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"ALL-ON-4" A CLINICAL CONCEPT OF FULL ARCH IMPLANT SUPPORTED REHABILITATION – A SYSTEMIC REVIEW AND META ANALYSIS.

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Abstract:
Aim and objective: In edentulous patients with severe bone resorption, bone augmentation procedures are required prior to the insertion of dental implants for successful outcome. These procedures prolongs the treatment time and increases the patient's morbidity during insertion of implants. A protocol, All-on-4 concept was developed to overcome the anatomic limitations in edentulous maxillary and mandibular arches. These implants use maximum bone available and allows immediate function loading with high survival rate. Therefore, the aim of this systemic review and meta-analysis is to summarize the clinical concept of All-on-4 implants on full arch supported rehabilitation of completely edentulous arches.
Materials and methods: All publications on the All‑on‑4 implant design, Indication of treatment related to ridge condition, need for bone regeneration, type of prosthetic restoration, complications and case follow- up for at least 5 years or more were considered. A total number of 99 articles were found through google scholar, pubmed and Cochrane library. Thirty-four articles were selected according to inclusion of clinical trials and laboratory studies on full mouth rehabilitation of complete edentulous arch using all-on-4 concept.
Result: A total no. of 34 studies from the year 2005- 2019 were included. In these studies implants are placed with or without flap reflection. The length of the implants used were 10-15mm or 10-18mm and the distal implant inclination was about 15^{o}, 17^{o}, 30^{o} or 45^{o}. The mean survival rate of implants was 94.3%. Prosthetic restorations were done with metal ceramic implant supported fixed prosthesis with titanium framework and all ceramic crowns were placed for full mouth rehabilitation.
Conclusion: The "All-on-4" treatment concept seems to be an alternative option for rehabilitating edentulous jaws compared with advanced surgical approaches without using removable prostheses.
Keywords: All-on-4 implants, Atrophic ridges, Implant angulation, Titanium framework, edentulous arches, Bone grafts.

INTRODUCTION:

Rehabilitation of completely edentulous upper and lower arches with dental implants having been used for more than 50 years now, and it is considered as a viable treatment modality to replace missing teeth with dental implants.[1] In edentulous patients with severe bone resorption, it requires bone augmentation procedures prior to the insertion of dental implants for successful outcome. These procedures not only prolongs the treatment time but also increases the patient's morbidity during insertion of implants.[1-2]

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Therefore, a protocol, All-on-4 concept was proposed by Paulo Malo, to overcome the anatomic limitations in edentulous maxillary and mandibular arches, that makes difficult for the insertion of dental implants.[2] Also as an alternative to bone augmentation procedures in which, four implants are placed in between the mesial wall of maxillary sinus in the maxillary arch of the completely edentulous jaw to support provisional, fixed and immediately loaded prosthesis.[2-3]

In All-on-4 treatment protocol, two most anterior implants are placed axially, two posterior implants are placed distally and angled to minimise the cantilever length, and to allow the fixation of prostheses with up to 12 teeth which may enhance the masticatory function efficiently.[4]

In All-on-4 protocol, mechanical and biological complication rates are decreased because of the easy removal of screw-retained implant prostheses and the prosthesis can also be removed for prosthetic hygiene or when there is a problem with the abutment and/or implants.[5]

In maxilla, the bone density and the immediate loading in this region is a great challenge than compared in the mandible. Implant anchorage in edentulous maxilla is restricted especially in posterior region due to bone resorption. So, bone grafting is often indicated in these region. As an alternative to bone grafting, tilted placement of the implants in the maxilla can be used especially in the more posterior region to improve implant anchorage, which can be achieved from the cortical bone wall of the sinus and the nasal fossa. Therefore, the use of four implants in the maxilla has a favourable load distribution for complete arch prostheses.[6] In some studies use of metal frameworks are recommended because of their high rigidity, compared to all-acrylic resin prostheses and all-acrylic resin prostheses without metal frameworks and have also reported high survival rates.[8]

The All-on-4 implants has been developed to use maximum bone available and allows immediate function loading with high survival rate.[7] The aim of this systemic review and meta-analysis is to summarize the clinical concept of All-on-4 implants on full arch supported rehabilitation of completely edentulous arches.

MATERIALS AND METHODS:

Search strategy:

A computerized literature search was performed using pubmed, Google Scholar and additional hand search was performed by screening the lists of all articles selected, and full texts of potentially interesting studies were examined. The search was limited to the English language. The search included scientific articles published until 2019.

Inclusion criteria:

The inclusion criteria included All‑on‑4 implant design, its use in complete edentulous maxillary and mandibular cases, need for bone augmentation, prosthetic restoration and any complications occurred by using this technique. Clinical trials followed up for long term period and laboratory studies on the subject using the full text and English language were evaluated.

Exclusion criteria:

Studies not meeting all inclusion criteria were excluded from the review.

