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Immediate dental implant placement, immediate restorative treatment and immediate loading: treatment options in dental practice?

Background

Immediate treatment concepts in dental implantology are becoming increasingly popular because the reduction in treatment time is highly appreciated by patients and uncomfortable provisional restorations can be avoided. Given the correct indication, the prognoses of immediately placed implants and their prosthetic restoration are comparable to conventional, delayed treatment concepts. Thus, immediate treatment concepts should be considered as therapeutic options in routine dental practice.

Introduction

A distinction is made between immediate, early and late treatment concepts in terms of both the surgical and prosthetic phases of implant therapy. This results in 9 different possibilities relating to the temporal sequence of treatment.

Implant therapy includes the following possibilities: immediate after tooth extraction, delayed-immediate after the healing of the mucosal wound (approximately 8–12 weeks after extraction) or late after bone healing (from 6 months after extraction). The healing of the implant can ensue non-submerged or submerged under the mucosa. If a partially edentulous dentition is restored, the implant is fitted immediately with a provisional fixed restoration in the form of a provisional crown or bridge, without static and dynamic occlusal contacts after its insertion. Immediate loading involves the direct insertion of a restoration that is in occlusion. In cases where the edentulous jaw is rehabilitated, immediate loading is thus achieved in principle. In prosthetic dentistry, a distinction is likewise made between early loading (after approximately 6 weeks/or rather 1–6 weeks after implant placement) and late loading concepts, with the latter approach ensuing after osseointegration (starting after approximately 6–8 weeks) [18, 19].

With regard to restorative treatment, fixed restorations and removable prostheses can be planned using different loading options. This emphasizes the need to specify which option is being referred to when discussing the topic of the temporal sequence in implant therapy. In a recent review, Gallucci et al. compiled implant survival rates of fixed implant-supported restorations as a function of the different, temporal treatment concepts in partially edentulous patients (Table 1). From the 9 conceivable surgical-prosthetic treatment options, the scientific data concerning 8 treatment concepts was evaluated and published. Very good implant survival rates of 96–100 % were described. No publications could be found regarding the option of delayed-immediate implant placement and immediate restoration, and therefore, this treatment option is an outlier. On the other hand, the following 4 options, which are supported by a large body of scientific data, are recommended as they show strong long-term clinical evidence:

- immediate implant placement and delayed loading (implant survival rate 96 %),
- delayed-immediate implant placement and delayed loading (implant survival rate 96.3 %),
- delayed implant placement and early loading (implant survival rate 98.3 %),
- delayed implant placement and delayed loading (implant survival rata 97.7 %).

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Surgery/implant placement after extraction	Restorative treatment, loading after implant placement	Implant survival rate	Scientific documentation
Immediate	Immediate	98.4 %	+
Immediate	Early	98.2 %	+
Immediate	Late	96 %	++
Early	Immediate	n.a.	o
Early	Early	100 %	o
Early	Delayed	96.3 %	++
Delayed	Immediate	97.9 %	+
Delayed	Early	98.3 %	++
Delayed	Delayed	97.7 %	++

++: scientifically and clinically validated
+: clinically documented
o: insufficient clinical documentation

Table 1 Different time-based protocols for surgical implant insertion and prosthetic implant restoration (according to Gallucci et al. [22])

Immediate implant placement and immediate restoration (implant survival 98.4 %) as well as late implant placement and immediate restoration (implant survival 97.9 %) also show very good values, but are less documented clinically in the long term [22].

Brånemark's treatment concepts, which represent the beginning of modern dental implantology, involve delayed implant placement and implant loading times [13]. This results in treatment periods of one year and more. In a recent review, it was stated that submerged implant healing is advantageous with regard to the implant survival rate. However, initially submerged implants displayed more crestal bone loss after one year of function, on average, than implants healing openly [48]. Open healing can also be used in conjunction with a provisional restoration. This appears to be advantageous given the appropriate indication because immediate loading tends to stabilize the peri-implant bone, and approximately 0.1–0.2 mm less bone resorption occurs than in late loading [19, 43]. This suggests that, in case of doubt, submerged healing should be performed. However, in cases where the bone condition is good, the implant's primary stability is sufficient, no bone or soft tissue augmentation is needed and the patient is in good general health, open healing may be preferable.

