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*Review*

# Minimally invasive rehabilitation with total removable implants supported prosthesis with conometric connection

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DISCLOSURE: **ALL AUTHORS REPORT NO CONFLICTS OF INTEREST RELEVANT TO THIS ARTICLE.**

## ABSTRACT

**Since its inception, modern dentistry has been a discipline in continuous evolution. Thanks to this progress, the prosthetic rehabilitation of the edentulous patient can now be effectively addressed by multiple therapeutic approaches rooted in the decision-making marriage between patient and clinician in both partial and total edentulous patients. From a historical perspective, the aesthetic-functional restoration of the completely edentulous maxillary arch has been subverted in the possibilities of intervention by the introduction of implantology, which has made it possible to overcome the otherwise mandatory use of removable devices with complete mucous support (1). The current study is intended to be an example of this evolution by describing one out of five clinical cases performed. Furthermore, it is intended to demonstrate how the newly proposed implant-prosthetic techniques, where a fixed implant rehabilitation is not possible due to age constraints, lack of bone support or unfavourable mechanical-aesthetics parameters, allow the rehabilitation of the upper total edentulous jaw with a removable device without a solidarizing intermediate bar to rely upon for the implants. The implants and the whole rehabilitation are, however, consolidated thanks to the stability provided by the presence of a telescopic connection, combining viable long-term survival (2) with optimal results for the patient in terms of cost (3), comfort, chewing capability (4), aesthetics and home hygiene.**

## INTRODUCTION

The therapeutic possibilities for the implant-prosthetic rehabilitation of the oral cavity afflicted by total edentulism can be primarily distinguished in relation to the possibility of removal, both by the patient and by the doctor, of the strictly prosthetic component constituting the rehabilitation.

According to reports by Misch (5) in 1990, there are five categories of implant-prosthetic rehabilitation for fully edentulous arches, three fixed and two removable; the distinction between the two removable options is mainly related to the fact that the support can either be based entirely on dental implants (RP-4) or be the combination of an implant-mucous one (RP-5).

According to the literature (6), the choice to carry out a removable implant-prosthetic rehabilitation may be justified by multiple reasons. Among these, the reduced cost offered by these treatment plans compared to the fixed counterparty, often resulting from a reduced implant demand, is very important for decision-making. Indeed, the implants are frequently placed in the anterior maxillary region, and the posterior region is supported by the combination of a cantilever element with mucous support, thus making it less pressing to perform higher bone additive procedures since the anterior bone resorption is, in general, less marked.

Other advantages attributable to a removable prosthesis on implants lie in the possibility of making up for soft tissue deficiency (7, 8), the best home hygiene that the patient can put in place, the possibility of removing the prosthesis at night to mitigate the effects of a possible parafunctional habit and the ease of repair, given the possibility of delivering the artefact to the dental laboratory.

While conducting a cost-benefit analysis of prosthetic rehabilitation, the clinician must assess the degree of atrophy and the patient's age (9). Regarding the degree of atrophy, one of the most appreciated classifications in the literature, that of Misch & Judy (10), published in 1987, notes the existence of a biomechanical relationship between the residual crestal bone amplitude and the maximum inclination of the dental implant with respect to the bone base, such that when the values of crestal amplitude are less than 5mm the inclination

as mentioned above should not exceed 20 degrees. In these scenarios, the therapeutic will to guarantee, through a full-mouth fixed bridge, adequate home hygiene and satisfying aesthetic contrasts with the implant biomechanics and, therefore, the needle of the balance "cost-effectiveness" tends towards a removable implant-prosthetic rehabilitation.

When it comes to the removable implant-supported rehabilitation of the completely edentulous upper arch, it is common to find in the literature (6, 10-13) that a device with a "bar" retention system with solidarized implants is superior on both the mechanical and hygienic-prognostic planes compared to other types of connections on non-solidarized dental implants (14, 15). From a combined clinical and biomechanical perspective, the magnitude of the stabilization mentioned above derives, at least partly, from the type of connection chosen. The literature (16, 17) reports a greater ability to withstand functional loads for "locator" attachments and bar-supported solutions when compared to "ball" attachments.

The literature is not so rich regarding "telescopic" or "conometric" connections; however, it is sufficient for some considerations. It is reported that the connections guarantee greater stability and rigidity than others (18) and allow the distribution of masticatory forces comparable to that obtainable with a bar, albeit with some differences (19); furthermore, one must consider that the literature has not come to a clear conclusion when considering the marginal bone loss as the effect of the overload applied on fully osseointegrated implants (20). The mechanical advantage of these connections is attributed (21) to the intimate circumferential contact between the components, resulting in the reduction of rotational torque generated by applying any masticatory load.

Considering the statements mentioned above, this study aims to report the possibility of performing an implant-prosthetic rehabilitation of the maxillary district through a telescopic connection without a "bar" superstructure, granting hygienic and economic benefits without mechanical or prognostic sacrifice.