Study selection

All publications on the All‑on‑4 implant design, Indication of treatment related to ridge condition, need for bone regeneration, type of prosthetic restoration, complications and case follow- up for at least 5 years or more were considered. A total number of 99 articles were found through google scholar, pubmed and Cochrane library. Thirty-four articles were selected according to inclusion of clinical trials and laboratory studies on full mouth rehabilitation of complete edentulous arch using all-on-4 concept.

RESULTS:

In this systemic review, a total number of 61 articles were screened and 34 studies are considered to be potentially relevant for this systemic review. Of these, 27 articles were excluded in which 18 articles were case reports and 9 were review articles.

In table.1, a total no. of 34 studies from the year 2005- 2019 were included. In all these studies, the treatments are indicated according to their ridge condition in both the upper and lower edentulous arch with sever atrophic ridges. In 16 studies, bone regeneration was carried out before the placement of implants for

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full mouth rehabilitation due to sever resorption of ridge. In 25 studies, the cases were followed-up for more than 5 years of period and in 9 studies, the follow-up period was 1 year post-operatively.

Table. 2, presents over all surgical procedures in the included studies, which was performed under local anaesthesia. In 28 studies, mid- crestal incision were given and in 6 studies, the implants were placed without flap reflection. The length of the implants used were 10-15mm or 10-18mm and the distal implant inclination was about 15^o, 17^o, 30^o or 45^o. The mean survival rate of implants was 94.3%. After the placement of implants, the provisional prosthesis of acrylic resin was given on the day of surgery and final restorations were done with metal ceramic implant supported fixed prosthesis with titanium framework and all ceramic crowns were placed for full mouth rehabilitation.

In most of the studies, the mechanical and biological complications are observed such as implant mobility, implant probing depth, peri-implantitis and also complications due to systemic diseases like diabetes, cardiovascular diseases and smoking habits. These biological complications are managed by thorough oral hygiene maintenance. The mechanical complications like prosthetic screw loosening, abutment loosening, and crown fracture was reported in some of the studies and these complications are corrected by retightening.

DISCUSSION:

All-on-4 implant designs were developed especially for the application in severely resorbed mandibular completely edentulous cases, but later, they were also applied in maxillary completely edentulous conditions.[2] In cases, with sever resorption in mandibular posterior region, implants can be placed in the interforaminal region for rehabilitation of full arch fixed prostheses.[3] Whereas in maxilla sinus-dependent implant applications are limited and the application can be performed so that the implants should not cross the mesial wall of sinuses.[2]

The rehabilitation for completely edentulous jaws with All-on-4 immediate function concept has proven to be clinically effective, patient pleasing and can be applicable with or without bone augmentation.[9]

The All-on-4 treatment concept is based on the placement of four implants in the anterior region of completely edentulous jaws to support an immediate implant supported fixed prostheses, two most anterior implants are placed axially and two posterior implants are placed with distal tilting of up to 45^0, on which prostheses with up to 12 teeth can be placed. This treatment concept was developed to maximize the use of available residual bone allowing immediate function and avoiding bone augmentation procedure that increases treatment costs, patient morbidity and complications inherent to these procedures.[10]

T. Liu et al., in his study demonstrated the biomechanical effects of using All-on-4 implants with different inclinations on the rehabilitation of moderately atrophied edentulous maxilla and found that the maximum principle stress is often used to observe the tensile stress and the minimum principal stress is used for compressive stress. Therefore, it is appropriate to use the principal compressive or tensile stress to analyze the biomechanical behavior of peri-implant bone.[11, 29]

Immediate loading is preferred for All-on-4 implant supported fixed prostheses. Following the implant application, temporary prosthetic restorations are made and start to function immediately.[8]The permanent prosthesis is made as a metal-ceramic full-arch fixed prosthesis approximately 3 months later. Prosthetic materials used in all-on-4 implant-assisted prostheses are an important factor affecting stress/ strains observed in implants and peri-implant bone. Full-arch all-on-four implant-assisted fixed dental prostheses are metal-reinforced ceramic restorations, metal-reinforced hybrid fixed prostheses, and zirconia-reinforced ceramic fixed prostheses. The increased rigidity associated with the metal frameworks in prostheses had an important role in the survival rates.[7]

When a large one-piece casting framework is fabricated for restoring a full ach, the dimensional changes may occur during the casting process. Also, following firing the gingival pink porcelain to the metal substrate the passive fit of a framework could be compromised. To achieve the passive fit, the framework should be cut and soldered into three segments and/or the non-engaging multiple unit screw retained abutments are used. Acrylic fracture is one of the most common complication in All-on-Four prosthesis and this complication can be prevented by regular occlusal adjustments and by using night guard. Porcelain fracture in implant-supported restoration is observed in normal dentition with lack of proprioception capacity.[14]

