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Current knowledge of prosthetic rehabilitation using implants: aliterature review

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Abstract

This study proposes a brief literature review on the current condition of implant dentistry with regard to rehabilitation of prosthetic osseo integrated implants. At this stage, manufacturers of implants and prosthetic components have provided a number of innovative options for dental surgeons with promises of high performance and predictability. However, it is known that the established concepts and biological conditions such asosseo integration parameters, surface treatment, implant design, and early and immediate loading are difficult to be changed. This scientific basis is increasingly necessary for the update of professionals who are active in the academic or clinical areas in order to provide the best quality of treatment to patients and consequent quality of life.

Summary of pertinent research

The need to replace missing teeth with the purpose of reestablishing proper dental function has been a common concern since the earliest civilizations. One option which has been tested throughout history is dental implants. Several metal alloys and surgical methods, and different types of implants(i.e., needle, bone-supported, blade implant) have been tested with little success [1-3]. During the1960s and1970s, Swedish physician Per Ingvar Bränemark published the results of his research showing the osseo integration of titanium implants and established the principles of their use in dentistry, reason why he is known as "the father of implant dentistry" [3,4] Initially, Ingvar's contemporaries within the Swedish dental community were skeptical of his work. This, however, may have ultimately contributed to the success of modern dental implants. Onecon sequence of this skepticism was the development of strict laboratory and clinical research parameters (i.e., the Bränemark protocols). Therefore, when the global dental scientific community was introduced to Bränemark's research, it had already been verified with clinical and longitudinal monitoring, material-related protocols, components, surgical and prosthetic techniques [5].

Using his work as a foundation, other scientists have tried to innovate dental implants by investigating the use of new implant materials, new implant designs, new external treatments, and novel surgical techniques [6,7]. Many also attempted to understand patient's systemic conditions, thereby hoping to reduce osseointegration time and extend the clinical application of implants without reducing the benchmarked success rate of the Bränemark protocols.

With regard to prosthetics, the successful translation of previously established knowledge into functional dental prostheses has been rapidly investigated. The main research focused on establishing protocols that would develop the ideal prosthetic plan for each clinical case [1,2,8,9]. Thus, studies on the rehabilitation of partially edentulous patients, using single and multiple prostheses, as well as the development of over dentures attached to the implant, were being developed [1,2,10,11]. Research emerged in the following areas: cemented prostheses, retention and connection of the prostheses to implants, development of new prosthetic abutments, biomechanical studies, tooth and implant connections, force distribution in patients wear ingre movable prostheses, studies of implant materials, and application of previous clinical and laboratorial techniques only used in conventional prostheses [12]. Special attention was given to occlusal aspects since the prosthesis attached to the implant transmitted compressive and shear occlusal forces to the bone when contrasted tothe tooth traction force, which transferred to the bone in a healthy occlusion [13,14].

The development and spreading of new techniques and commercial brands have made dental implants increasingly more affordable, which are often included in prosthetic planning. On the other hand, the range of possible applications of this treatment, even without scientific support, and the false sense of success despite correct surgical and prosthetic planning, has increased failures in this form of treatment [8]. The scientific community has been making an effort to determine the safety limits as to what extent dental implants may be used to attach dental prostheses and maintain a high success rate of this treatment.

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Therapeutic approach

Indications

One step in rehabilitation using prostheses is the understanding of the differences among a range of treatment options using implants and conventional dental rehabilitation. When properly planned, both types of fixed prostheses (i.e., on the tooth or an implant) have excellent success rates and prognoses, either for fully removable or partially removable prostheses [15]. For this reason, success rate cannot be the only variable considered when deciding whether to replace an endodontically treated tooth with an implant—generally speaking, preserving the tooth with the attached periodontal ligament is always the preferred method [16,17]. However, in order to replace a missing tooth, local and systemic conditions must allow for sufficient potential benefit to the patient; the best treatment option is an implant-attached prosthesis [18].

With regard to adhesive prostheses, despite its superiority in preserving the dental structure compared to conventional fixed prostheses, they had lower associated success rates than restoring edentulous spaces with prostheses attached to implants and even conventional fixed bridges [15,16]. Adhesive prostheses should only be used as a secondary option in clinical situations where there is greater cost/benefit for patients with socioeconomic challenges.

The complication types also differ among prostheses. Based on a short-term analysis (two years), dental prostheses appear to have had better success rates [19]. Any problems associated with the prosthesis biomechanics may be mitigated by the periodontal ligament. However, due to the lack of complications associated with prosthetic implants (e.g., tooth decay, endodontic treatment, and dental sensitivity) the number of long-term complications associated with a tooth-fixed prosthesis was higher than those associated with a implant-fixed prosthesis [20]. Additionally, Albrektss on et al. (2012) found that technical complications occur more frequently with fixed prostheses than with single prostheses, thus proving that fixed prosthesis were safer [18].

