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Review Article

ALL ON FOUR"-WHY, WHEN AND WHERE

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ABSTRACT:

The implant technology has come a long way from the time of its introduction by Per ingvar braenmark in 1965, with introduction of angled implants in 1990 for the edentulous prosthesis rehabilitation. Full mouth prosthetic rehabilitation usually include sinus lift. Sinus lifting and implant placement may become a problem and is not possible in every patient pertaining to its complexities and the healing time required before the start of actual placement of prosthesis and may arise uncertainities in the minds of the patient. To curb the complexities and reduce the treatment time, a method was developed by Dr. Paulo Malo to give prosthesis on four implants both in maxilla and mandible and tilting the posterior implants termed " all on four" which is being described in the present article.

Keywords:- NP Tapered Drill, RP Tapered Drill, V Point, M point, Trans-sinus

INTRODUCTION

Full mouth rehabilitation using implants is a very old concept, which to execute becomes very difficult in some of the edentulous cases, making it impossible to do without bone transposition and grafting. This creates a difficult situation for maintaining healthy oral condition and leads to poor nutrition. To prevent such situation and for overall well being of the patient who demanded fixed restoration, a technique was developed by Dr. paulo

malo in which four implant were placed: Two posteriorly tilted between 30° and 45° and two anteriorly, placed axially. All well anchorated achieving a primary stability of at least 30Ncm. The survival rate of this type of treatment is found to be 98% for the maxilla and 98.1% for the mandible after 5–10 years of follow-up.[1-3] The use of tilted and longer implants increases primary stability, allow decreased cantilever with excellent prosthetic support, and maximizes the use of available bone.[4] These implants are loaded immediately with a provisional fixed dental prosthesis.[5]

GENERAL CONSIDERATIONS [6]

- To achieve primary implant stability (35 to 45 Ncm insertion torque).
- Indicated with a minimum bone width of 5mm, minimum bone height of 10mm from canine to canine in maxilla and 8mm in mandible.
- If angulation is 30° or more, the tilted implants can be splinted.
- For tilted posterior implants, the distal screw access holes should be located at the occlusal face of the first molar, the second premolar, or the first premolar

ADVANTAGES OF THE ALL-ON-4 CONCEPT[6]

- Angled posterior implants avoid anatomical structures
- Angled posterior implants allow longer implants anchored in better quality bone
- Reduces posterior cantilever
- Eliminates bone grafts in the edentulous maxilla and mandible in majority of cases.
- High success rates
- Implants well-spaced, good biomechanics, easier to clean, immediate function and aesthetics
- Final restoration can be fixed or removable
- Reduced cost due to less number of implants and avoidance of grafting in the majority of cases.

BIOMECHANICAL ADVANTAGES OF "ALL-ON-4" DESIGN [7]

1. Implants follow a dense bone structure
2. Longer implants can be placed by tilting them posteriorly
3. Tilting improves A-P spread of implants
4. A-P spread enhances load distribution for prosthesis
5. Shorten cantilever (maximum of 7 mm for maxilla and 1.5–2.0×A-P spread for mandible) reduces prosthetic fracture/instability and marginal bone height stability
6. Marginal bone height of implants is maintained with rigid prosthesis
7. Tilted implants have similar success rate as traditional implants when splinted together

INCLUSION CRITERIA FOR "ALL-ON-4"[8]

1. No severe parafunctional habits
2. Standard mouth opening (40 mm)
3. Edentulous maxilla with minimum bone width of 5 mm and minimum bone height of 10 mm within the premaxilla
4. Edentulous mandible with minimum bone width of 5 mm and minimum bone height of 8 mm within the intra-foramen region[9]
5. Minimal 10 mm implant length for maxilla[10]

6. Tilt implant at 45° maximally to reduce cantilever
7. If angulation is 30° or more, it is necessary to splint the tilted implants
8. For posterior tilted implants, plan the distal screw access hole to be located at the occlusal surface of the first molar, second premolar, or first premolar
9. Can accommodate 10 to 12 teeth as a fixed prosthesis with a maximum 1 to 2 teeth cantilever in final prosthesis
10. If planned extraction cases, clean sites thoroughly and place implants in between extraction sites.