In All-on-4 concept, as implants are placed at an angle so, it is difficult to achieve the desired angulation because there are only two angulation options *i.e.*, 17 and 30 degrees in multiunit abutments due to which it is impossible to create absolute parallelism between the impression copings, which may affect the accuracy of the impression. Thus, the angulations of inserted implants play an important role in the angular and positional accuracies of the definitive impression. To improve cast accuracy the sectioned resplinted open-tray technique can be recommended when high discrepancies among the implants are present i.e. 30 degrees.[12]

A study done by *Narvaja et al*., demonstrated that the bacterial biofilm found around the axial implant has different microbial composition than that of biofilm found around the tilted implants. Thus, the microbial profile around the tilted implant is similar to that of subgingival microbial profile of implant in mucositis instead of healthy implants.[13]The success rate of All-on-Four prostheses mainly depends on the osseointegration of dental implants. Osseointegration can be compromised by the inflammatory process around the dental implant that leads to bone loss and implant loss in the long term.[51]

CONCLUSION:

The "All-on-4" treatment concept seems to be an alternative option for rehabilitating edentulous jaws compared with advanced surgical approaches without using removable prostheses. Although the vertical placement is standard for anterior implants, the application of posterior implant angles at different angles suggests that there is no standard for this situation and that it can vary according to the characteristics of the case. Moreover, despite being the implant recommended to be used in terms of implant types, not many studies were encountered on the use of different implant systems. No standard length and diameter could be determined for implant lengths. Because of the fact that an increase in comfort and aesthetic expectations of both the mandible and maxilla has been observed during prosthetic dental treatment in all‐on‐four protocols, it is possible to use them successfully. Nevertheless, it is necessary to increase long‐term reliability limit as a result of conducting further clinical‐based studies.

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REFERENCES:

1. Masih A, Choukse V, Srivastava R, Sharma N. Tilted Implants: A Review. Acta scientific dental sciences. 2018; 2(12): 65-70.
2. Horita S, Sugiura T, Yamamoto K, Murakami K, Imai Y, Kirita T. Biomechanical analysis of immediately loaded implants according to the "All-on-Four" concept. Journal of prosthodontic research. 2017; 61(2):123-32.
3. Malo P, de Araújo Nobre M, Lopes A, Moss SM, Molina GJ. A longitudinal study of the survival of All-on-4 implants in the mandible with up to 10 years of follow-up. The Journal of the American Dental Association. 2011 Mar 1; 142(3):310-20.

4. Soto-Peñaloza D, Zaragozí-Alonso R, Peñarrocha-Diago M, Peñarrocha-Diago M. The all-on-four treatment concept: Systematic review. Journal of clinical and experimental dentistry. 2017 Mar; 9(3):e474.
5. Durkan R, Oyar P, Deste G. Maxillary and mandibular all-on-four implant designs: A review. Nigerian journal of clinical practice. 2019 Aug 1; 22(8):1033.
6. Maló P, Rangert B, Nobre M. "All-on-Four" immediate-function concept with Brånemark System® implants for completely edentulous mandibles: a retrospective clinical study. Clinical implant dentistry and related research. 2003 Mar; 5:2-9.
7. Babbush CA, Kutsko GT, Brokloff J. The all-on-four immediate function treatment concept with NobelActive implants: a retrospective study. Journal of Oral Implantology. 2011 Aug; 37(4):431-45.
8. Malo´ P, Rangert B, Nobre M. All-on-4 immediate-function concept with Bra°nemark system implants for completely edentulous maxillae: a 1-year retrospective clinical study. Clin Implant Dent Relat Res. 2005; 7(suppl 1):S88–S94.
9. Thumati P, Reddy M, Mahantshetty M, Manwani R. " All-On-4/DIEM 2" A concept to rehabilitate completely resorbed edentulous arches. Journal of Dental Implants. 2015 Jan 1; 5(1):76.
10. 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. Clinical implant dentistry and related research. 2019 Mar 28.
11. Liu T, Mu Z, Yu T, Wang C, Huang Y. Biomechanical comparison of implant inclinations and load times with the all-on-4 treatment concept: a three-dimensional finite element analysis. Computer methods in biomechanics and biomedical engineering. 2019 Apr 26; 22(6):585-94.
12. Ozan O, Hamis O. Accuracy of different definitive impression techniques with the all-on-4 protocol. The Journal of prosthetic dentistry. 2019 Jun 1; 121(6):941-8.
13. Narvaja A, Awad Shibli J, Coppede A, Giro G, Feres M, Faveri M. Microbiologic Analysis of Immediately Loaded Full-Arch Implant-Retained Prosthesis Protocol After 2 Years of Loading: A Retrospective Study. International Journal of Oral & Maxillofacial Implants. 2018 Nov 1; 33(6).
14. Siadat H, Rokn A, Beyabanaki E. Full Arch All-on-4 Fixed Implant-Supported Prostheses with 8.5 Years of Follow-Up: A Case Report. Journal of dentistry (Tehran, Iran). 2018 Jul; 15(4):259.
15. Babbush CA, Kutsko GT, Brokloff J. The all-on-four immediate function treatment concept with NobelActive implants: a retrospective study. Journal of Oral Implantology. 2011 Aug; 37(4):431-45.
16. Korsch M, Baum A, Bartols A. Postoperative discomfort after implant placement according to the All-on-4 concept with or without Zygoma implants: A prospective clinical study. Clinical oral implants research. 2019 Sep 24.
17. ELsyad MA, Elgamal M, Mohammed Askar O, Youssef Al-Tonbary G. Patient satisfaction and oral health-related quality of life (OHRQOL) of conventional denture, fixed prosthesis and milled bar overdenture for All-on-4 implant rehabilitation. A crossover study. Clinical oral implants research. 2019 Nov; 30(11):1107-17.
18. Arcas-Sanabre AJ, Gutierrez-Santamaria J, López-López J, Ayuso-Montero R, Velasco-Ortega E. Horizontal augmentation of the maxillary alveolar ridge to change the prosthetic profile: Clinical and radiological results of a retrospective study. Journal of stomatology, oral and maxillofacial surgery. 2019 Aug 10.
19. Tannyhill RJ, Jensen OT. Computer Simulation and Maxillary All-on-Four Surgery. Oral and Maxillofacial Surgery Clinics. 2019 May 17.
20. Hoefler VJ, Al-Sabbagh M. Are There Alternatives to Invasive Site Development for Dental Implants? Part II. Dental Clinics. 2019 Jul 1; 63(3):489-98.
21. Hoefler VJ, Al-Sabbagh M. Are There Alternatives to Invasive Site Development for Dental Implants? Part I. Dental Clinics. 2019 Jul 1; 63(3):475-87.
22. 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. Clinical implant dentistry and related research. 2019 Mar 28.

