prosthetic restorative space
 - Establishes level alveolar plane and uniform implant levels
 - Establishes alveolar width for implant diameter selection
 - Accessible basal bone for implant fixation
 - Establish arch form, implant distribution, and anterior posterior spread
 - Identifies optimal implant sites
 - Identifies secondary implant sites
 - Facilitates posterior implant placement w/respect to nerve
 - Provides bone stock for secondary grafting

Prosthetic Restorative Space

- Inadequate interarch space = leads to prosthetic failure
- Minimum: 20 mm interarch space (room for abutment, titanium bar, and prosthetic restoration)
 - In Mn, this translate to ~5 mm of vertical bone reduction (more for segmental hypereruption)

Alveolar Plane

- Marked atrophy of posterior + anterior supraeruption = alveolar plane to be not leveled
 - Corrected via alveolar reduction
- Alveolar plane should be parallel w/interpupillary line
- When Mx and Mn All on 4 done simultaneous, both shelves should be parallel to each other

Alveolar Width

- Width may diminish due to hour-glass alveolar constriction
 - Treat with narrow diameter implants or further bone reduction until sufficient width of alveolar base

Basal Bone Access

- Mandible has dense bone (type I), but sometimes “hollow” in osteoporotic pts
- Add'l vertical bone height reduction may make inferior border more accessible for fixation using long implants – sometimes not possible with All on 4 shelf
 - Adequate ITV and ISQ for immediate loading cannot be obtained without cortical bone
 - Bone height should not be reduced where mentalis muscle is detached → leads to chin ptosis

Identification of Optimal and Secondary Implant Sites

- After All on 4 shelf made – 4 implants are planned from available bone
 - Secondary sites planned to fall back on if primary sites do not have adequate ITV
- Placement of implants in posterior first, then anterior

Lingual Plate

- w/sig osteoporosis or unable to reach inferior border – can use lingual plate
- Thicker lingual plate = more likely primary stability and osseointegration will occur

Posterior Implant Placement and the Mental Foramen

- Better perception of nerve as the alveolar plane is closer to mental foramen
- Posterior implant is angled at 30° to avoid the inferior alveolar nerve
- The angle allows placement of implant distal to the foramen/nerve – allows for increased A-P spread of several millimeters, usually 1 bicuspid tooth
- Can also angle transalveolarly buccal toward lingual if nerve is more anterior or highly atrophic ridge

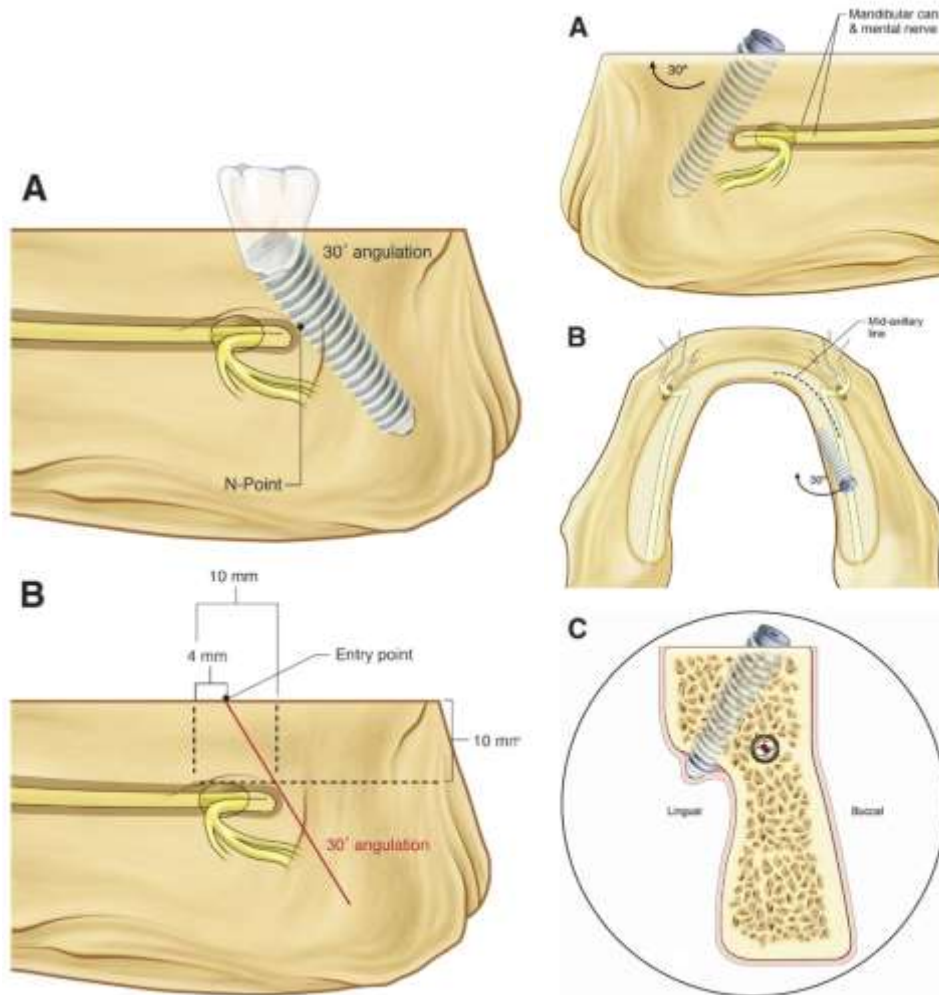
Bone Graft Stock

- The reduction results in bone that can be used for grafting isolated defects or exposed threads

Conclusion:

Rationale for All on 4 bone reduction (“shelf”) in the mandible:

- Establish optimal implant positioning for immediate function
- Gain A-P spread
- Avoid nerve injury



Topic: All-on-4 (Maxilla)

Authors: Jensen OT, Adams MW, Cottam JR, Parel SM, Phillips

Title: WR 3rd. The All-on-4 shelf: maxilla.