DISADVANTAGES[6]

1. Free hand arbitrary surgical placement of implant is not always possible as implant placement is completely prosthetically driven.
2. Length of cantilever in the prosthesis cannot be extended beyond the limit.
3. It is very technique sensitive and requires elaborate pre-surgical preparation such as CAD/CAM, surgical splint and very methodical planning (Table 1)

Table 1:- maxillary and mandibular resorption treatment options

ALL ON FOUR MAXILLARY AND MANDIBULAR RESORPTION TREATMENT OPTION[8], [11], [12]		
MAXILLARY TREATENT OPTIONS		
MILD 1. "All-on-4" 2. All-on-4: Shelf	MODERATE 1. "All-on-4" 2. All-on-4: Shelf	SEVERE 1. Zygoma 2. Quad zygoma 3. All-on-4: Shelf 4. Trans-sinus technique
MANDIBULAR TREATMENT OPTIONS		
MILD 1. "All-on-4" 2. All-on-4: Shelf	MODERATE 1. "All-on-4" 2. All-on-4: Shelf	SEVERE 1. All-on-4: "V-4"

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The different types of treatment protocol followed according to maxillary and mandibular arch are classified as under (Table 2 and 3):-

TABLE 2:-MANDIBULAR ARCH TYPES

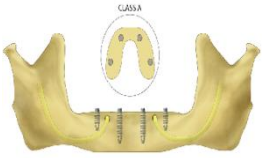
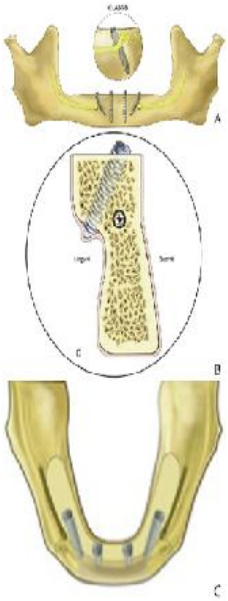
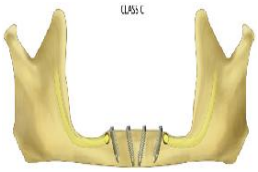
MANDIBULAR TYPES			
CLASS A	**CLASS B**	**CLASS C**	**CLASS D**
sufficient vertical bone in the posterior to place implants above the inferior alveolar nerve canal in first molar positions.[12] variant is such that even if the inferior alveolar nerve loops downward near the inferior border of the mandible and the mental foramen being higher up, still the implant can be placed posterior to the foramen. Implants are placed straight with the arch span exceeding 60mm.  Fig. 1:- Favourable A-P spread for implant placement in both premolar and 1st molar location	the posterior implants can be placed at an angle of at least 30° while the anterior implants being straight and parallel to each other. The posterior implants slightly bypasses the nerve as the implant appears to cross the nerve in anterior direction.[13]  Fig. 2:- Class B:- implant placement with forward angulation(A) and posterior implants bypassing the inferior alveolar nerve at 30° forwardly by engaging into lingual plate.(B, C)	no vertical bone above the foramen, and the angled implant entry point is forward of the foramen in the first premolar zone.[14] The anterior implants are arranged in V-4 fashion, placed equally and mesially, bend towards the midline because of the lack of vertical bone space at an angle of 30° apically.[15]  Fig. 3:- Placement of All the Four implants in the Intra-foramina Region with anterior two implants in the lateral and canine region	is less than 10 mm in vertical height and corresponds to Cawood Howell Class V-VI atrophy.[16] Three well-spaced implants are used with the posterior implants angled toward the midline. The inferior alveolar nerve is commonly dehisced and is usually on top of the ridge, where it can easily be reflected with a little manipulation. The implant site preparation can then begin in the foramen concavity itself to improve the A/P spread.[15]  Fig. 4:- mandible posterior implants placed through foramen with nerve being retracted.[17] Three implants are placed in a V-formation.