23. 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. Clinical implant dentistry and related research. 2019 Mar 28.
24. Maeda T, Mukaibo T, Masaki C, Thongpoung S, Tsuka S, Tamura A, Aonuma F, Kondo Y, Hosokawa R. Efficacy of electric-powered cleaning instruments in edentulous patients with implant-supported full-arch fixed prostheses: a crossover design. International journal of implant dentistry. 2019 Dec 1; 5(1):7.
25. Liu T, Mu Z, Yu T, Wang C, Huang Y. Biomechanical comparison of implant inclinations and load times with the all-on-4 treatment concept: a three-dimensional finite element analysis. Computer methods in biomechanics and biomedical engineering. 2019 Apr 26; 22(6):585-94.
26. Olesova VN, Amkhadova MA, Zaslavskii SA, Olesov EE, Shashmurina VR. Experimental Study of the Biomechanics of Maxillary Implants under Conditions of Biomechanical Modeling. Bulletin of experimental biology and medicine. 2019 Feb 15; 166(4):522-6.
27. Ozan O, Hamis O. Accuracy of different definitive impression techniques with the all-on-4 protocol. The Journal of prosthetic dentistry. 2019 Jun 1; 121(6):941-8.
28. Orphanos ES. Facial Esthetic Considerations with All-on-4: A Report on Two Cases. International Journal of Periodontics & Restorative Dentistry. 2019 Jan 1; 39(1).
29. Lofaj F, Kučera J, Németh D, Minčík J. Optimization of Tilted Implant Geometry for Stress Reduction in All-on-4 Treatment Concept: Finite Element Analysis Study. International Journal of Oral & Maxillofacial Implants. 2018 Nov 1; 33(6).
30. Siadat H, Rokn A, Beyabanaki E. Full Arch All-on-4 Fixed Implant-Supported Prostheses with 8.5 Years of Follow-Up: A Case Report. Journal of dentistry (Tehran, Iran). 2018 Jul; 15(4):259.
31. Tonellini G, Saez Vigo R, Novelli G. Double Guided Surgery in All-on-4® Concept: When Ostectomy Is Needed. International journal of dentistry. 2018; 2018.
32. Maló PS, de Araújo Nobre MA, Ferro AS, Parreira GG. Five-year outcome of a retrospective cohort study comparing smokers vs. nonsmokers with full-arch mandibular implant-supported rehabilitation using the All-on-4 concept. Journal of oral science. 2018; 60(2):177-86.
33. Maló P, Lopes A, de Araújo Nobre M, Ferro A. 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. International journal of oral and maxillofacial surgery. 2018 Aug 1; 47(8):1079-85.
34. Spencer KR. Implant based rehabilitation options for the atrophic edentulous jaw. Australian dental journal. 2018 Mar; 63:S100-7.
35. Brignardello-Petersen R. High proportion of implant and prostheses survive after 5 years in patients treated with the All-on-4 strategy in the maxilla. The Journal of the American Dental Association. 2018 Jan 1; 149(1):e38.
36. Vaz Ayub K, Ayub EA, do Valle AL, Bonfante G, Pegoraro T, Pegoraro LF. Seven-Year Follow-up of Full-Arch Prostheses Supported by Four Implants: A Prospective Study. International Journal of Oral & Maxillofacial Implants. 2017 Nov 1; 32(6).
37. Van Weehaeghe M, De Bruyn H, Vandeweghe S. A prospective, split-mouth study comparing tilted implants with angulated connection versus conventional implants with angulated abutment. Clinical implant dentistry and related research. 2017 Dec; 19(6):989-96.
38. Hopp M, de Araújo Nobre M, Maló P. Comparison of marginal bone loss and implant success between axial and tilted implants in maxillary All-on-4 treatment concept rehabilitations after 5 years of follow-up. Clinical implant dentistry and related research. 2017 Oct; 19(5):849-59.
39. Penarrocha-Diago M, Penarrocha-Diago M, Zaragozí-Alonso R, Soto-Penaloza D, on behalf of the Ticare M. Consensus statements and clinical recommendations on treatment indications, surgical procedures, prosthetic protocols and complications following All-On-4 standard treatment. 9th Mozo-Grau Ticare Conference in Quintanilla, Spain. Journal of clinical and experimental dentistry. 2017 May; 9(5):e712.
40. Li S, Di P, Zhang Y, Lin Y. Immediate implant and rehabilitation based on All-on-4 concept in patients with generalized aggressive periodontitis: A medium-term prospective study. Clinical implant dentistry and related research. 2017 Jun; 19(3):559-71.