Source: J Oral Maxillofac Surg. 2010 Oct;68(10):2520-7.

DOI: 10.1016/j.joms.2010.05.082.

Reviewer: Daeoo Lee

Type:

Keywords: maxillary, implant, all-on-4, hybrid

Purpose: Describe components for All-on-4 shelf for maxilla

Background: Bone is leveled by prosthetic prescription creating a flat surface termed the Allon-4 shelf.

Placed "on" this shelf are implants directed at angulations emerging from specific end points likely to gain primary fixation.

Discussion:

- Prosthetic Restoration Space

- Need interrestorative space = need adequate bone reduction
 - Dual arch cases: 22mm space
- Advantage of reduction
 - Esthetic: By locating the prosthesis tissue junction a minimum of 3 mm beyond the visible gingiva, the surgeon and restorative dentist are assured of hiding the prosthesis-tissue junction.
- **Alveolar Plane**
 - Alveolar plane is parallel to the interpupillary line
 - Avoids a cant in the positioning of implants and creates level placement of implant platforms.
 - Alveolar plane is level front to back: No taper
- Shelf Width
 - When the ridge is thin small-diameter implants are placed; if it is wide and osteoporotic, a wide-diameter implant may be prescribed.
 - sometimes removing more bone than necessary to optimize the width of implants used.
- Piriform Rim Proximity
 - The piriform rim is a thin, cortical layer of bone that outlines the nasal aperture. In laymen's terms, it's a *rim of dense bone around the nose*.
 - When there is alveolar crest atrophy, vertical dimension may still be present but at reduced width such that reduction of height will not only widen the shelf but bring the created alveolar plane in closer approximation to the piriform rim
 - the most desirable site for implant fixation using an M-4 (angulated) placement strategy
- Implant Angulation Strategy
 - Long face
 - After shelf reduction, may still have adequate bone for axial placement of implants
 - Short face
 - after bone reduction require all implants to be angled, usually using the M-4 strategy
- Optimal Osseous Implant Sites
 - Following bone reduction, the surgeon is able to identify either visually or tactically the best load bearing sites possible for implant placement.
 - Computer guidance systems are inadequate to the task, having no ability to assess bone reduction or implant torque
- **Determine Fallback Implant Sites**
 - In the process of creating 4 receptor sites, one or more sites may need to be abandoned because of a lack of bone quality or quantity for fixation.
 - The first site selected is the posterior site, not the anterior site. If that site does not work, moving slightly forward is the secondary site. After posterior implants are placed, anterior sites are selected in a distributed fashion.
- Palatal Cortical Plate
 - Palatal plate can be difficult to engage, but with shelf reduction, it usually is clear to the surgeon how best to gain access through the alveolus and engage at least a portion of the palatal cortex.
 - Due to facial bone loss (post extraction)
- Posterior Implant Placement and Anterior-Posterior Spread

- S-point: When the sinus is not exposed, a lateral punch hole into the sinus is made at the most anterior inferior extent of pneumatization to serve as a guide for implant placement and angulation.
- When there is confluence between the nasal fossa and maxillary sinus (1 cavity), no fixation points are available and the alveolar Allon-4 procedure may be **contraindicated** in favor of a zygomatic All-on-4 strategy
- Bone Stock sources
 - Grafting fenestrations, extraction wall defects, cystic cavities, exposed implant threads in narrow alveolar placements, and sometimes even for sinus grafting
- Nasolacrimal Duct
 - anatomic structure to be aware of is the nasolacrimal duct, which exits below the inferior turbinate sometimes anatomically near where M-point implant fixation is desirable in the piriform
 - most anterior inferior projection of the sinus where implants must bypass to not traverse the sinus cavity and where posteriorly, no load-bearing bone is present

Topic: Immediate vs conventional loading mandible

Authors: Peñarrocha-Oltra D., Covani U., Peñarrocha, M., Peñarrocha-Diago M.

Title: Immediate Versus Conventional Loading with Fixed Full-Arch Prostheses in Mandibles with Failing Dentition: A Prospective Controlled Study

Source: Int J Oral Maxillofac Implants 2015;30:427-4

DOI: oi: 10.11607/jomi.3534

Reviewer: Cyrus J Mansouri

Type: Prospective study

Keywords: controlled clinical trial, full-arch prosthesis, immediate loading, immediate implants, loading protocols

Purpose:

To compare implant success, biologic/prosthetic complications, success of provisional IL prosthesis, and MBL between immediate and conventional loading protocols for full-arch mand prostheses supported by dental implants.

Material and methods:

A total of 36 pts requiring implant supported full-arch fixed prostheses were recruited. A total of 18 subjects were treated with conventional loading, followed by 18 with immediate loading.

Surgery:

After adequate pre-op assessment and local anesthesia and IV sedation, hopeless teeth were removed and 4-6 dental implants were placed through a surgical guide. Kohno SP dental implants were used (zirconium sandblasted acid-etched titanium surface treatment in the coronal part, high-roughness plasma spray surface treatment in the apical part of the implant). Implants were placed epicrestal. Healed sites were preferred to extraction sites, when possible.