Based on past experience, conservative treatment concepts involving late loading tend to be selected in cases of doubt [42]. Modern implant designs and surfaces exhibit osseointegration features which permit the application of faster restoration concepts with predictable success. Current data shows that immediate concepts have equivalent implant survival and success rates as conventional protocols [2, 21, 34, 39].

The extraction wound initially closes with soft tissue after tooth extraction, whereas bone healing takes about 6 months. In this time, the remodeling and resorption of the bone occurs, after which, the bone structure remains relatively constant. The maxilla shows higher bone resorption rates than the mandible [16]. In a review, Tan et al. showed that within the first 4–12 months after extraction, circa 50 % of the width of the alveolar process and about 15 % of its height resorbed; a vertical loss of 3.1–5.9 mm and a horizontal loss of 1 mm took place [46]. Based on the thickness of the vestibular alveolar lamella, varying degrees of bone atrophy can be expected because the bundle bone close to the tooth resorbs after extraction. Thus, a large change in the vestibular contour results when thin alveolar walls are present (< 1 mm). Considerable bone loss often requires vestibular augmentation, especially in esthetically relevant jaw areas, which in turn prolongs the treatment time [3, 12, 23]. Due to the resorption of the bundle bone, on average, about 1 mm of resorption occurs in the anterior maxilla in immediate implant placement [12, 49]; therefore, immediate implant placement cannot com-

Figure 1 Initial radiological situation: fractured tooth 12

pletely prevent bone remodeling [17]. Moreover, the careful selection of the diameter and position of the implant is important in immediate implant placement. The diameter of the implant must not be chosen to be too large, and particularly for maxillary implants, a more palatal position should be selected due to the centripetal resorption pattern of the maxilla. These measures help to reduce the risk of vestibular recession with areas of exposed implant surface [5, 24, 49].

Immediate implant placement and immediate restorative treatment of the partially edentulous dentition is anticipated to result in a vestibular mucosal recession of approximately 0.5–0.9 mm on average, although more than 1 mm of recession may occur in 20 % of cases [9]. These soft tissue changes occur within the first 3 months [28]. The following variables have been identified as risk factors for increased mucosal recession [24]: smoking, absent or thin buccal alveolar walls (< 1 mm), thin gingival biotypes, limited buccal keratinized mucosa, facially-oriented implant positions, and excessive implant diameters [7, 26, 29, 37]. However, if guided bone regeneration in the form of filling the alveolar crevices with bone substitute material [3, 6, 12, 32] and/or buccal soft tissue augmentation with free connective tissue is performed at the same time as immediate implant placement, the esthetic result can be influenced favorably through the preservation of the buccal contour [23].

Immediate implant placement in conjunction with direct, immediate restoration using bridges or single provisional crowns helps support the circular soft tissues and preserve the existing optimal red-white esthetics. The peri-implant soft tissue is supported reliably in the papillae region [5, 10] and the preservation of the papillae facilitates the attainment of esthetically pleasing results. In delayed restorative therapy, the flattened proximal soft tissues must first be grown again and reconstructed into a pseudo papilla; via the step-by-step reconstruction of, or pressure on, the approximal emergence profile using provisional crowns, very

Figure 2 Initial clinical situation: fractured tooth 12

beautiful results can be achieved in early or late restorative treatment on implants. However, this procedure is rather labor-intensive, and thus, time-consuming and financially demanding for patients [20, 51].