41. Najafi H, Siadat H, Akbari S, Rokn A. Effects of immediate and delayed loading on the outcomes of all-on-4 treatment: a prospective study. Journal of dentistry (Tehran, Iran). 2016 Nov; 13(6):415.
42. Lopes A, Maló P, Sanchez-Fernández E. The N obel G uide® A ll-on 4® Treatment Concept for Rehabilitation of Edentulous Jaws: A Prospective Report on Medium-and Long-Term Outcomes. Clinical implant dentistry and related research. 2014 sep; 17: 406-416.
43. Tallarico M, Meloni SM, Canullo L, Caneva M, Polizzi G. Five-year results of a randomized controlled trial comparing patients rehabilitated with immediately loaded maxillary cross-arch fixed dental prosthesis supported by four or six implants placed using guided surgery. Clinical implant dentistry and related research. 2016 Oct;18(5):965-72.
44. De Araújo Nobre M, Maló P, Gonçalves I. Evaluation of clinical soft tissue parameters for extramaxillary zygomatic implants and conventional implants in all-on-4 hybrid rehabilitations: Short-term outcome and proposal of clinical recommendations for intervention in recall appointments. Implant dentistry. 2015 Jun 1; 24(3):267-74.
45. Chan MH, Holmes C. Contemporary "All-on-4" concept. Dental Clinics. 2015 Apr 1; 59(2):421-70.
46. Maló P, de Araujo Nobre MA, Lopes AV, Rodrigues R. Immediate loading short implants inserted on low bone quantity for the rehabilitation of the edentulous maxilla using an All-on-4 design. Journal of oral rehabilitation. 2015 Aug; 42(8):615-23.
47. Maló P, de Araújo Nobre M, Lopes A, Ferro A, Gravito I. A ll-on-4® Treatment Concept for the Rehabilitation of the Completely Edentulous Mandible: A 7-Year Clinical and 5-Year Radiographic Retrospective Case Series with Risk Assessment for Implant Failure and Marginal Bone Level. Clinical implant dentistry and related research. 2015 Oct; 17:e531-41.
48. Maló P, Araújo Nobre MD, Lopes A, Rodrigues R. Double full-arch versus single full-arch, four implant-supported rehabilitations: a retrospective, 5-year cohort study. Journal of Prosthodontics. 2015 Jun; 24(4):263-70.
49. Jensen OT. Complete arch site classification for all-on-4 immediate function. The Journal of prosthetic dentistry. 2014 Oct 1; 112(4):741-51.
50. Ayna M, Gülses A, Açil Y. Comprehensive comparison of the 5-year results of all-on-4 mandibular implant systems with acrylic and ceramic suprastructures. Journal of Oral Implantology. 2015 Dec; 41(6):675-83.
51. Abi Nader S, Eimar H, Momani M, Shang K, Daniel NG, Tamimi F. Plaque Accumulation Beneath Maxillary All-on-4™ Implant-Supported Prostheses. Clinical implant dentistry and related research. 2015 Oct; 17(5):932-7.
52. Browaeys H, Dierens M, Ruyffelaert C, Matthijs C, De Bruyn H, Vandeweghe S. Ongoing crestal bone loss around implants subjected to computer-guided flapless surgery and immediate loading using the All-on-4® concept. Clinical implant dentistry and related research. 2015 Oct; 17(5):831-43.
53. Hussein MO, Rabie ME. Three-dimensional nonlinear contact finite element analysis of mandibular All-on-4 design. Journal of Oral Implantology. 2015; 41(2):e12-8.
54. Maló P, de Araújo Nobre M, Lopes A, Ferro A, Moss S. Extramaxillary surgical technique: clinical outcome of 352 patients rehabilitated with 747 zygomatic implants with a follow-up between 6 months and 7 years. Clinical implant dentistry and related research. 2015; 17:e153-62.
55. Maló P, de Araújo Nobre M, Lopes A, Francischone C, Rigolizzo M. "All-on-4" immediate-function concept for completely edentulous maxillae: a clinical report on the medium (3 years) and long-term (5 years) outcomes. Clinical implant dentistry and related research. 2012 May; 14:e139-50.
56. Jensen OT, Cottam J, Ringeman J, Adams M. Trans-sinus dental implants, bone morphogenetic protein 2, and immediate function for all-on-4 treatment of severe maxillary atrophy. Journal of Oral and Maxillofacial Surgery. 2012 Jan 1; 70(1):141-8.
57. Malo P, de Araújo Nobre M, Lopes A, Moss SM, Molina GJ. A longitudinal study of the survival of All-on-4 implants in the mandible with up to 10 years of follow-up. The Journal of the American Dental Association. 2011; 142(3):310-20.
58. Jensen OT, Adams MW, Cottam JR, Parel SM, Phillips III WR. The all on 4 shelf: mandible. Journal of Oral and Maxillofacial Surgery. 2011; 69(1):175-81.