Biomechanics

Another important aspect that has been studied was whether the type of implant prostheses influenced its success rate, referred to whether it caused pain, movement or inflammation of the peri-implant tissue, or increased bone resorption [21]. Some authors mentioned that there was no difference between the success rates of unitary prostheses or bridges attached to implant [22,23]. Studies have shown that unitary crowns were the most successful at preventing implant faults, followed by fixed prostheses (partially or totally), and over dentures; this was consistent with various other studies [19,24,25]. Salvi et al. stated that the number of implants that supported a fixed prosthesis was neither associated to an increase in mechanical and technical faults nor it affected the success rate of dental implants with regard to their durability [25]. However, fixed prostheses were also associated with a greater number of technical failures than unitary prostheses [18].

With regard to the implant-attached prosthesis design and its influence on treatment success, the tooth/support ratio was a valid consideration for prosthetics attached to teeth only. This was due to the fact that for prostheses attached to implants—regardless of their size or the bone density in the edentulous region—force distribution occurred in the most cervical region of the implant (the first 10 mm) as verified in the laboratory research using FEA (finite element analysis), extensometry, and photo elasticity analyses [19].

Consequently, there has been no clinical evidence whether this ratio reflected a higher or lower degree of peri-implant bone resorption [25,26]. The crown/implant ratio must always be calculated by associating the crown with a 10 mm implant, as this is the minimum accepted value. Therefore, some caution must be exercised when there is a larger interocclusal distance, regardless of implant length. An increase in the number of implants, a reduction inlever arms, an increase in the implant diameter and/or insertion of implants with a greater surface area (surface treated implants), the use of removable prostheses (lower retention and the transmission of the load is facilitated by the mucous support), the removal of prostheses prior to sleep, and combining implants may reduce the unbalanced distribution of forces transmitted to the bone via the implant. Wang et al. stated that reduction in the lever arm (reduction in the crown/implant ratio) would be of greater benefit to the peri-implant bone than an increase in the implant width [27].

Further studies must be performed in order to prove that these biomechanical conditions, which appear in the laboratory setting, could be applied to dental consultations. For instance, clinical instances of severely resorbed bone, associated with the reestablishment of the vertical dimension of occlusion (VDO), were a common clinical condition in prosthetic rehabilitation consultations. This was due the fact that this had been barely researched. The best option was to completely or partially re-establish VDO by reducing the prosthesis/implant ratio. Therefore, further clinical studies that focused on the biomechanical parameters are required to better understand the safety limits of this and other clinical situations. Similarly, another gap in clinical and laboratorial studies relates to abutment angulation. 12 Although the laboratory research indicated a greater overload on the peri-implant bone and on the components fixing the prosthesis with angulated abutments (i.e., screws and cement lines), there was no clinical evidence in the literature to support such data. There was no direct association between abutment angulation and the survival rate of either prostheses or implants [25,28].

Moreover, systematic reviews also showed that there were no significant differences between the fixation techniques (i.e., screwed and cemented) used in fixed prostheses [25,28,29], despite the greater tendency for biological and mechanical complications in the cemented prostheses and screwed prostheses, respectively. One problem that was discovered when comparing the results of these types of prostheses was the lack of specific cementing protocols for this fixed prosthesis (for both the material and the technique used [30]. These studies stated that cemented prostheses, such as unitary prostheses and non-extended fixed bridges, had high success rates when properly used. For extended fixed bridges or cantilever prostheses, a screwed fixation would be more appropriate [27]. The main advantage of screwing in the prostheses was that they could be removed and replaced without damaging the structure of the prostheses or implants, there by facilitating subsequent clinical procedures [12,29,30].

Another important aspect that has influenced prosthetic and implant use planning was the attachment of the implant to the tooth [31]. One previous study stated that fixed and unitary prostheses attached to the teeth or implant must be the first choice when using a cantilever prosthesis, an adhesive prosthesis, ora prostheses joining the tooth with the implant [31]. Thus, it is recommended that this clinical situation is avoided whenever possible. However, provided that the prosthesis and abutments (tooth and implant) were satisfactory, there was no reason not to use either method when others are not applicable to the patient.

Restorative materials

With regard to the material used for prosthetic rehabilitation, there was lack of evidence to verify the success rate of prostheses and implants when using different restorative materials [21,32-34] gold, titanium, and zirconium, among others, exhibited better biocompatibility than alternative alloys (i.e.., Ni-Cr and Co-Cr) [35].