For IL protocol, a minimum of 4 implants with torque ≥ 35 Ncm were required. In CL group, implants were left to heal submerged. All patients received AMX 1g BID/6 days, starting 1h prior to surgery, Ibuprofen 600 mg TID/5days, and CHX 0.12% BID/14 days and 3 days prior to surgery. A soft diet was recommended for 8 weeks.

Prosthetic procedures:

For IL group, implant positions were registered intraoperatively to make an acrylic resin provisional full-arch screwed metal-reinforced prosthesis with no distal cantilever, delivered 3 days after implant surgery.

Provisional was not removed until 10 weeks after implant placement. The CL group wore removable prostheses until definitive prostheses were ready, and implant uncover was performed at 2 mo after insertion.

In both groups, definitive prosthetic was initiated 10-12 weeks after implant insertion and were delivered approx. 1 mo later.

Follow-up

Patients were examined at 1, 2, 3, 6, and 12 months after implant placement. Implant success, biologic and prosthetic complications, and MBLs were measured.

Results:

The final pt population consisted of 34 pts (16 CL; 18 IL), receiving 183 dental implants (98 IL; 85 CL).

Overall implant success: 98.3%

- Three implants failed (1 IL; 2 CL). The difference between success was not significant (99% IL; 97.6% CL).
- 11 implants in 6 pts (3 per group) presented with peri-implant mucositis at the 12-mo follow-up

After 12 mo, MBL was 0.71 mm for IL and 0.60 mm for CL (not SSD).

Prosthetic outcomes:

Success of IL provisionals: 100%

Screw loosening was encountered in 5 IL patients at the 1 or 2 mo recall.

- 2 pts presented with fractured teeth in the definitive fixed denture at 9 and 10 months.

All patients in the CL group reported discomfort with provisional removable denture.

- 6 reported with ulcers
- 5 reported only rarely using their removable denture.

Conclusion:

No significant differences were found in outcomes between IL and CL protocols. The patient transitioning from natural teeth to a full-arch prosthetic could benefit greatly from the IL protocol.

VX

Topic: All-on-4 Maxilla

Author: Maló, et al.

Title: The All-on-4 concept for full-arch rehabilitation of the edentulous maxillae: A longitudinal study with 5-13 years of follow-up

Source: Clin Implant Dent Relat Res. 2019 Aug;21(4):538-549

DOI: 10.1111/cid.12771

Reviewer: Ryan Higgins

Type: Retrospective Case Series

Keywords: all-on-4, biological complication, edentulous maxilla, immediate function, longer-term outcome, marginal bone loss, tilted implants

Purpose:

- To evaluate outcomes of the all-on-4 treatment concept for rehabilitation of edentulous maxilla 5-13 years post-op

Materials and Methods:

- 1072 patients (4288 maxillary implants)
- Primary outcome measures included cumulative prosthetic and implant success (life table analysis)
- Secondary outcome measures consisted of marginal bone loss (MBL) at 5 and 10 years, biological + mechanical complications

Results:

- Prosthetic success rate was 99.2%
 - o Healthy vs. compromised patients had a mean success rate difference of 1.9% at 10 years and 4.3% at 13 years
- Implant survival and success rate was 94.7% and 93.9% respectively
 - o 125 implants in 75 patients failed
- Male gender, smoking, and mechanical complications were significantly associated with implant failure
 - o MBL = 2.8mm at 5 years
- Average MBL at 5 years = 1.18mm, at 10 years = 1.67mm
- Biological complications = 7.8% at implant level w/ age and smoking significantly associated
- Mechanical complications = 7.3% for definitive prosthesis, 58.85 for provisional prosthesis

Conclusions:

- High success rate for both implants and prostheses for up to 13 years
- Low MBL confirmed with all-on-4
- Smoking negatively impacted the implant success, biological complications, and MBL outcomes

Topic: Fixed Complete Denture

Authors: Malo, P et al.

Title: Immediate function dental implants inserted with less than 30 Ncm of torque in full-arch maxillary rehabilitations using the All-on-4 concept: retrospective study

Source: Int. J. Oral Maxillofac. Surg. 2018; 47: 1079–1085

DOI: 10.1016/j.ijom.2018.04.008.

Reviewer: Nicolas Lobo

Type: Retrospective clinical study

Keywords: dental implants; fixed prosthesis; immediate loading; low density bone.

Purpose: to evaluate the short-term implant success rate and marginal bone loss in full-arch fixed prosthetic maxillary rehabilitations supported by implants in immediate function with the All-on-4 treatment concept placed with insertion torque of <30 Ncm or ≥30 Ncm.

Materials and Methods: Patients who underwent full-arch maxillary rehabilitation using the All-on-4 implant concept, receiving implants with insertion torque <30 Ncm, excluding those on active chemotherapy or with torque ≥30 Ncm. The surgical protocol involved implant placement with under-preparation to ensure maximum primary anchorage, followed by the connection of provisional prostheses on the day of surgery. Patients were evaluated postoperatively at regular intervals.

The primary outcome measures were implant success and prosthetic survival, with success criteria including functionality, stability, absence of infection, good aesthetics, and patient comfort. Failures were defined as implants removed or prostheses not maintained. Secondary outcomes measured marginal bone loss using peri-apical radiographs taken at surgery and 1-year post-operation.