59. Jensen OT, Adams MW, Cottam JR, Parel SM, Phillips III WR. The All-on-4 shelf: maxilla. Journal of Oral and Maxillofacial Surgery. 2010; 68(10):2520-7.
60. Takahashi T, Shimamura I, Sakurai K. Influence of number and inclination angle of implants on stress distribution in mandibular cortical bone with All-on-4 Concept. Journal of prosthodontic research. 2010; 54(4):179-84.
61. Jensen OT, Adams MW. The maxillary M-4: A technical and biomechanical note for all-on-4 management of severe maxillary atrophy—Report of 3 cases. Journal of Oral and Maxillofacial Surgery. 2009; 67(8):1739-44.

Table. I. Indication of treatment related to ridge condition

Sl.no	Author	year	No. of patients	location	Ridge condition	Need for bone regeneration	Follow up period
1.	Paulo Malo *et al.*,	2011	245	Lower arch	severe mandibular resorption,	yes	10 years
2.	Paulo Malo *et al.*,	2005	32	completely edentulous maxillae	Teeth were extracted during surgery	No	1 year
3.	Charles A. *et al.*,	2011	165	Both jaws	Edentulous maxilla and mandible	No	29 months
4.	A.J. Arcas-Sanabre e*t al.*,	2019	19	Upper arch	Atrophic maxillary ridge	yes	20 months
5.	Vaughan J. *et al.*,	2019	380	Both jaws	Sever maxillary and mandibular resorption	yes	7 years
6.	Paulo Maló *et al.*,	2018	471	Lower arch	completely edentulous mandible	No	10 and 15 years
7.	Paulo Maló *et al.*,	2019	1072	Upper arch	Edentulous maxilla.	No	5-13 years
8.	Toru Maeda *et al.*,	2019	09	Upper arch	maxillary edentulous arches	No	1 year
9.	Toru Maeda, *et al.*,	2018	14	Both jaws	completely edentulous mandible and maxillary arch	No	2 years.
10.	Gabriele Tonellini *et al.*,	2018	07	both	rehabilitation of edentulous jaws	yes	1 year

11.	Paulo S. Maló *et al*.,	2018	200	Lower arch	edentulous mandible	No	5 year
12.	P. Malo´ *et al.*,	2018	83	Upper arch	maxillary rehabilitations	No	1 year
13.	KR Spencer *et al.*,	2018	05	Both	atrophic and edentulous jaw	Yes	1 year
14.	Hopp M *et al.*,	2017	891	Upper jaw	maxillary rehabilitations	yes	5 year
15.	Keran Vas Ayub *et al.*,	2017	16	Lower jaw	edentulous mandible	No	7 year
16.	Man_u Van Weehaegh *et al.*,	2017	20	Lower jaw	Edentulous mandible.	No	48 months
17.	Milena Hopp et al	2017	891	Upper jaw	maxillary rehabilitations	No	5 years
18.	Sha Li, *et al.*,	2017	17	Both	immediate post-extraction implant and rehabilitation	yes	5 years
19.	Hossein Najafi *et al.*,	2016	30	Both	immediate and delayed rehabilitation of edentulous jaws	Yes	1 year
20.	Armando Lopes *et al.*,	2016	16	Both	edentulous patients	No	5 year
21.	Marco Tallarico *et al.*,	2015	40	Both	rehabilitation of complete edentulous patients	Yes	5 year
22.	Miguel de Araújo Nobre *et al.*,	2015	40	Upper jaw	complete edentulous atrophic maxillae	Yes	1 year
23.	Michael H.*et al.*,	2014	20	Both	edentulous mandible and maxillary arch	No	10 year
24.	P. MALo' *et al.*,	2015	43	Upper jaw	complete edentulous maxillae rehabilitations	No	6 years

