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THE AMSJI® (ADDITIVELY MANUFACTURED SUBPERIOSTEAL JAW IMPLANT) IN THE TREATMENT OF EXTREME MAXILLARY ATROPHY

The AMSJI® is not available in the USA.

Subperiosteal implants were proposed by Dhal in 1941 [1] and spread in clinical practice in the 1950s and 1960s and were then abandoned due to the great development of osseointegrated implants and the high incidence of complications. The implants of that era were conceptually very different from those that can be built today using the most modern engineering techniques.

The impression techniques, the materials, the construction, and the design of the implants of the time were very different from the current ones. Patient Specific Implants (PSI) made with 3D printing techniques are nowadays used for the replacement of various parts of the human body in many fields of medicine.

The AMSJI® is a patient-specific implant (PSI) of the latest generation sub-periosteal type, it can be said that it is a "High-Tech Sub-Periosteal Implant", and is indicated for edentulous patients with an advanced degree of bone atrophy such as in Cawood and Howell classes V to VIII (Fig. 1). The AMSJI® allows rehabilitation with fixed prosthesis with immediate masticatory function. The AMSJI® implant represents a valid alternative to zygomatic implants and bone grafts in implant rehabilitation of maxillary atrophies.

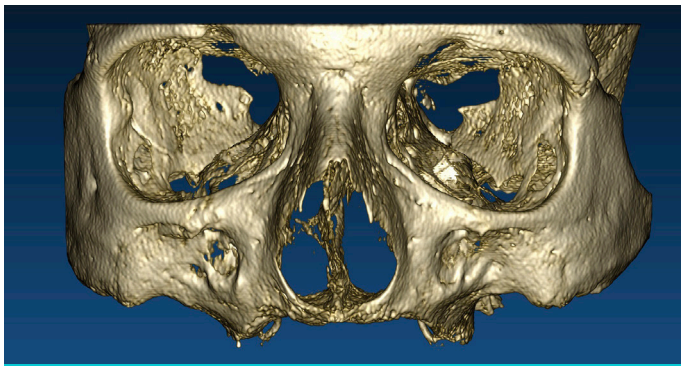


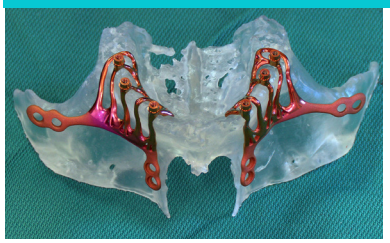
Figure 1. 3D CT image showing an advanced degree of bone atrophy. In these cases, implant rehabilitation is very difficult.

The AMSJI® System

Some clinical experiences of Prof. Maurice Y. Mommaerts with patient-specific titanium sub-periosteal zygomatic implants [2] made to treat oncological and post-traumatic cases represented the predecessors of the AMSJI® which was presented to the scientific literature with a first article published in the JOMFS in 2017 [3] which describes the original technique then followed by a second article which describes some evolutionary steps [4]. Since then, an international study group has met to share experiences, collect data and suggest changes to some details. In this way, the technique is continuously updated and improved both from the clinical point of view and from that of the construction technologies. For now, the AMSJI® is not available in the USA.

In the case of sub-periosteal implants, many micro and macroscopic details in design and construction can clearly differentiate the short- and long-term performances of very different products, united only by the common denomination of sub-periosteal implants. However, our experience with subperiosteal implants is limited to the AMSJI® and we have no direct experience with other systems.

Figure 2a. The two AMSJI® implants placed on the stereolithographic model of the maxilla.