In order to give scientific support to the therapeutic option proposed in the current paper, a search has been conducted on the bibliographic search engines PubMed and Scopus to identify similar publications, which allowed a broader spectrum of considerations than the ones directly inherited by the individual sample reported by the authors and which could therefore support the scientific rationale of the therapeutic plan.

*Case study*

The case involves an adult male patient (74 years) with a medical history positive for hypertension, which is reported to be pharmacologically compensated at the time of treatment. The patient, who has a total edentulous upper arch, has requested a prosthetic rehabilitation of this sector through an implant-prosthetic treatment, not bearing the possibility of a completely mucous-supported prosthesis.

Following the case study, carried out through gipsographic models, radiographic examinations and objective evaluation of the oral cavity, the therapeutic possibilities individualized for the specific case were illustrated. Given the massive bone atrophy and unfavourable aesthetic-prosthetic parameters when a fixed implant-supported device was considered, a removable prosthesis with telescopic connection on implants placed in the 1.3, 1.2, 2.2 and 2.3 sites was theorized.

From the subsequent comparison with the patient, it was decided to proceed with the therapy, given the criteria set out in the previous section and the lowest cost of the whole treatment plan. Therefore, the treatment plan was carried out with the placement of the dental implants, of size and diameter commensurate with bone availability and biomechanical aspects (14, 22), in the planned sites and, after waiting an adequate time for osteointegration to happen, with the positioning of the relative implant connection abutments. Then, the removable prosthetic device, coupled through a telescopic connection, was manufactured on those supports.

## MATERIALS AND METHODS

The preparation of the patient involved obtaining the preliminary analogue-digital documentation, consisting of initial photos (analysis of chewing - exposure of the smile - general aesthetics of the patient), study models and computed tomography to define bone availability. A radiological-surgical-prosthetic template was then commissioned to the dental laboratory, through which the position chosen for the dental implant was radiologically and prosthetically verified before the surgery (Fig. 1, 2).

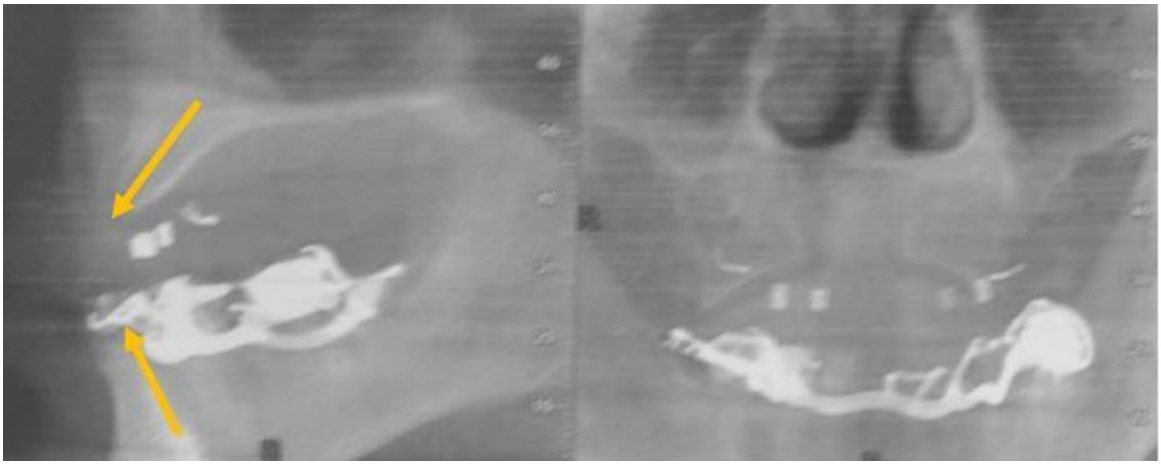

**Fig. 1.** *Implant-prosthetic project by cone beam computerized tomography.*

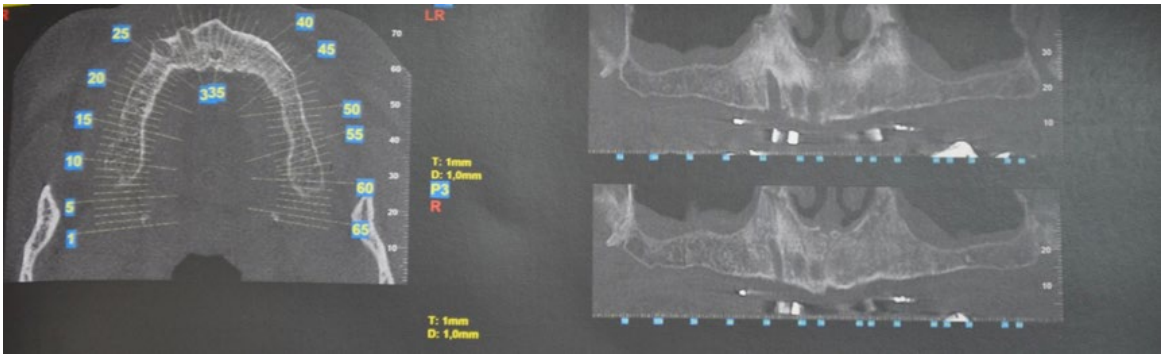


**Fig. 2.** *Pre-implant surgery orthopantomography.*

Then, we proceeded with the surgical phase. Firstly, perioral skin disinfection (Povidone Iodine 10%) was associated with Vaseline to moisten the tissues, and local anaesthesia followed. The gingival surface was then treated with a topical anaesthetic (Lidocaine + cetrimonium bromide 15 %), and plexal anaesthesia was inoculated both at the level of the upper vestibular fornix microcirculation and in the palate (Articaine 4% + adrenaline 1/200,000).