Results: This study included 83 patients, with an average follow-up of 30 months. A total of 332 implants were placed, divided into two groups: 120 implants were inserted with a torque of less than 30 Ncm, and 212 implants with torque greater than or equal to 30 Ncm. The overall cumulative success rates at the patient level and implant level were 97.5% and 97.8%, respectively. The implant survival rate was 98.3% for implants inserted with torque under 30 Ncm and 98.4% for those inserted with torque of 30 Ncm or higher. The prosthetic survival rate was 97.6%. Marginal bone loss after 1 year was significantly different between the two groups: 1.14 mm for implants with <30 Ncm of torque, and 1.39 mm for implants with ≥ 30 Ncm ($p < 0.001$).

Conclusions: Implants placed with insertion torques of <30 Ncm may show similar success rates and marginal bone loss after one year compared to those placed with insertion torques of ≥ 30 Ncm

Topic: Implants with high insertion torque

Authors: Khayat PG, et al.

Title: Clinical outcome of dental implants placed with high insertion torques (up to 176 Ncm)

Source: Clin Implant Dent Relat Res 2013;15:227–33

DOI: 10.1111/j.1708-8208.2011.00351.x

Reviewer: Mahya Sabour

Type: clinical study

Keywords: dental implants, insertion torque, bone

Purpose: to report bone levels and clinical results of 42 implants placed with an insertion torque ≥ 70 Ncm

Material and Methods:

- Partially edentulous patients that required implants
- Placed 4.5mm tapered screw-vent implants (Zimmer) that were multithreaded (3 threads) and both sandblasted and acid etched. Implants had deep internal hex (1.7mm) connections. Healing abutments placed and allowed healing for 2 months in the mandible and 3 in the maxilla.
- Clinical osseointegration evaluated through axial percussion, lateral pressure movements, removal of healing abutment, and radiographic evaluation.
- Measured marginal bone loss at loading and 6 months after, with a magnifying lens with a measuring scale divided into 0.1 graduations

Results:

- After excluding 15 implants, 51 implants in 38 patients were evaluated
 - Control group: 9 implants placed with 30-50 Ncm insertion torques (Mean: 37.1 Ncm)
 - Experimental group: 42 implants placed with insertion torques ≥ 70 Ncm (Mean 110.6 Ncm)
- Successful osseointegration in all implants and all were clinically stable 1y after loading
- Mean marginal BL was 1.03 mm for the control group and 0.72 mm for experimental group at the time of loading and 1.09 mm and 1.24 mm 1y later, respectively.
 - No correlation between insertion torque and marginal bone loss at any time
 - BL for both groups is within the range included in the Albrektsson criteria for implant success (1.5mm) and did not increase with higher insertion torques
- This study reports no negative effects from increased insertion torque and marginal bone loss. Possibly due to:
 - Implant design: tapering without marked steps, edges, or other design features leading to a continuous lateral bone compression and stress distribution along the implant, potentially leading to a lack of adverse effects.

Conclusion:

In tapered multithreaded implants, high insertion torques (up to 176 Ncm) do not prevent osseointegration nor do they increase marginal bone resorption

Topic: immediately loaded maxilla

Authors: Stephen M Parel 1, William R

Title: A risk assessment treatment planning protocol for the four implant immediately loaded maxilla: preliminary findings

Source: J Prosthet Dent . 2011 Dec;106(6):359-66

DOI: 10.1016/S0022-3913(11)60147-9

Reviewer: Amber Kreko

Type: clinical study

Keywords: tilted implants, maxilla, risk factors

Purpose: To determine what risk factors, if any, may increase the likelihood for implant failure in immediate function by using a tilted distal, 4-implant approach in the maxilla.

Material and methods:

- Retrospective study for patients treated with 4 implants providing immediate function for complete arch implant supported prostheses.
- Data was collected about patient to assess for potential maxillary implant failure factors.

Results:

- 285 patients included – 41 implants failed in 20 patients

TABLE II. Rate of occurrence of either primary or secondary contributors to implant failure (n=41) in 20 patients

Factor	Occurrence
Opposing natural dentition	16 of 20
Opposing implant-supported complete arch restoration	4 of 20
Poor Bone Density	17 of 20
Male gender	15 of 20
Posterior implant	32 of 41
Bruxism	9 of 20
Smoker	4 of 20

TABLE III. Decision tree for risk analysis of immediate loading in maxilla based on occurrence of these risk factors as findings at time of initial examination. Any single finding is elevated as potential risk for failure when combination of factors occurs.

Highest Risk
Male Patient
Opposing Natural Dentition
Poor Bone Density
Lesser Risk
Systemic Factors
Local Infections/Pathology
Opposing Complete Arch Implant Restoration
Bone Volume
Smoking
Bruxism
Distal Posterior Implant Site

- Existing opposing natural mandibular dentition (80%) and poor bone density (85%) had highest percentages of all failure scenarios. All failure sites recorded measurements of 100 HU or less

Conclusions: Opposing natural dentition, male gender, lack of bone density, distal implant site, and parafunction were frequent occurrence to suggest that either the use of additional implants or delayed loading and the provision of a complete denture as an interim prosthesis may be more appropriate in the management of patients identified as being high risk.

