IMMEDIATE LOADING IMPLANTS: REVIEW OF THE CRITICAL ASPECTS

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SUMMARY

Purpose. Modern dentistry have witnessed, a rapid and continuing evolution. Concerning the implant-rehabilitation protocols, they have been redefined in order to satisfy patient's increasing expectations in terms of comfort, aesthetic and shorter treatment period. The purpose of this review is to explore the concept of implant immediate loading and the indications for clinical practice. All the critical aspects that could influence the outcomes of this treatment will also be considered.

Materials and methods. Three protocols for implant load timing have been classified: immediate loading implants (ILI); early loading implants (ELI); and conventional loading implants (CLI). Two subclassifications point out the different loading modality: 1) Occlusal loading or Non-Occlusal loading, 2) Direct loading or Progressive loading. Micromovements have been considered, since the start of implant dentistry, one of the main risk for the success of osseointegration. The determinant and most accessible parameter to assess the primary stability is the implant insertion torque value. To achieve the necessary torque value to perform immediate loading, it is therefore important to evaluate the bone density at the implant site. Computerized tomography (CT) has been regarded as the best radiographic method to evaluate the residual bone.

Results. The clinical success of this technique is highly dependent on many factors: patient selection, bone quality and quantity, implant number and design, implant primary stability, occlusal loading and clinician's surgical ability. Among these, implant primary stability is undoubtedly the most important.

Conclusion. Studies on ILI show that successful outcome can be expected, if the previous criteria are fulfilled. It seems that ILI demonstrate a greater risk for implant failure when compared to CLI, although the survival rates were high for both the procedures. The use of different surgical procedures, type of prostheses, loading times and have very different study designs. This lack of homogeneity limits the relevance of the conclusions that can be drawn.

Key words: immediate loading implants, implant stability, implant design.

Modern dentistry has witnessed, over the last decades, a rapid and continuing evolution of techniques in different fields (1-44, 122-125). Concerning the implant-rehabilitation protocols, they have been redefined over the years, as a result of new knowledges in implant surgery and in order to satisfy patient's increasing expectations in terms of comfort, aesthetic and shorter treatment period.

Since Branemark introduced the osseointegration system in 1977 (45), new protocols have been proposed regarding the prosthetic-load timing, up to the immediate implant loading.

Classic protocols propose that implants should receive no loading during the osseointegration period, usually 3 to 4 months in the mandible

and 6 to 8 months in the maxilla (46-48).
Updated protocols have shortened the healing period, so that implants could be loaded early and even immediately, before osseointegration is completely obtained.
The purpose of this review is to explore the concept of implant immediate loading and the indications for clinical practice. All the critical aspects that could influence the outcomes of this treatment will also be considered.

Implant loading time protocols

Esposito et al. (49) have defined 3 protocols for implant load timing: immediate loading implants (ILI), within 1 week from implant placement; early loading implants (ELI), between 1 week and 2 months; and conventional loading implants (CLI), after 2 months from implant placement.
Two subclassifications point out the different loading modality: 1) Occlusal loading or Non-Occlusal loading, 2) Direct loading or Progressive loading.
This Cochrane systematic review (49) concludes that there is no convincing evidence of a clinically important difference in prosthesis failure, implant failure, or bone loss associated with different loading times of implants.
The results of a meta-analyses by Enríquez-Sacristán et al. (50) report that ILI, ELI and CLI share similar success and survival rate.
A recent meta-analyses, by Sanz-Sànchez et al. (51), together with a recent study by Zhu et al. (52), shows that ILI demonstrate a greater risk for implant failure when compared to CLI, although the survival rates were high for both the procedures.
Moreover ILI, ELI and CLI were found not significantly different in terms of the associated marginal bone loss, changes in implant stability, and health status of the peri-implant tissues, which indicated that these loading protocols behaved similarly once osseointegration occurred (52).