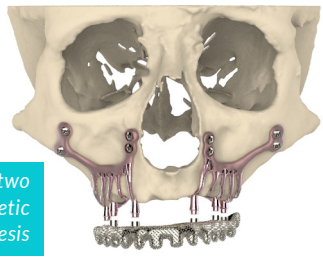


Figure 2b. 3D rendering of the two implants joined by the prosthetic structure of a hybrid prosthesis

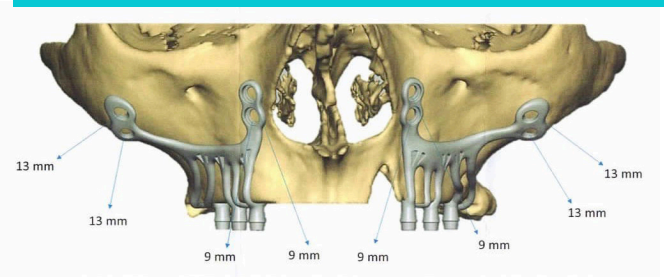
The AMSJI® system [5] consists of two right and left implants that are fixed to the maxillary bone and are joined together by the prosthetic structure (Fig. 2a, 2b). Each implant

Figure 3. Each AMSJI® implant consists of a mainframe from which extend two wings for fixation to the bone with osteosynthesis screws and three arms for prosthetic connection. The implants are made of titanium ELI 23.

consists of the mainframe from which two wings branch off with the fixation holes for the osteosynthesis screws and three arms with the prosthetic connections for the prosthetic structure (Fig. 3). Each arm is equipped with ramifications that allow the cutting and removal of a single arm in case of peri-implantitis, without having to remove the entire system.

The construction techniques use modern engineering technologies such as Topological Optimization which is a mathematical method that optimizes material layout for maximizing the performance of the system. A Finite Element Analysis (FEA) is used for every AMSJI® to match the elasticity of the AMSJI® to the underlying bone to avoid stress shielding and material failure due to an incorrect distribution of the forces. Topological Optimization and Finite Element Analysis guarantees resistance to cracks in the frame and at the same time resiliency with underlying bone.

Figure 4. Diagram of the location & length of the osteosynthesis screws.



AMSJI® implants are fixed to the zygomatic buttress and to the frame of the piriformis opening, these are stable bone areas that do not undergo significant resorption.

Figure 5. The components of the AMSJI® system: drills, screwdrivers and osteosynthesis screws; stereolithographic model; temporary prosthetic structure; two AMSJI® implants; provisional prostheses and incision guides; cement; final prosthetic structure: hybrid prosthesis; prosthetic screws. All components are sent to the surgeon.

The surgeon receives a diagram of the length of the screws to be used (Fig. 4). The AMSJI® system consists of the incision guide, the two subperiosteal implants, the temporary prosthetic structure, the temporary prosthesis, and the definitive prosthetic structure (Fig. 5). Even if different solutions are being studied that could allow you to have the definitive prosthesis made directly by your own dental laboratory by choosing the type of prosthetic connection.

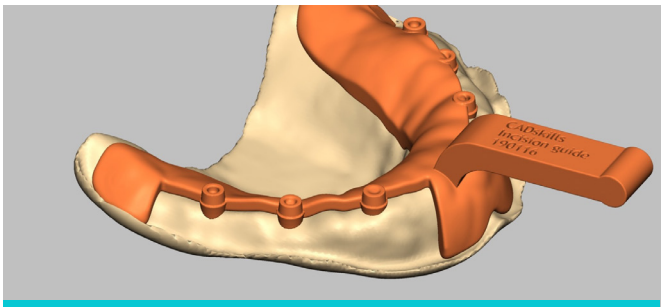


Figure 6. Incision guide: the crestal incision guide shows the position of the posts for connection with the prosthetic structure.

Surgery Technique

The surgery of positioning an AMSJI® [5] can be performed under local anesthesia or under general anesthesia depending on the different clinical situations. The incision guide (Fig. 6) is used to trace the incision at the gingival level; two types of incision guides are available: paracrestal and crestal. The seats of the posts for the prosthetic connection are indicated on the incision guide so that the surgeon can decide where to draw the incision line in relation to the position of the posts, around which the gingival flaps must be sutured. The operation continues with the exposure of the bone surface on which the AMSJI® will be placed, it is advisable, already in this phase, to perform periosteal incisions to lengthen the flaps. The two right and left AMSJI® implants are