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25.	Paulo Maló *et al.*,	2014	324	Lower jaw	rehabilitation of edentulous mandibles	Yes	7 years
26.	Paulo Malo	2014	110	Both	maxillary single-arch rehabilitations or mandibular single-arch rehabilitations	Yes	5 year
27.	Armando Lopes, *et al.*,	2014	23	both	completely edentulous jaws	No	5 year
28.	Armando Lopes, *et al.*,	2014	27	Lower jaw	edentulous mandible	No	5 years
29.	Hilde Browaeys, *et al.*,	2014	20	Both	completely edentulous jaws	Yes	3 years
30.	Paulo Maló *et al.*,	2013	152	Upper arch	edentulous patients with atrophic maxillae	yes	7 years
31.	Paulo Maló, *et al.*,	2011	242	Upper arch	edentulous maxilla	No	3 and 5 years
32.	Ole T. Jensen,*et al.*,	2012	10	Upper jaw	atrophic maxillae	Yes	1 year
33.	Paulo Malo, *et al.*,	2011	245	Lower jaw	edentulous mandibles	No	10 year
34.	Paulo Maló, *et al.*,	2005	32	Upper jaw	edentulous maxilla	Yes	1 year

Table. II. Surgical procedure:

Author	year	No. of patients	Seda-tion	Incis-ion	Implant length (mm)	Distal Implants Inclination (º)	Implant Survival Rates %	Type of restoration placed	Complica-tions.(if any)
Paulo Malo *et al.*,	2011	245	Yes	crestal	10-18	30	99.2	metal-ceramic implant-supported	Failure of implant occurred due to

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								fixed prosthesis with a titanium framework and all-ceramic crowns (Nobel-Procera titanium framework, NobelProcera crowns and Nobel Rondo pressed ceramics, all manufactured by Nobel Biocare)	Bisphosphonate therapy, hypertension, diabetes and smoking habits.
Paulo Malo *et al.*,	2005	32	yes	crestal	10-15	17 and 30	97.6	All-acrylic	The only mechanical complications recorded were fractures of prostheses in bruxing patients
Charles A. *et al.*,	2011	165	yes	flapless	10-18	17 and 30	92.2	milled titanium frame with a wrap-around heat-cured acrylic resin (Ivocap high-impact acrylic)	-
A.J. Arcas-Sanabre *et al.*,	2019	19	yes	crestal	10-18	30	93.75	porcelain fused to metal	-
Vaughan J. *et al.*,	2019	380	yes	crestal	10-18	15-45	95.5	All-acrylic	tooth fracture, loosening of prosthetic and abutments screws and replacement of denture teeth
Paulo Maló *et al.*,	2018	471	yes	crestal	7	45	96.9	metal ceramic implant-supported fixed	Implant failure, biological complications, smoking and the

								prosthesis with a titanium framework and all-ceramic crowns	presence of a systemic condition
Paulo Maló *et al.*,	2019	1072	yes	crestal	7-15	30-45	93.6	acrylic resin crowns	Implant infections, peri-implant disease,
Toru Maeda, *et al.*,	2019	09	yes	crestal	10-15	17-30	93.3	metal ceramic	-
Toru Maeda, *et al.*,	2018	14	yes	crestal	10-18	30	90.3	metal ceramic	-
Gabriele Tonellini *et al.*,	2018	07	yes	crestal	10-18	17-30	92.6	acrylic resin with titanium cylinders	-
Paulo S. Maló1) *et al.*,	2018	200	yes	crestal	7	45	97.3	metal ceramic implant-supported fixed dental prostheses with a titanium framework and all-ceramic crowns (Procera titanium framework, Procera crowns, Nobel Rondo ceramics, Nobel Biocare)	smoking status and presence of biological complications.
P. Malo´ *et al.*,	2018	83	yes	crestal	10-18	17-30	99.6	high-density acrylic resin and acrylic resin crowns	-
KR Spencer *et al.*,	2018	05	yes	crestal	10-18	45	90.4	acrylic resin with titanium cylinders	-
Hopp M *et al.*,	2017	891	yes	crestal	10-15	30-45	93.5	metal-acrylic prostheses with a titanium	Biological complications, namely