Topic: Full-arch implant-supported prosthesis

Authors: Pieri, Francesco et al

Title: Immediate fixed implant rehabilitation of the atrophic edentulous maxilla after bilateral sinus floor augmentation: a 12-month pilot study

Source: Clinical implant dentistry and related research vol. 14 Suppl 1 (2012): e67-82

DOI:10.1111/j.1708-8208.2011.00360.x

Reviewer: Tam Vu

Type: Clinical

Keywords: immediate, implant placement, sinus augmentation, implant success rate

Purpose: to evaluate outcomes of immediately loaded full-arch implant-supported fixed prosthesis w/bilateral sinus augmentation and to compare implants placed in sinus-grafted versus native sites in the same patients 1 year after loading

Material and methods: 20 pts referred for Mx full-arch, implant supported rehab w/severe atrophic ridge, anterior ridge had sufficient bone for minimum: 3.5 mm x 9 mm implant. Pts underwent bilateral Mx sinus augmentation w/composite graft (50:50, autogenous:Bio-Oss). Implants placed 4-5 mo after sinus aug. 7-8 implants placed into Mx: native anterior bone (control group) and posterior sinus-grafted sites (test group). ITV and ISQ were measured. Definitive prosthesis delivered within 1 week. Recall at 2 and 4 wks, and 3, 6, and 12 mo: clinical (plaque, bleeding, PD, ISQ) and radiographic exam completed, and post op pain, swelling, and pt satisfaction evaluated.

Results:

- Sinus membrane perforation: 6 (15%) cases
 - Treated with BioGide
- 155 implants placed
 - Control: 65 (41.9%)
 - Test: 90 (58.1%)
- Implant success rate:
 - Control: 100%
 - Test: 97.7% (2 failures, placed in 1st or 2nd molar position in soft bone quality)
- Prostheses success rate: 100%
- Biologic complications (4):
 - Soft-tissue soreness (1)
 - Peri-implant mucositis (3)
- Prosthetic complications
 - Teeth fracture (most common)
 - Abutment screw loosening
 - Prostheses modification due to pressure on mucosa
- Implant stability
 - ITV mean [SSD btn groups]
 - Control: 37.88 Ncm
 - Test: 29.18 Ncm
 - ISQ mean [SSD btn groups]

	At placement	6 mo	12 mo
Control	66.14	66.36	67.08
Test [SS]	60.98	62.65	64.38

- Clinical parameters
 - Sig diff in plaque and bleeding btn control and test groups at 3 mo, but NSD at 12 mo
 - Sig decr in plaque and bleeding in both groups from 3 – 12 mo
 - Sig decr in PD in both groups over time, NSD in PD btn groups

- NSD in keratinized mucosa within or between groups

TABLE 3 Gingival Parameters of the Control and Test Implants Evaluated at 3 and 12 Months (Mean $\pm$ Standard Deviation)

Parameter	Group	3 Months	12 Months	p
mPI	Control	0.79 $\pm$ 0.54	0.48 $\pm$ 0.68	.0033
	Test	0.6 $\pm$ 0.53	0.4 $\pm$ 0.42	.0131
mBI	Control	0.58 $\pm$ 0.53	0.33 $\pm$ 0.39	.0016
	Test	0.88 $\pm$ 0.57	0.38 $\pm$ 0.43	<.0001
PD (mm)	Control	3.42 $\pm$ 0.82	3.17 $\pm$ 0.64	.0385
	Test	3.66 $\pm$ 0.81	3.38 $\pm$ 0.87	.0361
KM (mm)	Control	2.8 $\pm$ 0.63	2.92 $\pm$ 0.67	.093
	Test	2.62 $\pm$ 0.74	2.76 $\pm$ 0.78	.0601

- Radiographic evaluation

MBR	At prosthesis placement	6 mo	12 mo
Control	0.07 mm	0.3 mm	0.47 mm
Test [SS]	0.08 mm	0.27 mm	0.43 mm

- Sig incr in marginal bone resorption (MBR) within groups over time, NSD btn groups
- Pain, swelling, pt satisfaction
 - Sig more pain & swelling after sinus aug
 - Majority of patients were satisfied with esthetics, masticatory function, and speech
 - Ease of cleaning was good in half of the cases, and sufficient for other half

Conclusion: Small population, short term study concluded that Atrophic edentulous Mx can be successfully treated with immediate implant-supported definitive prosthesis by combination placement of dental implants in native premaxillary sites and in grafted sinuses. Similar success rate to delayed loading protocol. After 1 year, implants placed in sinus-grafted and native bone showed similar clinical and radiographic outcomes. (Factors for implant success: osseointegrative implant surface, under-prepped osteotomy, and stabilization with passive/rigid connection).

Topic: Double full arch hybrid

Authors: Papaspyridakos P, Bordin TB, Natto ZS, Kim YJ, El-Rafie K, Tsigarida A, Chochlidakis K, Weber HP.

Title: Double Full-Arch Fixed Implant-Supported Prostheses: Outcomes and Complications after a Mean Follow-Up of 5 Years.

Source: J Prosthodont. 2019 Apr;28(4):387-397

DOI: 10.1111/jopr.13040

Reviewer: Daeoo Lee

Type: Retrospective

Keywords: hybrid, double arch, implant

Purpose: To retrospectively assess complications and clinical and radiographic outcomes of edentulous patients treated with double full-arch implant-supported fixed complete dental prostheses (IFCDPs) after a mean observation period of 5 years.