TABLE 3:- MAXILLARY ARCH TYPES

MAXILLARY TYPES			
CLASS A	**CLASS B**	**CLASS C**	**CLASS D**
an anatomic variant with a thick palatal wall of bone available medial to the first molar extraction site, usually just anterior to the palatal root socket. This entry point, angling forward at 30°, will enable implant placement into the cortical bone of the palatal wall, avoiding the immediately adjacent sinus cavity.[18], [19] An M-shaped pattern is formed by the anterior implants on oral pantomogram. This implant placement pattern is designated M-4 with all 4 implants angled at 30° and establishes support for a restoration requiring little or no cantilever and with an anterior posterior spread approximating 20 mm and an inter-implant arch span greater than 60 mm. All implants engage the M point, the location of maximum bone mass at the lateral pyriform rim above the nasal fossa.[20]	maxilla has moderate atrophy and prominent sinus cavities with a relatively thin palatal wall requiring an entry point for the placement of the implants in front of the sinus cavities. Implants paced posteriorly usually enter in the second premolar zone before angling forward at a 30-degree angle to gain primary stability at the M point. The implants may pass through a portion of the sinus, but if there is secure bi-cortical fixation, sinus grafting is not needed.[21], [22] There is M-4 distribution of the implants with A/P spread of approximately 15mm and inter-implant arch span between 45-55mm.	the alveolar process is absent, the sinuses project anteriorly and trans-sinus implant placement is required to obtain an adequate A/P spread.[23], [24] The M-point bone mass is generally reduced in volume such that only the posterior implants can obtain fixation there. Therefore, anterior implants must engage midline bone at what is designated the V point, which is the point of maximum bone mass at the most superior aspect of the midline within the nasal crest near the junction of the vomer.[17] Treatment for the Class C maxilla is designated V-4 placement, as all implants converge toward	V point bone but no M point bone mass and corresponds to Cawood Howell Class V-VI atrophy.[16] When posterior bone is not present, zygomatic implants are prescribed. Zygomatic implants in this setting require little or no insertional torque such that all the load initially is beared by the anterior implants requiring high mechanical stability. In general, many Class D maxillary situations can be treated with a V-4 approach by using trans-sinus implants instead of zygomatic implants, but the sum of the insertion torques must be at least 120 Ncm to permit loading.[24] Anterior Implants must have a high insertional torque or delayed loading to be adopted.

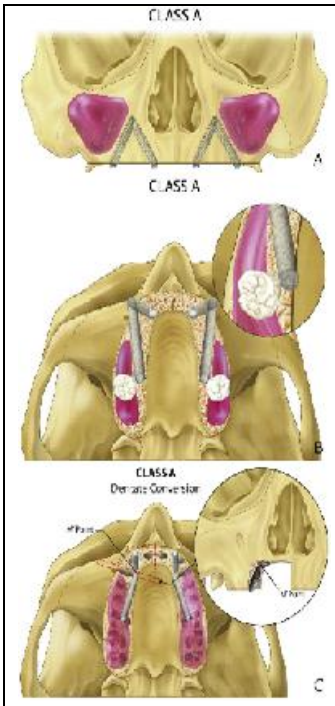


Fig. 5:- Class A maxilla entry point for posterior implants angle forward hugging palatal wall to engage cortical bone aimed apically toward canine fossa but not extending to lateral nasal rim. B, Class A maxilla after bone reduction maintains cortical palatal wall, a favorable entry point angling forward buccally toward M point. C, Implants can sometimes be confined to palatal wall in robust individuals with thick palatal walls to fix into maximum available cortical bone mass (designated M' point) at palatal wall/palatal wall.[17]

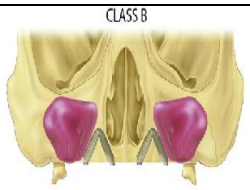


Fig. 6:- Class B maxilla has thin palatal wall and more prominent sinus such that posterior implant entry point is second premolar location angling forward to M point. Anterior implants angle the midline in an upside down V formation to include 2 transsinus grafted implants posterior and 2 vomer implants anterior.[25] The A/P Spread is about 10mm with inter-implant arch space between 40-45mm.

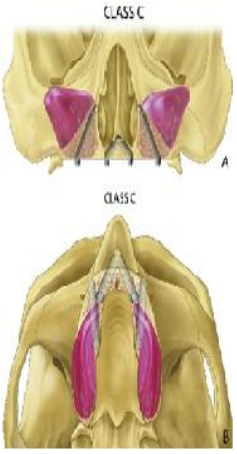


Fig. 7:- Class C maxilla very prominent sinus cavities can be membrane reflected for trans-sinus placement with entry points first or second premolar and apical fixation at M point. Anterior implants angle back to M point and often touch posterior implants, but more often they

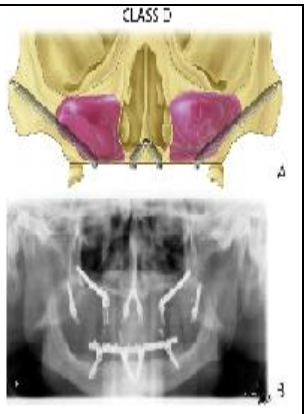


Fig. 8:- Class D maxilla is M point bone and V point bone mass deficient. Implant fixation is zygoma, pterygoid plate, and sometimes nasal crest. B, Use of pterygoid implants requires 6-implant scheme, usually 2 pterygoids, 2 zygomatics, and 2 vomers. C, Use of quad zygomatics, 2 zygomatic implants on each side, is alternative for immediate function. Sinus graft for delayed alveolar implant placement can be considered.

		angle forward into midline bone at V point. B, Trans-sinus implant placement should be grafted with BMP-2 if implant is not well fixed[17]	

SURGICAL PROCEDURE

Implants in the maxilla are placed with two distal implants in the posterior region which are tilted anterior to the maxillary antrum while in the mandible implants are positioned anterior to the mental foramen. They should be inserted at an angulation of 30°-45°. The use of All-on-4 surgical guide assists in ensuring the placement of implants with correct positioning, angulation and emergence. The guide is placed into a 2mm osteotomy that is made in the midline position of the maxilla or mandible and the titanium band is contoured to follow the arc of the opposing arch.[6] The vertical lines on the guide are used as a reference for drilling at the correct angulation, which should not be greater than 45°.