Immediate implant placement for single restorations is performed more frequently in the anterior region than in the posterior region. This is reflected by the number of existing scientific studies. Immediate implant placement in the posterior region is likely to result in increased bone loss, although the presence of a buccal alveolar lamella reduces the bone loss [37, 40]. In immediate implant placement, the implant's stability is usually ensured by the residual bone apical to the alveolar socket. A height of 3 mm should be available in this case. Especially for implants that are intended to support single crowns, sufficient primary stability seems to be relevant. With regard to implant geometry, tapered (conical) implants are superior to parallel-walled implants [4]. A favorable condition for immediate loading is usually considered to be an ISQ of 60 and an insertion torque of 35 Ncm [42]. However, there is disagreement in the literature as to whether primary stability values of 35 Ncm or 25 Ncm should be used for immediate loading. In a recent review, the implant survival rates did not differ between torque values of 25 Ncm or 32 Ncm [49]. In principle, higher torque seems to lead to better implant survival rates, notably, when 40 Ncm or 50 Ncm was defined as the limit [30]. Lower primary stability values have been described successfully for splinted full-arch restorations as well [31, 50]. For immediate loading, ideally, a quadrangular, primary splinting of the implants appears to be beneficial for the survival prognosis [41]. For instance, the secondary splinting of immediately loaded interforaminal implants using 1 to 2 Dalla Bona-type ball attachments averaged an implant survival rate of only 81.6 % after one year, although the majority of the implant failures occurred within the first month after loading [27]. In contrast, when a dolder bar was used for the primary splinting of 2 implants, a survival rate of 98.8 % was seen after 1–3 years [45].

When planning the immediate loading of several implants, implant splinting should be performed in the healing phase. The "All-on-Four" concept of cross-arch splinting, for example, shows very good results when 4–6 implants are splinted together in the edentulous jaw. Given that the "All-on-Four" method has been well-documented in the literature, it is has become an evidence-based and real planning option that can be discussed with patients [33, 38, 44]. The "All-on-Four" method restores the edentulous jaw with fixed restorations by using 4 implants which are placed specifically into the existing subnasal maxilla or interforaminal mandibular bone, preferably in the region of the second incisors and second premolars. Bone augmentation over the inferior alveolar nerve

Figure 3 Prepared provisional restoration (CAD/CAM)

Figure 4 Post-operative X-ray: immediate implant placement in region 12 (SICvantage tapered: 3,7 x 14,5 mm/ SIC invent AG, Basel, CH), Flap-less, Guided-Surgery.

or in the region of the maxillary sinuses is avoided through the distal inclination of the dorsal implants, and an adequate prosthetic support polygon is thus established. Implants that are placed obliquely do not show increased failure rates or increased bone resorption compared to vertically placed implants [15, 35]. The "All-on-Four" concept, developed as an immediate implant placement protocol by Malo in the 1990s, has the advantage that the phase of passive edentulism can be avoided.

The extent to which occlusal loading should be avoided for immediate restorations in partially edentulous dentition and the provisionals should initially be designed in non-occlusion has not been scientifically clarified so far; single-tooth implants appear to osseointegrate under occlusal load with similar success rates as in non-occlusion [11, 19, 49]. On the other hand, the splinting together of several implants appears to be beneficial because single provisional restorations show poorer implant survival rates compared to horseshoe-shaped full-arch restorations [41]. At present, non-occlusion is recommended clinically for the immediate restoration of single-tooth implants [41].

In a recent review, flap-less surgery was shown to be riskier in terms of implant survival compared to open surgery (risk factor: 1.70-fold). If immediate loading is also performed, the risk increases to 2.24-fold [12, 52]. The extent to which current digital techniques will optimize these results is currently the subject of clinical studies; in a currently ongoing study by the Implantology and Biomaterials Research Group at the University of Bonn (DRKS No. 00022273), very good intermediate results have been documented for flap-less, guided implantology in a fully digital workflow with prepared single-tooth provisionals (CAD-CAM technique), for both the indication immediate implant placement and immediate loading as well as the indication late implant placement and immediate loading (Fig. 1–6).

Immediate concepts show an optimized patient satisfaction and are preferred by patients; long treatment times represent a burden for patients because the provisional phase is usually associated with shortcomings in terms of the masticatory function, phonetics, and esthetics [1, 25]. This helps to explain why clinical experimentation with shorter, immediate treatment concepts began as early as the 1970s and why various protocols with shortened treatment times were documented. The collected data points to the fact that immediate treatment approaches have an evidence base and can be successfully applied in clinical practice nowadays, given that the indication is carefully selected [13]. In summary, from the patient's viewpoint, immediate implant placement combined with immediate restorative treatment in the visible region and immediate loading in the edentulous jaw, in the form of either immediate or late implant placement, appear to be particularly interesting.