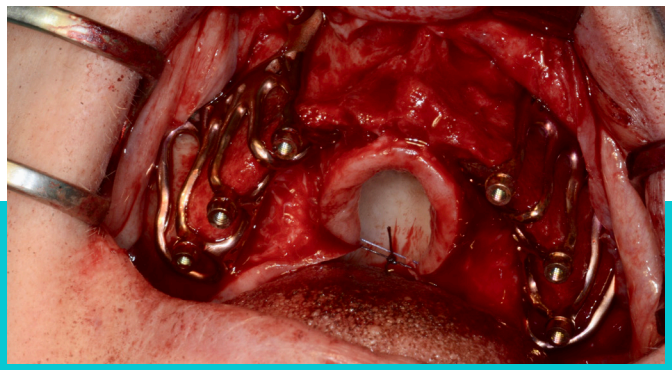
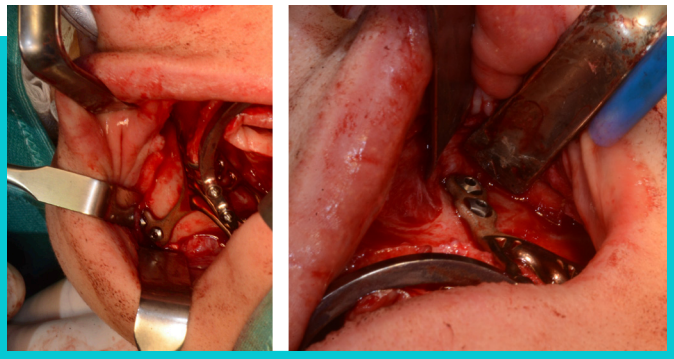


Figure 7. The two right and left AMSJI® implants are positioned on the bone surface. The perfect fit on the bone surface can be seen.



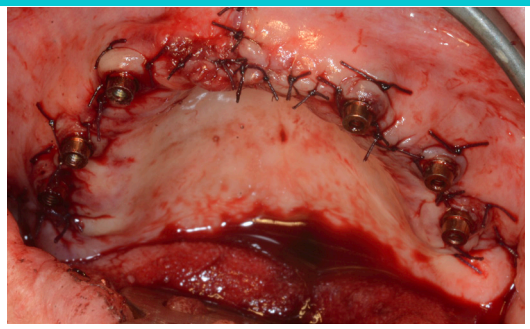
Figures 8a, 8b. Fixation of the implants with osteosynthesis screws: to the zygomatic buttress (a) and to the frame of the piriformis opening (b).

Figure 10. Final fixed screw-retained hybrid prosthesis.

positioned on the bone surface (Fig. 7) which must be freed from the presence of any soft tissue.

It is necessary to check that the implants are perfectly adherent to the bone and are stable. Small hammer taps with a metal ram can be used to find the perfect AMSJI® seat. At this point, the temporary prosthetic structure is screwed to the implants, and the temporary prosthesis is positioned. The patient is brought into centric occlusion and only at this point, after having re-checked the adherence of the implants to the bone surface, are the seats prepared and the osteosynthesis screws positioned. AMSJI® implants are fixed to the maxillary bone with 8 osteosynthesis screws to the zygomatic buttress and the frame of the piriformis opening (Fig. 8a, 8b). At this point of the surgery, the prosthetic structures are disassembled and the gingival flaps are carefully sutured with continuous or detached sutures and with mattress sutures around the posts (Fig. 9).

Figures 9a, 9b. The gingival flaps are carefully sutured with continuous or detached sutures and with mattress sutures around the posts (a). Tissue healing (b).



Absorbable sutures must be used because the prosthesis will not be removed for the first two months or so. At the end of the suturing, the prosthetic structure is screwed back on with a torque wrench, the temporary prosthesis is cemented to it, and occlusion is checked. After about two hours of surgery, the patient can use a fixed prosthesis and can already eat soft food. After about two months, the prosthesis and the temporary superstructure can be removed by unscrewing the occlusal screws and an impression is taken so that the dental laboratory can make the resin or PMMA coating of the definitive prosthetic structure that was sent with all the components of the AMSJI® system (Fig. 10).