Material and methods:

- Retrospectively screen record who received double full arch IFCDP (2005-2015), Tuft University.
- Clinical and radiographic examination data
 - Single visit comprehensive exam gathering clinical and radiographic data
- Evaluation of complications
 - Minor
 - Biological: soft tissue recession; inflammation under the fixed prosthesis; peri-implant mucositis; and hypertrophy/hyperplasia of soft tissue.
 - Technical: wear of the prosthetic material; chipping of prosthetic material; loosening of abutment/occlusal screw; and decementation (loss of retention of cement-retained IFCDPs)
 - Major (require additional treatment and costs)
 - Biological: peri-implantitis and late implant failure.
 - Technical: fracture of prosthetic material; fracture of framework; fracture of abutment; and fracture of abutment/occlusal screw
- Definition/metrics
 - Implant survival: implant remaining in situ and supporting a functional prosthesis during the entire observation time
 - Prosthesis survival: prosthesis remaining in situ with or without modifications during the entire observation time
 - Peri-implantitis: Bleeding and suppuration on probing and radiographic bone loss more than 2 mm were the criteria to be used for diagnosis of peri-implantitis
 - Porcelain chipping and fracture: California Dental Association rating system for quality was used to characterize ceramic failures
 - Acceptable (surface is deficient but can be polished) or unacceptable (surface is fractured and restoration must be repaired or replaced). For simplicity, the previous descriptions were replaced by the terms porcelain chipping (minor complication) and porcelain fracture (major complication), respectively
- Statistical analysis

Results:

- 19 pt (10F/9M)
- Mean follow-up time: 7.4 yrs
- 249 moderately rough surface implant (Nobel and Straumann)
 - 2 implants failed after prosthesis insertion (99.2% survival rate)
- 38 IFCDP
 - 20-cement retained / 18-screw retained
 - 3 IFCDPs were lost (92.1% survival rate)
- Biologic complications
 - A total of 151 biologic complications were registered, affecting 35 IFCDPs (92.1%), with an average of 4.3 complications per prosthesis (minimum of 1, maximum of 14)
 - Total minor and major biologic complication rate of 92.1%.
 - Minor (82.8%) vs. Major (17.2%)
 - Minor
 - The most frequently observed minor complication: soft tissue recession (9.1%)

- The cumulative rate for “prosthesis free of minor biologic complications” after 5 years was 52.8%
 - Major
 - The most frequently observed major biologic complication was peri-implantitis (1.9%), followed by late implant failure (0.2%)
 - “prosthesis free of major biologic complications” after 5 years was 89.7%
 - Peri-implantitis was encountered in 24 implants (9.6% or n = 24/249) supporting 10 prostheses (26.3% or n = 10/38) with an estimated 5-year rate of 9.5%
- Technical complications
 - A total of 139 technical complications were registered, affecting 31 IFCDPs (81.6% or n = 31/38), with an average of 4.5 complications per prosthesis.
 - The cumulative rates for “prosthesis free of complications” at 5 and 10 years were 57.1% (95% CI: 39.3-71.5) and 5.2% (95% CI: 0.6-17.4), respectively.
 - Minor
 - The cumulative rates for “prosthesis free of minor complications” at 5 and 10 years were 57.1% (95% CI: 39.3-71.5) and 5.2% (95% CI: 0.6-17.4), respectively.
 - frequently observed minor technical complication was wear of the prosthetic material (9.8%)
 - Major
 - occurred in 11 prostheses (28.9% or n = 11/38) 42 times, with an average of 3.8 complications per prosthesis (minimum of 1, maximum of 13)
 - The cumulative rate for “prosthesis free of major technical complications” at 5 years was 80.3% (95% CI: 61.4-90.6) and at 10 years was 45.4% (95% CI: 21.1-67.0)
 - The most frequently observed major technical complication was fracture of the prosthetic material (1.6%) with an estimated 5-year rate of 8.0%
 - Cement retained vs. screw retained IFCDPs
 - Biologic complications
 - The estimated annual rate of soft tissue recession was 7.9% (95% CI: 5.9-10.4) for group C, and 10.0% (95% CI: 8.0-14.2) for group S
 - Technical complications
 - the estimated annual rate for the complication “wear of the prosthetic material” was 8.7% (95% CI: 4.2-15.9) for group C, and 10.9% (95% CI: 5.8-19.1) for group S

Conclusions:

- High implant (99.2%) and prosthesis (92.1%) survival rates were observed after a mean exposure time of 5.1 years (range: 1-12 years).
- The most frequent major biologic complication was periimplantitis with an estimated 5-year implant-based rate of 9.5% (95% CI: 6.7-11.3), and the most frequent major technical complication was fracture of the prosthetic material with an estimated 5-year dental-unit rate of 8.0% (95% CI: 6.6-10.1).
- The 5-year estimated cumulative rates for “prosthesis free of biologic complications” was 50.7% (95% CI: 33.7-65.4) and for “prosthesis free of technical complications” was 57.1% (95% CI: 39.3-71.5).
- There was no difference regarding biologic complications between cement-retained (group C) and screw-retained (group S) IFCDPs. Conversely, a difference ($p < 0.0001$) was found in regards to technical complications, where the estimated annual rate of prosthetic material fracture (dental unit level) was 0.9% (95% CI: 0.5-1.6) for group C, and 2.4% (95% CI: 1.6-3.5) for group S.

- The presence of bruxism, the absence of nightguard use, and the use of porcelain as prosthetic material were associated with increased risk for chipping/fracture for the double full-arch IFCDPs.
- Regular maintenance is important for patients who underwent double full-arch implant rehabilitation, and customized maintenance protocol should be implemented.

Transsinus, Zygomatic and Pterygoid implants

Topic: M-4 all-on-4, BMP2, immediate loading

Authors: Jensen OT., Cottam J., Ringeman J., Adams M.