CLINICAL EVALUATION FOR "ALL-ON-4"[9]

1. VDO
2. Composite defect detection (hard and soft tissue loss)
3. Smile line
4. Lip support and A-P tooth position of maxilla
5. Alveolus ridge plateau

DRILL SEQUENCE FOR "ALL-ON-4" (RP) 4.3 MM×13 MM TAPERED IMPLANTS[26]

1. Place "All-on-4" guide in the midline of the arch
2. Start with posterior sites, angle drill 30°–45° distally
3. Precision drill (Starter Drill) for initial osteotomy (Max. 800 rpm)
4. 2.0 mm Twist Drill (Max. 800 rpm)
5. NP Tapered Drill (Max. 800 rpm)
6. RP Tapered Drill (Max. 800 rpm)
7. RP Dense Bone Drill for 13-mm to 16-mm length implants or dense bone regions (Max. 800 rpm)
8. (Optional) Screw tap tapered drill for dense bone regions (Max. 45 Ncm)

9. Insert implant with handpiece at maximum 45 Ncm
10. Repeat steps 3 to 8 for anterior implants with 0° tilt.

PROSTHETIC PROCEDURE: "ALL-ON-4"[7]

PROVISIONAL PROSTHESIS CONVERSION WITH EXISTING MANDIBULAR DENTURE FOR IMMEDIATE LOAD

1. Confirm implant torque to greater than 35 Ncm
2. Take a bite registration
3. Place 30° or 17° multiunit abutments at posterior sites and place 0° or 17° multiunit abutments at the anterior sites so they emerge toward the occlusal surface of the denture
4. Confirm seating with a radiograph and then torque the posterior abutments to 15 Ncm and 30 Ncm for the anterior abutments[27]
5. Place a protective healing cap on these abutments and suture the surgical site with resorbable sutures (ie, 3-0 or 4-0 chromic gut).
6. Index the denture with impression material (ie, polyvinylsiloxane [PVS]).
7. Create adequate space with an acrylic bur in the denture where index markings are present.
8. Remove the protective healing cap and place temporary coping (multiunit) onto the multiunit abutments.[27]
9. Adequate clearance is needed for temporary coping (multiunit) and denture.
10. Recheck occlusion to be coincident before luting with acrylic.[27]
11. Lute the temporary coping (multiunit) with acrylic material.
12. Lute the tissue-baring surface of the denture to the temporary coping (multiunit) with acrylic.
13. Reduce excess temporary coping (multiunit) flush with denture level.
14. Provisional prosthesis is inserted with prosthesis screws at 15 Ncm.[27]
15. Seal access hole with material (ie, thread seal tape and cavit or PVS).[27]
16. Bilateral group function occlusion with one-tooth cantilever maximum.
17. Soft diet recommended.[27]

IMPRESSION TECHNIQUE FOR PROVISIONAL PROSTHESIS FABRICATION DAY OF SURGERY (2–3 HOURS AFTER SURGERY)[26], [28]

1. Confirm implant torque to greater than 35 Ncm.
2. Place multiunit abutments on implants.
3. Suture flaps closed.
4. Place the impression copings closed tray onto the multiunit abutments.
5. Take an impression and send to laboratory.
6. Place protective healing caps on abutments while provisional is being made.
7. Provisional prosthesis is torqued to 15 Ncm.
8. Seal access hole.
9. Bilateral Group Function Occlusion with one tooth cantilever maximum.
10. Soft diet recommended.

FINAL PROSTHESIS: "ALL-ON-4" (4–6 MONTHS AFTER INITIAL IMPLANT PLACEMENT)[26]

1. (Visit 1) Remove provisional and confirm torque of implant greater than 35 Ncm.
2. (Visit 1) Replace provisional and take bite registration.
3. Remove provisional and place multiunit laboratory analog to denture and mount on articulator against a counter model.
4. Index the prosthesis with putty.
5. (Laboratory procedure) Resin pattern is fabricated in sections.
6. (Visit 2) Transfer the sectioned resin pattern to patient's mouth and lute the sections together with resin.
7. (Laboratory procedure) This resin pattern gets scanned and framework is made by CAD/CAM technology.
8. (Visit 3) Try-in framework (passive fit) in patient's mouth.
9. (Visit 3) Soft tissue index of framework and intaglio's surface.
10. (Visit 4) Wax try-in with teeth.
11. (Visit 5) Final delivery of prosthesis.