Secondly, an oblique incision of the tissues at the vestibular paracrestal level was made with full-thickness tissue cleavage palatally and narrowly at the vestibular level (scalpel 12C). The total bone exposure made it possible to trace the reference points determined by the positioning of the radiological-surgical-prosthetic template and the consequent execution of exploratory milling using “lanceolate” milling (1.9 mm) at 5mm in the predetermined sites 1.3-1.2-2.2-2.3.

After a clinical examination of bone density (D3 classification of Misch (5)) with an implant probe, the first milling (2.2mm) was performed at 5mm and then completed, radiologically verified the inclination, up to 13 mm in sites 1.2-2.2 and up to 11 mm in sites 1.3-2.3. A second milling for 5mm (diameter 2.8 mm) and a third

milling (diameter 3.3 mm) was subsequently carried out for 3mm to prevent excessive bone pressure by the implant element during insertion, favoring the primary osteogenesis but also ensuring implant stability. Four implants (titanium 5 HRS surface) were inserted, with a diameter of 3,75 mm and a length of 12 mm in the 1.2 and 2.2 locations, and a diameter of 3,75 mm and a length of 10 mm in the 1.3 and 2.3 locations, up to 1 mm below the bone ridge, favoring prosthetic aesthetics (23).

Following the insertion of the cap screw on each implant, a check orthopantomography was performed to verify the operation's success. Next, the flap was carefully sutured using a closing flap through single intrapapillary stitches in positions 1.4-2.4 and a horizontal mattress crossed between the vestibular and palatal front portions.

This method, the wrapping of the suture in the vestibular paracrestal position obtained from the initial incision mode, has decreased the risk of infection of the implant stumps since the incision and the consequential suture are both laterally placed to the insertion site (glycolic acid absorbable suture).

The patient was discharged following pharmacological indications, antibiotic bactericidal and anti-inflammatory (amoxicillin with clavulanic acid 1gr every 8 hours for six days and paracetamol with codeine 500mg + 30mg when needed), associated with post-surgical indications, indications to hygiene and, for the first month, to a soft diet. The patient was finally given the temporary, pre-packaged, mobile prosthesis with light silicone relining, adapting the occlusion to the lower arch. Three weeks later, the sutures were removed, and a monthly radiographic check was carried out for a quarter. We proceed with the radiographic control three months after the surgery to assess osseointegration (Fig. 3).

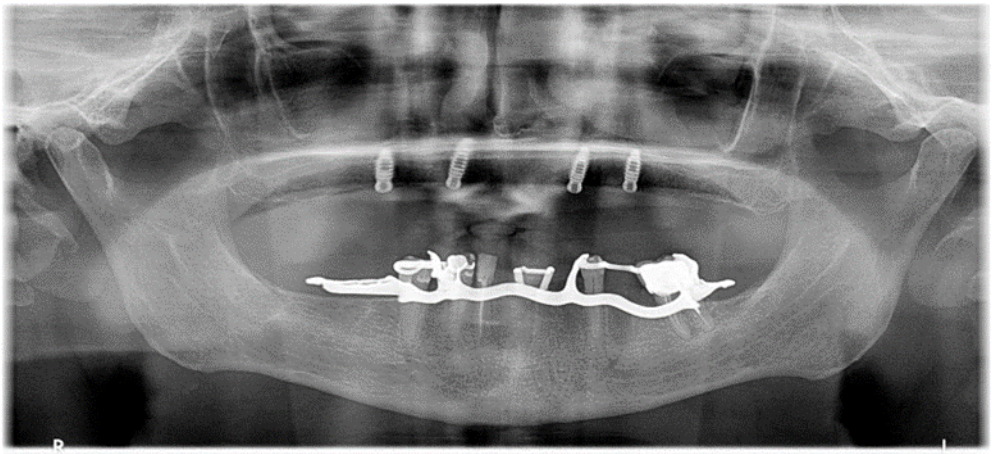

**Fig. 3.** *Post-implant surgery orthopantomography.*

The optimal results in the radiogram made it possible to proceed with the second surgical phase of implant uncovering to start the prosthetic rehabilitation. In this phase, about a quarter from the previous one, we proceeded with the same procedure of disinfection and anesthesiology, as reported above. We then drew a flap characterized by an oblique paracrestal palatal incision with partial thickness cleavage vestibular and full thickness palatally (scalpel 12C). This incision increased the volume of vestibular tissues, the simultaneous exposure of the smooth peri-implant collar and the subsequent placement of healing screws (Fig. 4).