Discussion

This type of high-tech subperiosteal implant has been the subject of scientific publications that have considered various aspects: the construction techniques [2,3], biomechanical resistance [6], bone remodeling after one year of loading [7], patient satisfaction [8, 9] and soft tissue response to AMSJI® implants [10]. Research continues and the products are continuously updated and improved, but the results obtained are already very satisfactory. For this reason, the AMSJI® technique can be a very interesting alternative to bone grafts and zygomatic implants.

The AMSJI® technique, when compared to bone grafts, appears to be less traumatic and above all allows immediate masticatory function. While reconstructions with autologous bone grafts require more invasive surgery to harvest bone from the iliac crest or calvaria. Furthermore, they require a long waiting time for the integration of the grafts and the osseointegration of the implants. A long time therefore during which the removable prosthesis must be used as little as possible in order not to load the bone grafts, this is perhaps the greatest discomfort reported by the patients we have treated with bone grafts.

Compared to zygomatic implants, the AMSJI® technique allows prosthetic rehabilitation in all degrees of bone atrophy, especially in extreme atrophies where the alveolar crest has completely disappeared [11]. In these extreme cases the zygoma-quad technique, which involves four zygomatic implants, is difficult to do. In fact, in these cases the zygomatic implants would result in having a position far inside the maxillary sinus or be too far away from the bone surface, exposing the patient to the risk of dehiscence at the soft tissue level. We remind you that the most frequent complications reported in the scientific literature of zygomatic implants are sinusitis and soft tissue dehiscences. One could hypothesize that the frequency of complications with zygomatic implants is related to the degree of bone atrophy.

The AMSJI® implant being a patient specific implant (PSI), is custom built to adapt to the patient's anatomy and can therefore be used when other techniques can no longer be used due to unfavorable bone morphology. A frequently encountered situation is that of having different degrees of atrophy alternating along the alveolar ridge. We can find defects in height with flattened bone and areas with knife-edge bone. This situation is frequently found when the teeth have been extracted at different times and when there are fixed prostheses on natural teeth coupled with removable prostheses, in terminal periodontal disease, in the case of cystic lesions that cause bone resorption, in traumas, and many other situations. These different degrees of bone resorption, irregularities in the bone surface, and knife-edge ridges are not conducive to the design of subperiosteal implants because they would force the construction of sharp subperiosteal structures which would favor dehiscence of the gingival tissue and exposure of the implant.

To standardize these different bone morphologies and make the bone more suitable for receiving an AMSJI®, we have developed a protocol [12] that uses cutting guides to reduce the bone in the vertical (VOG: vertical osteotomy guide) (Fig. 11) and horizontal (HOG: horizontal osteotomy guide) (Fig. 12) allowing to install, immediately after the osteotomies, the AMSJI® which was specifically built to rest on the osteotomies. The technique surgically anticipates the physiological post-extraction bone resorption (Fig. 13). The use of the VOG and HOG guides extends the use of the AMSJI® technique also to post-extraction cases and cases with inadequate bone morphology (Fig 14a, 14b, 14c).

Figure 11. Vertical osteotomy guide (VOG) with holes for the osteosynthesis screws. This cutting guide is used to perform the vertical osteotomy.

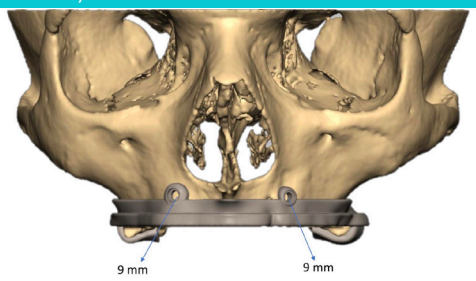


Figure 12. Horizontal osteotomy guide with holes for the screws. This guide is used to perform the horizontal reshaping.