Title: Trans-Sinus Dental Implants, Bone Morphogenetic Protein 2, and Immediate Function for All-on-4 Treatment of Severe Maxillary Atrophy

Source: J Oral Maxillofac Surg 70:141-148, 2012

DOI: 10.1016/j.joms.2011.03.045

Reviewer: Cyrus J Mansouri

Type: Prospective study

Keywords: BMP2 – immediacy – all-on-4 – sinus augmentation – immediate loading

Purpose:

To describe the use of trans-sinus posteriorly angled implants for maxillary all-on-4 immediate function with simultaneous sinus floor and ridge augmentation with BMP-2 grafting and immediate loading, as a tx alternative to zygomatic implants.

Material and methods:

10 maxillary edentulous patients were recruited with severely resorbed maxillary ridges. Several patients had pneumatization of the premaxilla to the area of the canine in 5, the lateral incisor in 3, to the distal of the central incisor in 2.

Patients underwent the use of the M-4 all-on-4 technique, with anterior and posterior implants converging apically, demonstrated below. Implants used were internal hex (Nobel Active TiUnite) or external hex (Nobel Speedy TiUnite) with angled abutments placed day of surgery (torques 15 Ncm) for immediate loading. Implants were 4.3 mm diameter except for one 3.5 mm, with lengths 15-18 mm.

Implants were placed with bicortical stabilization to engage the M point. Exposed implant threads were grafted with 1.5 mg recombinant human BMP-2. Final restorations were placed 4-6 mo later and follow-up radiographs and CT scans were made.

Results:

A total of 19 trans-sinus implants were placed at second pre-molar sites.

- One implant failed in the presence of well-formed bone (success rate of 94.8%)

CT scans were obtained in 7/10 patients and demonstrated relatively high bone density

- Mean Hounsfield unit of 460, a value consistent with type 2 bone.
- Continuity of density was favorable at grafted sites, indicating adequate consolidation.

Regarding RBL, 2 implants were reported with ~1 mm loss of 1 year.

All trans-sinus implants were angled at 30 degrees and corrected with 30-degree abutments.

No infections or sinus complications were encountered.

Some implants perforated 1-2 mm into the nasal fossa but remained covered by mucosa. No nasolacrimal duct dysfunction was encountered.

Conclusion:

The article demonstrates another alternative to zygomatic implants in a variation of the all-on-4 protocol. It is still technique sensitive and more long-term studies are indicated to validate the technique.

VX

Topic: Zygomatic Implants

Author: Goker

Title: Clinical outcome of 302 zygomatic implants in 110 patients with a follow-up between 6 months and 7 years

Source: Clin Implant Dent Relat Res. 2020 Jun;22(3):415-423

DOI: 10.1111/cid.12909

Reviewer: Ryan Higgins

Type: Retrospective Case Report

Keywords: dental implants, maxillary atrophy, oral rehabilitation, zygomatic implants

Purpose:

- To report on clinical outcomes of zygomatic implants at follow-up between 6 months and 7 years

Materials and Methods:

- 110 patients with 302 zygomatic implants
 - o 60 females, 50 males
- Intra and postoperative complications and survival rate of implants was evaluated

Results:

- Implant survival rate of 98.34%
 - o 5 implant failures in 4 patients
- One intraoperative and 17 postoperative complications developed in 18 patients
 - o Intraoperative = Fracture of zygomatic bone
 - o Postoperative = mucositis, temporary paresthesia, permanent paresthesia, zygomatic bone periostitis, inflammation with cutaneous fistula, oroantral sinus communication, periimplantitis, overloading
- Implant survival was not influenced by gender, smoking, implant location, or implant design

Conclusions:

- For cases of atrophic posterior maxilla zygomatic implant surgery can be an effective and safe alternative to conventional implants and bone grafting procedures

Topic: Zygomatic Implants

Authors: Vrielinck, L et al.

Title: Retrospective cohort assessment of survival and complications of zygomatic implants in atrophic maxillae

Source: Clin Oral Impl Res. 2023;34:148–156

DOI: 10.1111/clr.14027

Reviewer: Nicolas Lobo

Type: Retrospective longitudinal cohort

Keywords: complication, dental implants, maxillary atrophy, survival, zygoma, zygomatic implants

Purpose: to report on zygomatic implant survival rate and associated complications

Materials and methods: Patients who received zygomatic implant (ZI). Inclusion criteria were adults with atrophic maxilla requiring ZI insertion, and patients without sufficient medical data were excluded.

Preoperative evaluations included bone quality assessments and scans (CT/CBCT). Surgical procedures followed established techniques like intrasinus, extramaxillary, or sinus slot, performed under general anesthesia. Implants were placed based on individual anatomy, with varying surgical techniques depending on the rehabilitation plan. Immediate and delayed loading protocols were applied based on the time period and surgical scheme. Postsurgical follow-up occurred at set intervals, with clinical evaluations and radiographic assessments. Complications were recorded and categorized as mechanical or biological, with specific criteria for implant success and failure defined by the Zygomatic Success Code.

Results: 302 patients received zygomatic implants (ZIs). Most patients were treated for complete edentulism (89%) and a smaller proportion for hemimaxillectomy (2%). 940 ZIs and 451 standard implants were placed. Patients had a mean 7.9-year follow-up period. Among the patients, 10.1% of ZIs and 18.6% of standard implants failed, mostly within the first five years. Implant failure rates were influenced by factors such as the surgical technique used (intrasinus, extramaxillary, sinus slot), implant surface type, and loading protocols. Additionally, complications like sinusitis, infections, and implant-related issues (e.g., dehiscence, hypoesthesia) were common. The most frequent infectious complication was sinusitis, while mechanical issues included prosthetic loss and screw fractures. Risk factors for implant failure included radiation therapy, hemimaxillectomy, mixed treatment schemes, intrasinus technique, delayed loading, absence of grafting material, and complications like sinusitis and peri-zygomatic infections.