GUIDED SURGERY FOR "ALL ON FOUR"

Guided surgery allows the clinician for very accurate placement and flexibility of with flap and flapless surgery. Flapless surgery is indicated for patients who have sufficient keratinized gingival tissue, good interarch opening (around 40 mm), and edentulous arches that do not require preprosthetic surgery. An advantage of the flawless approach is that it requires less surgical time without suturing.[7]

Following are requirements of guided surgery:-[7]

1. fully healed extraction sites.
2. minimal mandibullar opening of 40 mm.
3. smile line assessment.
4. evaluated for quantity and quality of soft tissue.
5. Diagnostic mounting for determining VDO and A/P spread

CLINICAL EVALUATION AND WORKUP FOR GUIDED SURGERY[28]

1. (Visit 1) Clinical exam (1. fully healed extraction sites, 2. MIO > 40 mm, 3. smile line assessment, 4. evaluate soft tissue quality & quantity.)
2. (Visit 1) Diagnostic impression
3. (Visit 2) Diagnostic models (verify VDO & tooth set-up)
4. (Laboratory procedure)Create a radiographic guide with 6–8 spherical points.
5. Create a surgical index with radiographic guide or guides against counter model mounted on an articulator
6. (Visit 3) Dual scan technique (patient with surgical guide with surgical index and surgical guide alone)
7. Perform virtual planning (prosthetic driven approach) using software.
8. Laboratory technician fabricates (surgical guide, provisional prosthesis, and Jig). (Table 4)

TABLE 4:- SUMMARY OF GUIDED SURGERY

FLOW CHART FOR GUIDED SURGERY[26]	
Flapless (Inculsion)	Flap or Mini Flap (Inculsion)
1. Sufficient keratinized tissue 2. MIO >40 mm 3. Requires no preprosthetic surgery 4. Partial or edentulous arch(es) 5. Decrease surgery time, bleeding, and swelling	1) Minimal keratinized tissue 2) Allows simultaneous bone grafting 3) MIO >40 mm 4) Partial or edentulous arch(es)

OCCLUSAL SCHEMES[29]

Occlusal schemes to be followed are:-

1. Establishment of stable jaw relationships with maximum intercuspal contacts that are bilaterally identical.
2. Establishment of " freedom in centric" within the overall occlusal scheme.
3. Elimination of any interference between the maximum intercuspal and retruded contact positions.
4. Provision of harmonic, free mandibular movements with light tooth contacts during both lateral and protrusive maneuvers.

DISCUSSION

For the long term success rate and results certain guidelines to be followed for this procedure like minimizing the length of cantilever, simultaneous bilateral contacts on all teeth, teeth exclusion distal to implant emergence, in side to side movements, group function occlusion with guidance of flat linear pathways and minimal vertical super impositon excluding teeth in cantilever.[29] In protrusive movements, anterior guidance is kept to minimum with little overlap of teeth just enough to maintain esthetics. Balancing contacts are avoided if the prosthesis is opposite to removable complete denture. The occlusal pattern should have relatively flat cusps i.e. the inclination of the cuspal planes should be less than the inclinations of the condylar path.[29]

Also if surgical aspect is considered the angulated implants avoids critical anatomical structures, immediate function and low cost of treatment due to less no. Implants are major factors to be considered. The Procedure is technique sensitive and free hand surgeries to be avoided.

Malo and colleague[1] performed 968 implants on 242 patients in the maxilla and found a cumulative success rate of 98% at 5 years. These reports are compatible with literature review by Duello.[30] Full-arch fixed prosthesis using the "All-on-4" design has a high degree of predictability in the medium and long term. Current data reveal a cumulative success rate of 99.2% for the mandible in 10 years and 100% in the maxilla for 5 years.[1], [31]

SUMMARY AND CONCLUSION

The working biomechanics of the "All-on-four" concept has proved its clinical reliability and high success rate, with lower rate complication making it a treatment alternative for

patients with high satisfaction both for doctor and patients even in cases with immediate extraction and implant placement. Atrophic jaws that normally would require traditional bone grafting before implant placement will increase treatment time, costs, and morbidity associated with these grafting procedures.[7] All on four becomes a viable alternative in such cases with satisfactory occlusal function.

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