Clinical Recommendations

In **immediate implant placement and immediate restorative treatment**, the implant is placed in the area of the fresh extraction socket during the same appointment as tooth extraction. Immediate implant placement is not indicated in an alveolar socket that shows signs of acute inflammation. On the other hand, chronic apical periodontitis does not represent a contraindication for immediate implant placement. The scientific literature largely describes similar implant survival rates as in immediate implant placement in healthy alveolar sockets [8, 29, 37]. However, a recent review reports a 3-fold increased risk in the rate of implant failure [14]. This suggests that thorough excochleation of granulation or cystic tissue is necessary before implant placement.

Clinical studies show very good results for immediate implant placement with an implant survival and success rate of 98.4 % after 2 years (95%-CI: 97.3–99 %) and < 1 mm of bone loss. An improvement of the survival rate could be achieved by administering systemic antibiotic therapy post-operatively [28]. Immediate implant placement is possible for both fixed restorations and removable prostheses. However, the position of the implant does not usually follow the exact course of the alveolar socket. Instead, attention is needed to ensure that the implant's axis is inclined away from the alveolar socket's original course, to be offset palatally into the local bone and deepened into the basal bone; this approximates to 1 mm below the buccal bone level or 3 mm apical to the cementoenamel junction of the adjacent teeth [49]. For multi-rooted teeth, insertion into the interradicular bone or positioning into the palatal alveolar socket is also possible. When the implant is positioned, caution to achieve primary stability and to anticipate subsequent alveolar healing should be exercised. Usually, this results in a palatal offset and a subcrestal position of the implant's shoulder.

Figure 5 Clinical situation: 1 week after immediate restoration with a provisional restoration in non-occlusion.

Figure 6 Close-up X-ray: 1 week after immediate restoration

(Tab. 1, Fig. 1–6: N. Enkling)

The impending prosthetic restoration should also be taken into account when positioning the implant; if a screw-retained crown is planned in the anterior region, a steep implant axis should be chosen so as to allow screw access in the area of the palatal cingulum and prevent contact with the incisal edge. If, on the other hand, a steeply placed implant is to be restored with a cemented crown, a palatally over-contoured crown would be the result. An implant that is planned for cementation must have an oblique insertion direction so that the abutment required for cementation can be integrated in the contour of the crown. Good surgical and prosthetic planning is therefore essential [49]. Given sufficient primary stability, the prognosis of implant success for immediate restorative treatment is comparable to the results of restorative treatment after osseointegration has been completed [13]. The provisional restoration is usually prepared and inserted during implant surgery. The splinting together of adjacent implants is desirable during the provisional phase.

Conversely, **immediate loading** represents an implant-supported prosthesis in the edentulous jaw which is fixed, if possible, within the first day (up to the third day) after implant placement [13]. In this case, occlusal loading is unavoidable. The restoration may be either provisional or definitive. Immediate loading is possible for both fixed restorations and removable prostheses. According to current data, the restoration of the edentulous mandible using a dolder bar on two standard implants is considered a safe immediate loading concept [36, 47]. When quadrangular primary splinting is used for immediate loading, as is the case in the "All-on-Four" concept, even implants with lower primary stability (around 20–30 Ncm) can be loaded immediately in the mandible and maxilla with success [31, 50]. A combination of immediate implant placement and immediate loading is possible. However, from a prosthetic standpoint, it must be noted that a pronounced change in hard and soft tissue morphology occurs as a result of alveolar healing; this leads to a change/cavity formation in the interface between the mucosa and the prosthesis, thus requiring the adjustment of the prosthesis at a later point [13]. Provisional restorations are usually used for double immediate treatment for this reason. Exceptions to this are definitive restorations with PMMA coating; PMMA can be used as part of a relining procedure and the transition subsequently optimized.