Primary stability

Micromovements have been considered, since the start of implant dentistry, one of the main risk for the success of osseointegration (47). It has been proved that if the micromovements range results to be over 150 µm, this could jeopardize the osseointegration process. This excessive micromotion results to be directly implicated in the formation of the implant fibrous encapsulation (53, 54). The literature suggests that there is a critical threshold of micromotion above which fibrous encapsulation prevails over osseointegration. This critical level, however, was not zero micromotion as generally interpreted. Instead, the tolerated micromotion threshold was found to lie somewhere between 50 and 150 microns (54, 126).
In this tolerated micromovements range, an early load on the implant surface could even stimulate the newly formed bone to remodel, accelerating the osseointegration process.
That being said, all the studies in literature agree that achieving good implant primary stability is key condition to ILI success (55).
Primary implant stability is influenced by many factors including local bone quality and quantity, implant macro-design and surgical technique (56, 127-132).

Implant primary stability evaluation

The determinant and most accessible parameter to assess the primary stability is the implant insertion torque value.
Torque values ranging from 30 to 40 Ncm and higher have been usually chosen as thresholds for immediate loading (57, 58). That torque minimum level is important both to assure the

osseointegration process and to give enough engaging strength to the implant-abutment connections, via the fixation screw. Nonetheless, some studies assess that also ILI placed in a weak bone with a final torque ≥ 20 Ncm have an equally successful prognosis as the CLI (59).
Furthermore, if enough implants are placed, ILI can be performed even if not all the implants achieve an adequate stability, thanks to the support of adjacent implants, but the unstable implants should be left unloaded (60).
To measure the implant primary stability, recently it has been developed an Implant Motor (TMM2®, Idievolution) that allows the clinician to measure the bone density during both the preparation of the implant site and the implant insertion.
Two other methods to measure the primary stability are the resonance frequency analysis (RFA) and the Periotest® (PT).
The RFA (Osstell®) is a reliable device that measures the resonance frequency of a transductor attached to the implant body (61). The result of the measurement is the implant stability quotient (ISQ), which reveals the hardness of the implant-bone connection (62). ISQ values greater than 65 have been regarded as most favorable for implant stability, whereas ISQ values below 45 indicate a poor primary stability (63).
The PT indicates implant stability by measuring the time of contact between the instrument's tip and the implant, during repetitive percussions generated by this device.
The lack of well-defined reference values, both for the RFA and for the PTV, and the possibility of some operator-dependent variations in the measurements, make their routine clinical use not efficient (64).

Bone quality and quantity

To achieve the necessary torque value to perform immediate loading, it's therefore important to evaluate the bone density at the implant site. Computerized tomography (CT) has been regarded as the best radiographic method to evaluate the residual bone (65).
Several classifications regarding bone density have been proposed. In 1990, Misch (66) proposed a classification based on macroscopic cortical and trabecular bone characteristics: Class I: dense cortical bone; Class II: porous cortical bone; Class III: coarse trabecular bone; Class IV: fine trabecular bone.
When Class III or Class IV bone is present at implant site, the operator can overcome this limitation performing specific surgical techniques and using implant with peculiar macro surfaces.

Surgical techniques

In several studies, Authors introduced different techniques to locally optimize bone density and subsequently improve primary stability, such as 1-2 mm subcrestal implant placement (67, 68), bicorticalization into the nasal or sinus floor whenever possible (69), implant site under preparation (70) and bone condensing technique (71). The implant site under preparation and the bone condensing technique are the most commonly used techniques, performed nearly always when in presence of Class III or Class IV bone: the first consists in the use of a final drill diameter which is smaller than the diameter of the implant (70); with the second technique cancellous bone is pushed aside with bone condensers (osteotomes), thus increasing the density of the implant surrounding bone (71).
Through the use of these procedures, it has been reported high survival rates with ILI (67, 72).
In areas where bone augmentation is needed, CLI should be the first choice (48, 73, 74). Most titles on ILI do not use bone graft or sinus lift procedures. Recent studies report successful use of bone grafts to fill horizontal gaps be-

tween the implant surface and the extraction socket walls and to cover the vestibular dehiscences (60,73).