Regarding the methods used to create the implant infrastructure, one previous study stated that there was no better technique than CAD/CAM [36]. However, some authors recommended the use of CAD/CAM, either with metal (titanium) orceramic (zirconia), only for patients who needed highly individualized abutments and for dentists/laboratories with a high level of experience with this technique. This was due to the pre-made components which must be properly adaptable to the single implant platforms [21,32,34].

Functional loading x Prosthetic design

For the planning of prostheses attached to implants, what researchers studied most was the required time for the functional loading of implants [13]. Hence, time-related terms such as *immediate loading, premature loading*, and *conventional loading* (referring to the protocols established by Bränemark) were common topics at conferences and symposia in this field. The search for high success rates of osseo integration for implants associated with predictable results from a prosthetic/surgical point-of-view, with regard to the immediate or premature loading of implants, have given rise to various studies that investigated different surgical techniques, modifications in the design and area of implants, and the planning of prostheses [13,37-41].

Some authors found that there was no significant difference between immediate, premature, and conventional loading, despite the latter's success rate which was consistent with the results of a previous study performed by Esposito et al. in 2008 [42-44]. However, it was discovered that the comparison could not be made due to the differences in location, technique, and implants used in both studies [42]. Consequently, some authors made recommendations based on systematic revisions by assessing the type of prosthetic rehabilitation. For protocol prostheses, both immediate and premature load are viable for the maxilla and mandible [21]. In contrast, for over dentures, immediate and premature loading have not been well documented for the maxilla and it should only be used in the mandible [21,42].

For partially edentulous individuals, in the esthetic region (anterior maxilla), authors disagreed with the previously mentioned applications [28]. Many of them still believed that immediate and premature loading could be used in this region when no risk factors are involved. However, Atieh et al. stated that conventional loading was statistically better and that one should only alter this protocol incases selected by a dentist with minimum specific knowledge and technical skills [46].

Similarly, implants in the posterior region of the mandible that were subject to immediate or premature loading may be used under the same criteria, although further studies are required to establish a safe protocol for different load applications [28,47]. For the posterior region of the maxilla, in 2009, Weber et al. stated that premature loading was the most viable alternative to speed up the six-month period suggested by the Bränemark protocol [28].

However, Roccuzzo stated that there were still no well-defined protocols which confirmed the preferred use of immediate or premature loading over conventional loading; many studies proposed criteria where premature or immediate loading would be contra indicated [48]. In clinical situations, such asbruxism or surgical sites with fresh alveoli or those subject to guided bone regeneration, short implants, and implants without primary stability, immediate or premature loading should follow the waiting time established by the initial protocol for osseo integration. In addition, the surgical technique, type of implant, and surface treatment may have influenced the success rate when immediate or premature loading was used [28,43,46,47]. Atieh et al. recommended that the implant should have the largest diameter possible so that the prosthesis may be screwed without being in contact with the maximum intercuspation and in excursive movements [46].

Clinical procedures

After appropriate prosthetic planning and surgical execution during the implantation of prostheses, some clinical steps may still compromise biomechanical and esthetic results of the prosthesis. Therefore, the selection of materials, molding techniques, and the esthetic manipulation of supporting tissues were important steps that need to be observed.

With regard to the main molding applied techniques, it is stated that the joining of transferents, prior to molding, increased the reliability of the model and favored a more passive prosthesis positioning. 49 As of the transfer, for clinical cases in which a reduced number of implants was required <3), there was no difference between open or closed molding. In situations where the prosthesis would be replaced by four or more implants, the open molding technique was statistically better [49]. As for the mold material, there was no difference in performance between silicon and polyester [49]. Pita et al. found that internally connected implants were more stable upon insertion and there by facilitated molding and connection [50].

In reference to the manipulation or remodeling of gum tissue resulting from prolonged use of temporary prostheses, there is little clinical evidence in the literature about associating clinical manipulation with implant prostheses, despite being acommonly used procedure in clinical prosthetics. Factors that included the distance between the implants or between the teeth and the implant, thickness of the buccal bone plate, and gum health were factors that positively contributed to prosthetic treatment for esthetic purposes [51,52]. Using 'switching' platform or Cone Morse abutments also helped preserving the height of the peri-implant bone crest and promoted thicker connective tissue around the implant [35,50,53].

Conclusion

Research studies referencing mechanical and biological failures often occur when clinical and laboratorial criteria are not synchronized when the implant prostheses installation. The limits for the application of these techniques are gradually changing as implants and surgical methods develop and evolve. Continuous technical and scientific improvement by medical professionals who perform clinical procedures and technicians who perform laboratory procedures should be pursued in order to extend the life of implants and rehabilitation treatment success rates.

Conflict of interest

The authors claim no conflicts of interests.

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