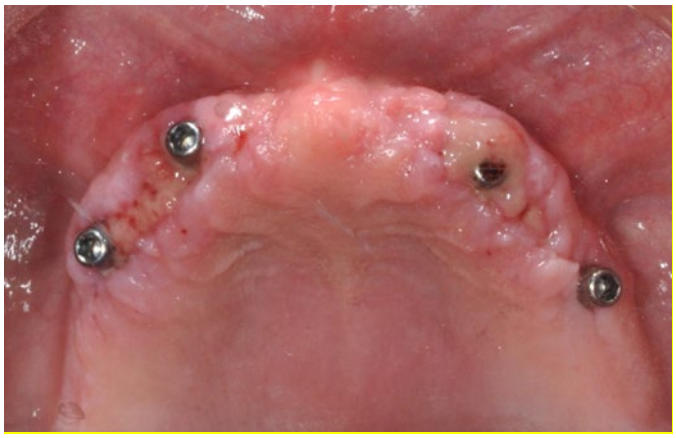

**Fig. 4.** *Mucosa during implant activation.*

Once the necessary healing screws were placed, the suture (glycolic acid absorbable suture) and the readaptation of the temporary mobile prosthesis were performed. Finally, the photographic documentation was updated, and an alginate impression was taken to create an individual impression holder before the surgical phase mentioned above.

Once the time of the healing of the perimplant tissues had elapsed, the treatment plan was continued with the taking of a first analogic precision mucostatic impression (polysulfide) necessary for the realization of the removable prosthesis. In the same session, a second precision analogic impression was performed (polysilicon) using transfers to determine the correct position of the implant pillars. With this information, the intermediate supports necessary for the subsequent screwing of the primary telescopic abutment (standard length 4.3mm and standard angle 5 of the patient) were chosen, relying on the gum volume at the intraoral level and the parallelism between primary stumps at the extraoral level on dedicated models (Fig. 5).

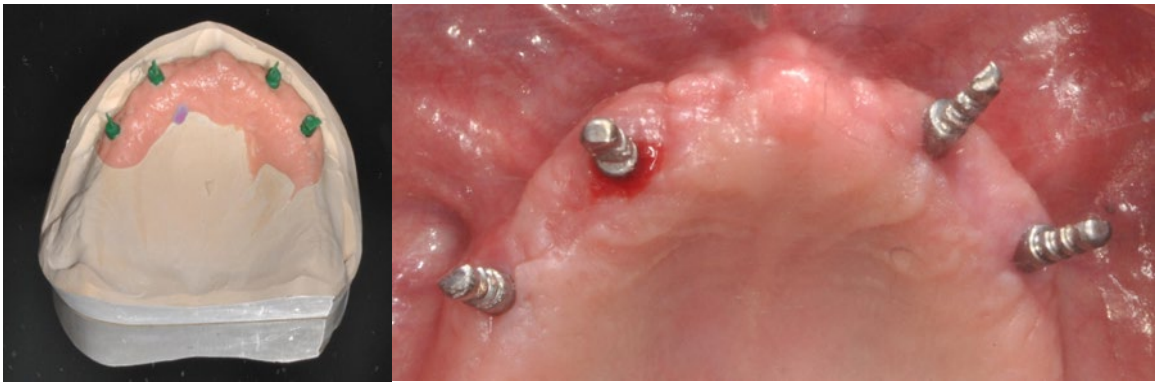

**Fig. 5.** *Implant position evaluation.*

Specifically, an intermediate support of length 1.5mm with an inclination of 25° was placed in position 1.3; in seat 1.2, the length was 5mm with an inclination of 15°; in site 2.2 length was 5mm with an inclination of 35° and in seat 2.3 length was 3mm with an inclination of 25° (Fig. 6, 7).