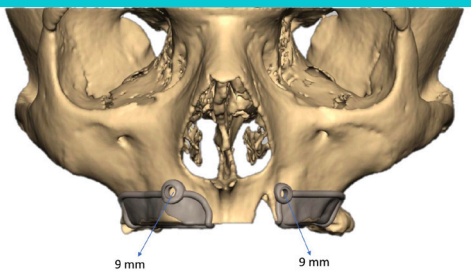
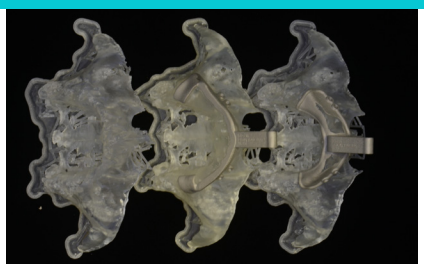
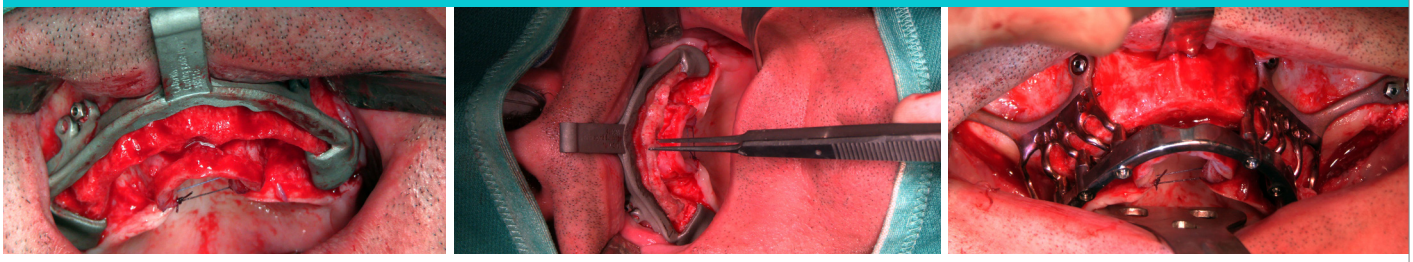


Figure 13. VOG & HOG protocol. Stereolithographic models, from left to right: original bone, VOG and bone after the vertical osteotomy, HOG and bone after horizontal osteotomy.



Figures 14a, 14b, 14c. Use of cutting guides. Vertical osteotomy guide (VOG) fixed to the bone with osteosynthesis screws (a). Removal of the alveolar bone crest after vertical osteotomy (b). The implants fit perfectly to the maxillary bone after the osteotomies (c).



A final consideration: there is a lot of talk about the long-term success rates of zygomatic implantology, but it would also be legitimate to ask what will happen next, after many years of using the implants, when will they have to be removed? Patients will have become elderly, may have developed some morbidity, and will still be forced to undergo surgery to remove the zygomatic implants. The removal of zygomatic implants could be difficult exposing the patient to the risk of oro-antral communications, bone fractures, and requiring a FESS due to frequent sinusitis [13]. In the need to remove an AMSJI, the operation will be simpler, and the patient will find himself as he was before.

Marco Rinaldi, MD, DMD

Dr. Rinaldi has developed a specific experience in Reconstructive Surgery, using 3D Technologies. He has contributed to international studies and research on Computer Guided Implantology and Stereolithographic Models.

He is a past president of the Computer Aided Implantology Academy (CAI Academy), director for Italy of Computer Aided Implantology Academy, a past president of SimPlant Academy Italy, an active member of IADDM, an active member of Italian Society of Oral Surgery (SIdCO), a life member of Academy of Osseointegration (AO), an honorary member of CAI Academy and the Italian Society of Zygomatic and Pterygoid Implantology (SITIZIP). Dr. Rinaldi is a member of the editorial board of several scientific magazines and teaches at the University Masters in various universities.

As an international speaker, Dr. Rinaldi has taken an active part in national and international courses, seminars, and congresses. He is the author of a large number of scientific publications and of some books including: “Computer Guided Applications for Dental Implants, Bone Graft and Reconstructive Surgery” published by Elsevier U.S.A. in 2016 and translated into Spanish and Chinese. Editor of “Implants and Oral Rehabilitation of the Atrophic Maxilla-Advanced Techniques and Technologies” published by Springer in 2023.

Dr. Rinaldi works as an Oral Surgeon in Bologna, at Clinica Privata Villalba GVM Care & Research, and in his dental clinic.

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