In the "All-on-Four" concept, prosthetically, the red esthetics are made using pink gingival replacement materials (PMMA or ceramic). The transition zone between the pink gingival replacement material and the natural mucosa must be located outside of the esthetically relevant zone, which is visible during laughter. Therefore, it is often necessary to level the alveolar bone; this means that, in immediate implant placement, the crestal alveolar portions must be removed generously and the implant is placed primarily in the basal bone. The extent of bone remodeling that occurs after implant placement is not comparable to immediate implant placement in a preserved extraction socket, but is considerably less. The surgical vertical ridge reduction must be taken into account beforehand, especially when the vertical bone availability is evaluated in order to determine realistic implant lengths. This flattening of the alveolar bone and the possible smooth, basal design of the bridge pontics presents hygiene advantages; the contact surface between the mucosa and the base of the restoration is reduced and it becomes easy to clean using hygiene tools.

A risk factor for a subsequent increase in the incidence of peri-implant mucositis and peri-implantitis is the amount of keratinized mucosa at the implant [37]. Thus, the quality of the soft tissue (keratinized gingiva and biotype) must be considered before making a decision [26, 29, 37], and this emphasizes the need for appropriate patient selection; if the initial esthetic and anatomical situation is good, immediate concepts should be applied to preserve good esthetics.

Conclusion

The expected vestibular contour changes of the alveolar process when immediate concepts are used must be functionally and esthetically accept-

able. An ideal starting point for the use of immediate concepts is thus an excess of hard and soft tissue [9]. Particularly for fixed prostheses in the esthetically relevant zone, especially maxillary anterior prostheses where a gummy smile exists, the indication for immediate therapy should be decided with caution because a vestibular soft tissue recession of 0.5–1 mm must be expected. If hard and soft tissue deficits need to be compensated for through augmentative procedures, delayed or late treatment concepts are preferable. In this respect, immediate treatments supplement, but do not replace conventional protocols. A timely and precise collaboration between surgeons and prosthodontists is required for the implementation of immediate restoration and immediate loading concepts. Ideally, this is best achieved in a team. Further clinical research would be useful in order to continue to optimize treatment protocols for immediate treatment concepts.

Conflicts of interest

In the past, Prof. Dr. Norbert Enkling has given paid lectures at scientific conferences and lectures with workshops for implant companies such as Nobel Biocare, SIC Invent, Dentaurum Implants, 3M Espe and Condent.

References

1. Abdunabi A, Morris M, Nader SA, Souza RF: Impact of immediately loaded implant-supported maxillary full-arch dental prostheses: a systematic review. J Appl Oral Sci 2019; 27: e20180600

2. Al-Sawai AA, Labib H: Success of immediate loading implants compared to conventionally-loaded implants: a literature review. J Investig Clin Dent 2016; 7: 217–224

3. AlKudmani H, Al Jasser R, Andreana S: Is bone graft or guided bone regeneration needed when placing immediate dental implants? A systematic review. Implant Dent 2017; 26: 936–944

4. Atieh MA, Alsabeeha N, Duncan WJ: Stability of tapered and parallel-walled dental implants: a systematic review and meta-analysis. Clin Implant Dent Relat Res 2018; 20: 634–645

5. Benic GI, Mir-Mari J, Hämmerle CH: Loading protocols for single-implant crowns: a systematic review and meta-analysis. Int J Oral Maxillofac Implants 2014; 29 (Suppl): 222–238

6. Caneva M, Botticelli D, Morelli F, Cesaretti G, Beolchini M, Lang NP: Alveolar process preservation at implants installed immediately into extraction sockets using deproteinized bovine bone mineral – an experimental study in dogs. Clin Oral Implants Res 2012; 23: 789–796

7. Caneva M, Botticelli D, Rossi F, Cardoso LC, Pantani F, Lang NP: Influence of implants with different sizes and configurations installed immediately into extraction sockets on peri-implant hard and soft tissues: an experimental study in dogs. Clin Oral Implants Res 2012; 23: 396–401

8. Chen H, Zhang G, Weigl P, Gu X: Immediate placement of dental implants into infected versus noninfected sites in the esthetic zone: a systematic review and meta-analysis. J Prosthet Dent 2018; 120: 658–667