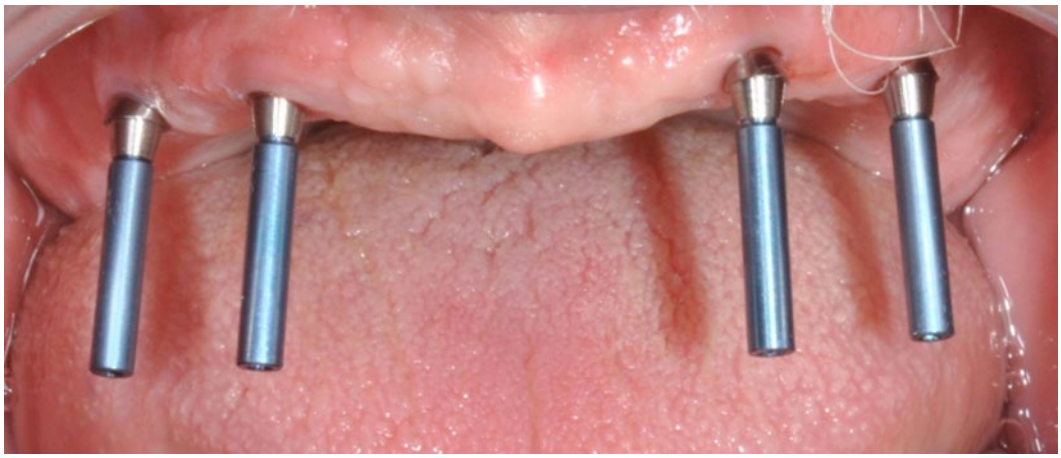

**Fig. 6.** *Intermediate supports for screwing the telescopic primary stumps.*

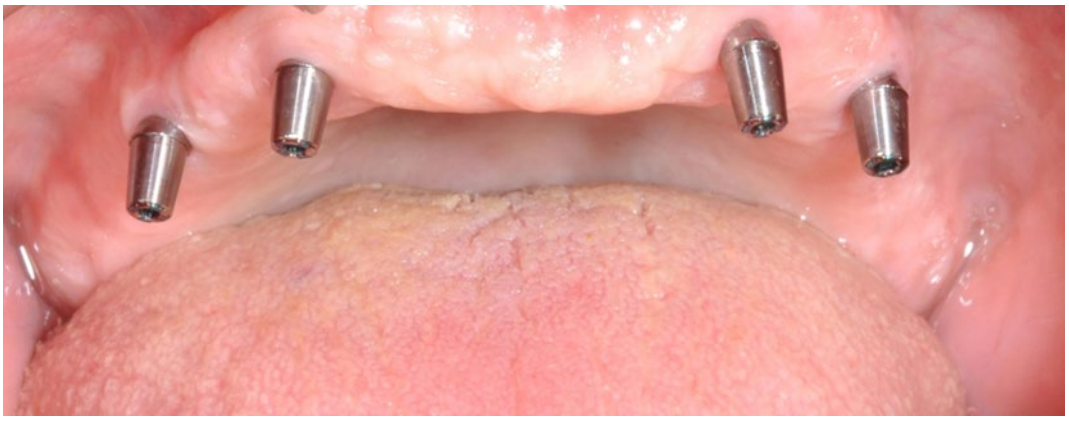

**Fig. 7.** *The telescopic primary stumps.*

In the following sessions, we realized the prosthesis through the test of the wax rims, placed on the provisional prosthetic flange, and thus detecting the vertical dimension, the correct model of occlusion, through precise mastication on dedicated auxiliary wax, and the interdental midline related to the tip of the nose and chin.

The tooth test was then performed, first in the front and then in the rear (Fig. 8, 9); the prosthesis was also subjected to a chewing control, in which we assured that while performing lateral excursions and protrusions, there were not too many tangential stresses (Fig. 10).