Implant design and positioning

Regarding the implant macro-design, tapered (root-form) implants were introduced to overcome the poor bone quality and quantity limitations. The goal behind using tapered implant was to exercise a degree of compression of the surrounding bone during the insertion phase, and the decrease of their apical diameter allows to accommodate them in area with small bone volume available, like the labial concavity or between adjacent roots (75).
Implant surface characteristics and diameter have also been shown to influence primary stability: rough implant surfaces make the area of implant-bone contact even more extended (76).
Clinical studies have shown that, in cases with a limited bone volume, implants with less than 3 mm diameters can reach sufficient primary stability (77). Wider implants are often used in posterior regions with poor quality bone (70).
Single teeth implants demonstrate greater risk of failure, when compared to immediately loaded full arch restorations (51).
To obtain full-arch rehabilitation with ILI, most studies consider 6 implants to be the lowest adequate number to achieve a predictable outcome (36, 37). Malo et al. (25) described a technique to achieve successful results with only 4 implants.
Regarding implant position, all studies give importance to an uniform distribution along the alveolar arch (78); distal implants should be inserted in place of the 2nd premolar or 1st molar, even with a tilted position in order to minimize the need of cantilevers (78). The avoidance of distal cantilevers is considered a success key by many Authors.
Regarding implant length, all Authors prefer using longer implants whenever possible, with a minimum of 8 mm length, being 13 and 15 mm implants the most frequently used (78). Tilting may enable placement of longer implants in posterior regions (78).
Computer-guided surgery minimize the errors in implant positioning compared to manual or conventional surgical guide implant placement (79), resulting in lesser post-operative morbidity and increased patient satisfaction (80).

Patient selection

Of course, when performing ILI, the patient selection criteria can influence the success of this technique (81).
Most studies in literature propose the following criteria: good general health, edentulous area or teeth with impossible prognosis, adequate bone quality and quantity, absence of acute infection, and primary stability of implants. The exclusion criteria are: systemic disease, immunodeficiencies, head and neck radiotherapy, alcohol or drug abuse, pregnancy, pathologies of the oral mucosa, or lack of cooperation of the patient.
There is no consensus on bruxism or smoking habits (78).

Complications

According to different Authors (82, 83), the ILI protocol more often leads to technical complications. The most common of those were fractures of the prostheses, loosening of the abutment screws and denture contouring adjustments.
The last could be explained by the secondary gingival healing after surgery in the early loading prostheses, which may result in space around the abutments, while relining impressions performed in the conventional loading implants after a period of healing avoided this space (65).

Anyhow, all these complications are solved by adjusting the implants or prostheses without affecting the outcomes of the procedures (78).
All together the above mentioned variables are of paramount importance to reduce the risk of peri-implantitis (34, 35, 37, 84-119).

Conclusions

Literature data showed that ILI could represent a reliable and effective protocol to rehabilitate single or multiple missing teeth and offers important advantages for the patient, in terms of function, aesthetics and comfort. However the clinical success of this technique is highly dependent on many factors: patient selection, bone quality and quantity, implant number and design, implant primary stability, occlusal loading and clinician's surgical ability. Among these, implant primary stability is undoubtedly the most important.
Studies on ILI show that successful outcome can be expected, if the previous criteria are fulfilled. It seems that ILI demonstrate a greater risk for implant failure when compared to CLI, although the survival rates were high for both the procedures (120).
Single teeth implants demonstrate greater risk of failure, when compared to immediately loaded full arch restorations (51).
Shimmel M. et al. (121) in a recent review concluded that although all three loading protocols provide high survival rates, ELI and CLI protocols are still better documented than ILI and seem to result in fewer implant failures during the first year.
Studies available use different surgical procedures, type of prostheses, loading times and have very different study designs. This lack of homogeneity limits the relevance of the conclusions that can be drawn.

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