Conclusions: Zygomatic implants (ZIs) achieved a survival rate of 89.9% for rehabilitating severely atrophied maxillae, with most failures occurring within the first five years. Sinusitis was the most common complication, often developing years after implant placement. Other contributing factors to ZI loss included zygomatic region infections, oroantral communication, and prior standard implant failure. Future multicenter, randomized controlled trials and long-term studies are recommended to better understand the risk factors for implant failure and improve patient care.

Topic: Pterygoid implants

Authors: Peñarrocha M, et al.

Title: Retrospective study of 68 implants placed in the pterygomaxillary region using drills and osteotomes

Source: Int J Oral Maxillofac Implants 2009 Jul-Aug;24(4):720-6.

DOI:

Reviewer: Mahya Sabour

Type: Retrospective study

Keywords: pterygomaxillary region, pterygoid implants, osteotomes

Background: Pterygomaxillary implants allow the placement of implants into the posterior maxilla without sinus augmentation and allow us to avoid lengthy cantilevers that might be necessary in cases where only anterior implants are used for full-arch restorations.

Purpose: to evaluate the success rate of 68 pterygoid implants placed with a combination of drills and osteotomes.

Material and Methods:

- 45 Patients with severely resorbed edentulous posterior maxilla that received pterygoid implants between January 2000 and 2006 with a minimum of 12 months of follow up after loading were sampled.
- Surgeries were all performed by a combination of osteotome and drills of increasing diameter. Osteotomes were used to expand the bone, while assuring direct manual contact and sense of

touch as the procedure is visibly inaccessible. 4x16mm Implants were placed using conventional techniques and the final restorations were fabricated 3 months after.

- PAN was taken after surgery and loading, 1 year after loading, and at final examination. Bone loss was radiographically assessed.
- Implant success was based on the Albrektsson criteria:
 - o Absence of clinically detectable implant mobility
 - o Absence of exudate, persistent inflammation, patient discomfort, or bleeding
 - o Absence of periapical radiolucencies
 - o Absence of progressive bone loss greater than 0.2mm annually after the first year of implant placement
- A visual analogue scale was used to assess patient satisfaction at 1 year after loading



Fig 4a Posterior atrophic maxillary ridge.



Fig 4b Use of osteotomes to create the implant bed.



Fig 4c Drills are used to increase the diameter of the site.



Fig 4d Pterygoid implant placement.



Fig 4e Intraoral view of the prosthetic abutments.



Fig 4f A screw-retained fixed partial prosthesis is placed.



Fig 4g Orthopantomogram following placement of the prosthesis.

Results:

- The one-year success rate for 68 pterygoid implants was 67.05%. 2 failed due to lack of osseointegration before loading (without symptoms, pain, infection, mobility, or radiolucencies).
- No more implants failed between the 1-year and final follow up appointment (mean 35.5 months) and no sinus or prostheses complications observed
- MBL 1 year after loading was 0.71mm (0.78mm mesially and 0.64mm distally)
- The general satisfaction at the final follow up was 9/10 (comfort, stability, phonetic, ease of cleaning, esthetics, self-esteem, and functionality of prosthesis)

Conclusion:

Using drills and osteotomes for placing pterygoid implants is an alternative treatment option for atrophic posterior maxillary rehabilitation with great patient satisfaction.

Topic: pterygomaxillary

Authors: Rodríguez X, Méndez V, Vela X, et al

Title: Modified surgical protocol for placing implants in the pterygomaxillary region: clinical and study of 454 implants

Source: Int J Oral Maxillofac Implant 2012;27:1547-155

DOI: NA

Reviewer: Amber Kreko

Type: clinical study

Keywords: atrophic maxilla, follow-up period, pterygoid buttress, pterygoid implant

Purpose: To assess the effect of placing pterygoid implants more vertically than has been the standard (45 degrees) over a functional loading period ranging from 2 months to 14 years.

Material and methods:

- Retrospective study of patients with pterygoid implants.
- Implant length, implant diameter, implant success, and the angulation of the pterygoid implants were measured.

Fig 3 The handpiece moves in a posterior, medial direction.

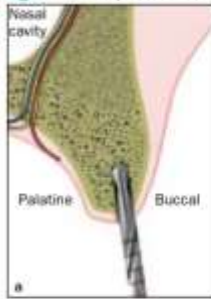


Fig 3a Coronal view.



Fig 3b Surgical view.

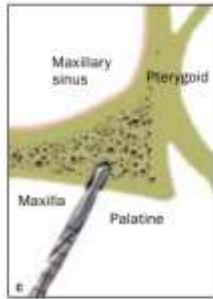


Fig 3c Mesiodistal view.

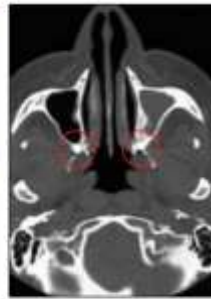


Fig 4 CT scan: implants anchored in the palatine bone and the pterygoid process.

Results:

- 392 patients included with 454 pterygoid implants included
- 18mm implant length was the most favored
- Implant diameter was 3.75 in 98.6% of cases
- Mesiodistal angulation was 70.4 degrees



- At mean follow up period of 6 years, 96.5% of implants were successfully osseointegrated

Conclusions: Mesiodistal inclination of the pterygoid implant at 70 degrees to the Frankfort plane following the bony column of the pterygoid region decreases the non-axial loads of the rehabilitation and exhibits good long term survival.