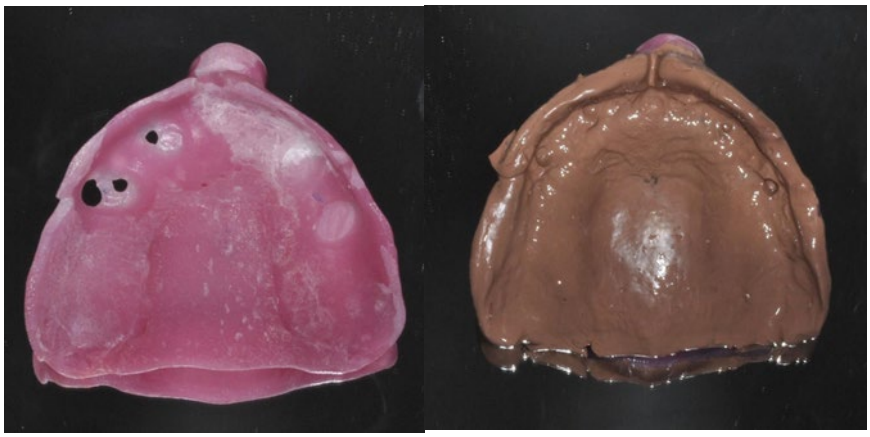

**Fig. 8.** *Accurate impression in order to produce a removable prothesis.*

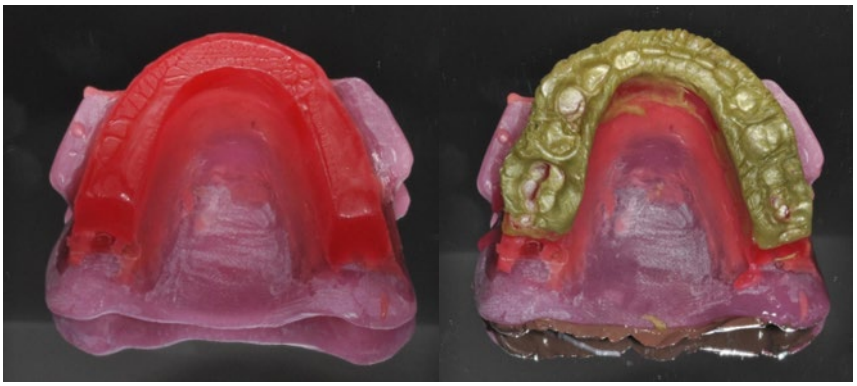

**Fig. 9.** *Structure test - vertical dimension evaluation - chewing test.*

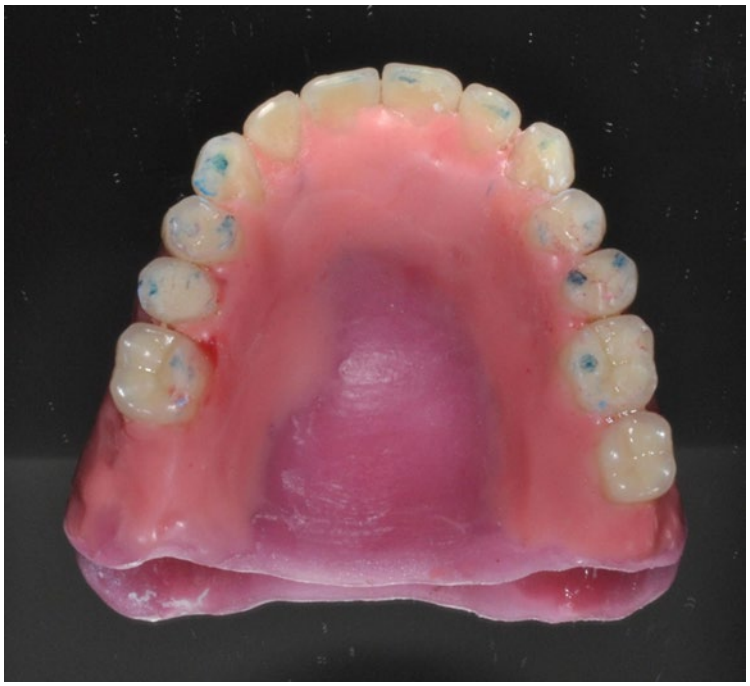

**Fig. 10.** *Chewing test.*

In the same session, a phonetic test was also carried out, associated with a further aesthetic evaluation by a family member. As a final step, the palatal coverage was removed from the prosthesis, and an alloy reinforcement grid (chromium-cobalt) was incorporated at the dental laboratory.

Finally, at the time of delivery, four secondary telescopic crowns in peek (Standard length 4.3mm and standard angle 5,6 mm) have been inserted into the final removable prosthesis using a direct relining (polymethyl methacrylate). Those were calibrated for the primary telescopic abutments of the implant elements 1.3-1.2-2.2-2.3 and were necessary to determine the telescopic anchorage on the implant elements of the said prosthesis (Fig. 11-13).