								framework (Procera) high-density acrylic resin (PalaXpress Ultra,) and acrylic resin crowns (Premium teeth),	infection,fistula, mucositis,peri-implant pathology, or abscess.
Keran Vas Ayub *et al.*,	2017	16	yes	crestal	13	15-45	97.2	Acrylic resin	Technical complication: tooth fracture, loosening of abutments or screws,
Man_u Van Weehaeghe *et al.*,	2017	20	yes	crestal	10-18	15-45	92.3	full-zirconia with a microlayer of porcelain (BruxZir) or milled cobalt-chromium with veneering porcelain (PFM)	-
Milena Hopp *et al.*,	2017	891	yes	crestal	10-18	30	99.2	metal-acrylic prostheses with a titanium framework (Procera) high-density acrylic resin (PalaXpress Ultra,) and acrylic resin crowns (Premium teeth),	Biological complications, namely infection,fistula, mucositis,peri-implant pathology, or abscess.
Sha Li, *et al.*,	2017	17	yes	flapless	10-18	45	90.3	high-precision CAM metal framework (Nobel Biocare) with a wrap-around heat-cured acrylic resin (Heraeus	Mechanical complications, involved with loosening of abutments or screws, fracture of abutments, framework

								Kulzer highimpact acrylic), as well as 12 acrylic resin teeth units (Heraeus Kulzer), or all-ceramic crown units (Procera Nobel Rondo ceramics).	
Hossein Najafi *et al.*,	2016	30	yes	crestal	10-18	15-45	96.5	The metal resin prosthesis	Mechanical complication was acrylic tooth chipping, abutment screw loosening, prosthetic screw loosening and prosthetic screw fracture.
Armando Lopes *et al.*,	2016	16	yes	flapless	10-18	17-30	89.4	metal-ceramic prosthesis with titanium framework and all-ceramic Zirconia crowns (Procera titanium framework, Procera crowns, and NobelRondo Ceramics; Nobel Biocare AB)	prosthetic fracture to abutment or prosthetic screw loosening, crown fracture, peri-implant pathology, abutment or prosthetic screw loosening.
Marco Tallarico *et al.*,	2015	40	yes	crestal	10-18	30-45	97.7	titanium or zirconia frameworks was screwed	veneering material fracture, screw loosening
Miguel de Araújo Nobre *et al.*,	2015	40	yes	crestal	10-18	45	99.2	metal-ceramic" implant-supported fixed prosthesis with titanium	Fracture of the immediate provisional acrylic prosthesis, abutment screw

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								framework (NobelProcera, Nobel Biocare AB) and all-ceramic crowns	loosening, and prosthetic screw loosening
Michal H.*et al.*,	2014	20	yes	crestal	10-18	30	98.4	Ceramo-metal restoration	bleeding, swelling, bruising, pain, and possible transient paraesthesia, Detachment of final prosthesis Fracture of provisional prosthesis, Fracture of final prosthesis.
P. Maló *et al.*,	2015	43	yes	crestal	10-18	15-30	90.3	high-density acrylic resin and acrylic resin crowns	prostheses fractures and abutment screw loosening).
Paulo Maló *et al.*,	2014	324	yes	crestal	10-18	17-30	97.8	metal ceramic implant-supported fixed dental prostheses with a titanium framework and all-ceramic crowns (Procera titanium framework, Procera crowns, Nobel Rondo ceramics, Nobel Biocare)	Implant infections, peri-implant disease
Paulo Malo *et al.*,	2014	110	yes	crestal	10-18	17-30	99.5	high-density acrylic resin and acrylic resin crowns	Fracture of provisional prosthesis, Fracture of final prosthesis.
Arman	2014	23	yes	flaple	10-18	15-45	96.3	metal-ceramic	prosthetic

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do Lopes, *et al.*,				ss				prosthesis with titanium framework and all-ceramic Zirconia crowns (Procera titanium framework,	fracture to abutment or prosthetic screw loosening, crown fracture, peri-implant pathology, abutment or prosthetic screw loosening
Arman do Lopes, *et al.*,	2014	27	yes	flaple ss	10-18	30	94.3	The metal resin prosthesis	prosthetic screw loosening, crown fracture, peri-implant pathology, abutment or prosthetic screw loosening
Hilde Browae ys, *et al.*,	2014	20	yes	flaple ss	10-18	30	92.4	Ceramo-metal restoration	prostheses fractures and abutment screw loosening
Paulo Maló *et al.*,	2013	152	yes	crestal	10-18	30	93.8	high-density acrylic resin and acrylic resin crowns	prostheses fractures and abutment screw loosening).
Paulo Maló, *et al.*,	2011	242	yes	crestal	10-18	45	99.1	acrylic resin crowns	Implant infections, peri-implant disease,
Ole T. Jensen, *et al.*,	2012	10	yes	crestal	10-18	15-45	92.9	titanium or zirconia frameworks was screwed	veneering material fracture, screw loosening
Paulo Malo, *et al.*,	2011	245	yes	crestal	10-18	30	96.2	metal ceramic implant-supported fixed prosthesis with a titanium framework and all-ceramic crowns	Implant failure, biological complications, smoking and the presence of a systemic condition
Paulo Maló, *et al.*,	2005	32	yes	crestal	10-18	30	99.2	All-acrylic	The only mechanical complications recorded were fractures of

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