**Fig. 11.** *Peek® secondary telescopic crowns.*

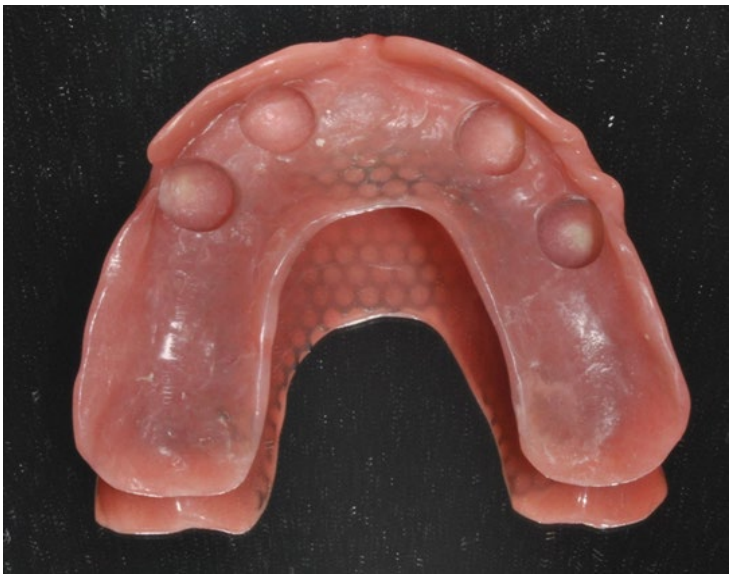

**Fig. 12.** *Peek® secondary telescopic crowns insertion.*

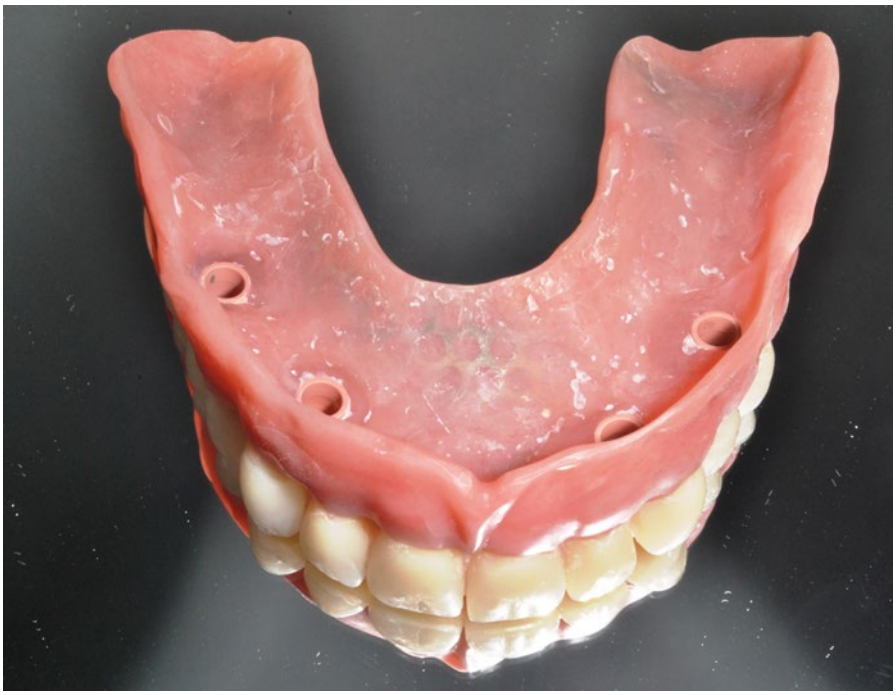

**Fig. 13.** *Removable prothesis.*

After approximately one month, the patient was reviewed for the execution of an indirect relining through the support of the dental laboratory updating, in the same session, the photographic documentation and verifying the positive course of rehabilitation (Fig. 14).

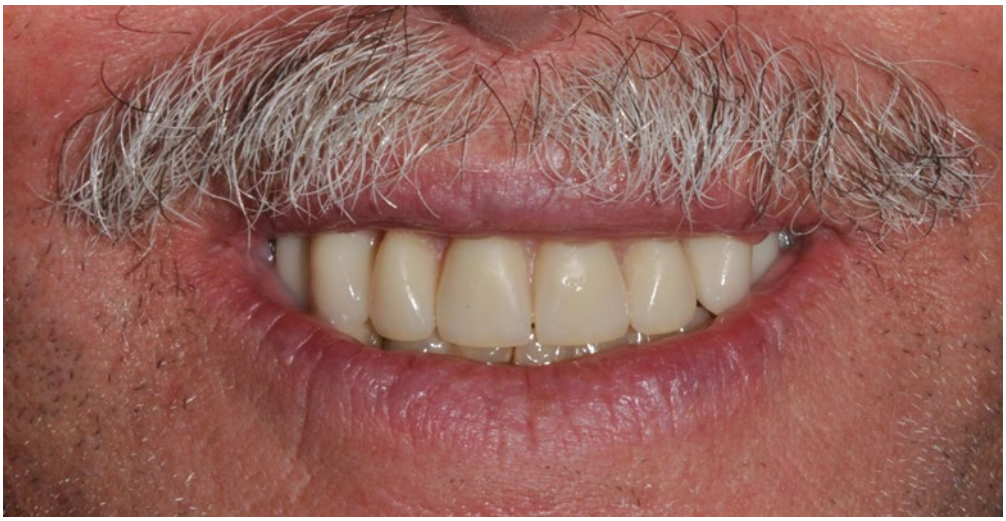

**Fig. 14.** *Smile.*

In order to perform a comparison of the proposed rehabilitation protocol with other similar publications, a search has been carried out on the search engines PubMed and Scopus, using as a query the following string:' ("Telescopic" or "Conometric" or "Milled bar") AND ("Overdentures" or "implant-supported prosthesis" or "Dental Bridge" or "Removable prosthesis") AND "Dental Implants"'. The titles and abstracts of the 93 individual results were then analyzed to make a further selection of the comparative studies, and the three independent revisors involved selected a preliminary total of 4 publications.

Only one article (15) was found to be suitable for comparison since it included removable telescopic-coupled overdentures, among other types of connections, supported by more than 4 implants in treating patients with edentulous upper jaws.

## RESULTS

At the end of the first trimester, the first clinical inspection checked the stability of the implants, the intermediate prosthetic components and the gum tissue structure and professional oral hygiene were performed. After delivery, the second clinical and radiographic check was carried out to analyze the stability of the implants, the intermediate prosthetic components and the gum-tissue structure.

In both measurements, the stability of the implants, prosthetic components, and gingival-tissue structure was optimal, accompanied, in the second examination, by the radiographic evidence of complete osseointegration. Therefore, professional oral hygiene was carried out every four months for the first year, ensuring gum health of the mucous channels and making the patient aware of the importance of such attention to achieve an optimal duration of the prosthetic rehabilitation.

## DISCUSSION

Dentistry is a medical discipline that requires a certain amount of therapeutic flexibility on the part of the practitioner: no protocol allows all clinical cases to be successfully concluded, but all clinical cases can be fully satisfied by the correct choice of a treatment plan (24).

A further aspect of peculiarity, which constitutes the foundation of modern medicine, is the continuous evolution of therapeutic methods, where what was generally considered not optimal in the past can be, to date, thanks to technical progress, considered the best desirable treatment for a specific patient (25).

A clear example of the importance of adapting the prosthetic treatment plan to the patient's needs using new therapeutic algorithms has already been reported by Zanotti and colleagues in the minimally invasive telescopic prosthetic restorations (26). The concept is further evidenced by the reported clinical cases, in which the need to converge objectives on the appropriate levels of stability, aesthetics and durability of rehabilitation sought by the clinician with the patient's expectations, existing both clinically and economically, has imposed an innovative approach to the total removable prosthetic rehabilitation of the upper jaw, denying the poor predictability that is attributed in the literature to IODs (27, 28) (maxillary implant-supported overdentures).

The rehabilitation method adopted, assuming as a requirement the adequate availability of bone in the premaxilla, has allowed the placement of the implants in the optimal locations for the realization of a removable prosthesis with mixed implant-mucous support and thus allowed to reduce costs and discomfort for the patient compared to fixed alternatives, which would have required surgical bone augmentation procedures.

The contextual design of a telescopic device based on mixed support, as opposed (29, 30) to the ones solidarized by bars or other types of connections, has further contained costs without sacrificing stability and prognosis, in line with the assertions in the previous sections. Furthermore, an advantage obtained, thanks to the prosthetic-implant design proposed, further than those mentioned above, consists in the possibility to reduce the prosthetic flange on the vestibular side and eliminate the palatal component, thanks to the convergence of the coronal prosthetic component to the implant support resulting from the absence of a rigid superstructure.

Eliminating the palatine component improves patient comfort since many phonemes are produced by addressing the tip of the tongue to the premaxilla, and the presence of clutter is often referred to as an obstruction to the phonation (31). At the same time, the reduction of the vestibular flange made the rehabilitation more appealing aesthetically, in compliance with the perioral musculature.

There is no clear evidence that implant solidarization employing a bar is favourable for the survival of the rehabilitation, where the possible advantage of its use as a better compensation of the tangential forces in a phase of disengagement of the device in the case of non-aligned implants in patients with marked modification of the original arch shape, would not have been significative in the specific patient analyzed.

What emerges clearly from the literature (31, 32) is the strong influence that the "hygienic potential" conferred by the prosthetic design has on peri-implant disease. For example, Serino (31) reports that in 48% of the samples analyzed, peri-implantitis was associated with poor prosthesis hygiene and that this parameter had predictive power for the onset of the pathology for 82%. The authors, therefore, consider, in the light of the above literary data and based on their clinical experience, that they can summarize the advantages of the treatment solution adopted as follows.

The first aspect is the possibility of rehabilitating an elderly edentulous patient if the initial bone volume does not allow the realization of a fixed implant-supported prosthesis without performing regenerative surgery, with low costs compared to bars and comparable costs to alternative couplings. The second advantage is that compared to the aforementioned alternative couplings, namely 'Interlock' and "ball" attachments, the wear of the structural components seems to be lower, while the hygienic potential of the device is kept extremely high. The clinician should also note that telescopy is an approach that makes extreme precision its pivotal point and therefore requires meticulous accuracy in all its steps, which from a certain point of view, can be a disadvantage;

Secondly, telescopic systems tend to show a more significant number of mechanical complications during maintenance. However, it should be noted that in the literature, this data is discordant (33, 34), and, in the scenario of those happening, they are fully manageable on a regular ambulatorial recall.

## CONCLUSIONS

In the reported scenarios, the chosen therapeutic plan made it possible to achieve optimal and stable clinical results, giving a hopeful demonstration of the importance of critically interpreting the consolidated prosthetic dictates resulting from empirical experience. The authors also consider it necessary to stress that, in addition to the obvious advantages in economic terms and invasiveness compared to fixed or bar-supported counterparts, the approach adopted, that is, the use of a removable device without a fixed superstructure has allowed for improved hygiene at home, which is by no means secondary to the incidence of peri-implant disease (32, 33, 34).

In order to document the difficulty of comparing the therapeutic approach described therein with statistical data available in the literature, a recent systematic review is considered, published by Kern et. Al (35). The work has shown that the factors influencing the clinical success of implant-prosthetic rehabilitation are many. In general, fixed rehabilitations have a greater survival rate than the removable alternatives; that is why the latter would be preferable under idealistic conditions. However, the same publication also reports the impossibility of making a direct comparison between the implant's survival rate obtainable with "ball" attachments and telescopic connections rather than between "bar" structures and telescopic connections since the number of studies available is very limited.

It is therefore considered, in agreement with the literature, plausible to conclude that, although within the limitations of the experiential sample considered, the total removable prosthesis with telescopic connections may constitute a therapeutically and prognostically comparable alternative (36), if not even superior in terms of peri-implant soft tissues health (37), to bar retained IODs in cases where, due to medical, clinical or economic reasons, fixed rehabilitation loses absolute value; while adopting this approach the clinician should, however, consider the possibility of encountering a slightly higher number of mechanical complications during maintenance visits: this statement is based on literary data (15), given the already mentioned timespan and sample limitations of this study.

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