9. Chen ST, Buser D: Esthetic outcomes following immediate and early implant placement in the anterior maxilla – a systematic review. Int J Oral Maxillofac Implants 2014; 29 (Suppl): 186–215

10. Cheng Q, Su YY, Wang X, Chen S: Clinical outcomes following immediate loading of single-tooth implants in the esthetic zone: a systematic review and meta-analysis. Int J Oral Maxillofac Implants 2020; 35: 167–177

11. Chrcanovic BR, Albrektsson T, Wennerberg A: Immediately loaded non-submerged versus delayed loaded submerged dental implants: a meta-analysis. Int J Oral Maxillofac Surg 2015; 44: 493–506

12. Clementini M, Tiravia L, De Risi V, Vittorini Orgeas G, Mannocci A, de Sanctis M: Dimensional changes after immediate implant placement with or without simultaneous regenerative procedures: a systematic review and meta-analysis. J Clin Periodontol 2015; 42: 666–677

13. De Bruyn H, Raes S, Ostman PO, Cosyn J: Immediate loading in partially and completely edentulous jaws: a review of the literature with clinical guidelines. Periodontol 2000 2014; 66: 153–187

14. de Oliveira-Neto OB, Lemos CA, Barbosa FT, de Sousa-Rodrigues CF, Camello de Lima FJ: Immediate dental implants placed into infected sites present a higher risk of failure than immediate dental implants placed into non-infected sites: systematic review and meta-analysis. Med Oral Patol Oral Cir Bucal 2019; 24: e518–e528

15. Del Fabbro M, Bellini CM, Romeo D, Francetti L: Tilted implants for the rehabilitation of edentulous jaws: a systematic review. Clin Implant Dent Relat Res 2012; 14: 612–621

16. Del Fabbro M, Testori T, Kekovic V, Goker F, Tumedei M, Wang HL: A systematic review of survival rates of osseointegrated implants in fully and partially edentulous patients following immediate loading. J Clin Med 2019, 8(12), 2142; https://doi.org/10.3390/jcm8122142

17. Denardi RJ, da Silva RD, Thomé G et al.: Bone response after immediate placement of implants in the anterior maxilla: a systematic review. Oral Maxillofac Surg 2019; 23: 13–25

18. Esposito M, Grusovin MG, Coulthard P, Worthington HV: Different loading strategies of dental implants: a Cochrane systematic review of randomised controlled clinical trials. Eur J Oral Implantol 2008; 1: 259–276

19. Esposito M, Grusovin MG, Maghaireh H, Worthington HV: Interventions for replacing missing teeth: different times for loading dental implants. Cochrane Database Syst Rev 2013;2013:Cd003878.

20. Furze D, Byrne A, Alam S, Wittneben JG: Esthetic outcome of implant supported crowns with and without peri-implant conditioning using provisional fixed prosthesis: a randomized controlled clinical trial. Clin Implant Dent Relat Res 2016; 18: 1153–1162

21. Gallardo YNR, da Silva-Olivio IR, Gonzaga L, Sesma N, Martin W: A systematic review of clinical outcomes on patients rehabilitated with complete-arch fixed implant-supported prostheses according to the time of loading. J Prosthodont 2019; 28: 958–968

22. Gallucci GO, Hamilton A, Zhou W, Buser D, Chen S: Implant placement and loading protocols in partially edentulous patients: a systematic review. Clin Oral Implants Res 2018; 29 (Suppl 16): 106–134

23. Grunder U: Crestal ridge width changes when placing implants at the time of tooth extraction with and without soft tissue augmentation after a healing period of 6 months: report of 24 consecutive cases. Int J Periodontics Restorative Dent 2011; 31: 9–17

24. Hammerle CH, Araujo MG, Simion M:. Evidence-based knowledge on the biology and treatment of extraction sockets. Clin Oral Implants Res 2012; 23 (Suppl 5): 80–82

25. Huynh-Ba G, Oates TW, Williams MAH: Immediate loading vs. early/conventional loading of immediately placed implants in partially edentulous patients from the patients' perspective: a systematic review. Clin Oral Implants Res 2018; 29 (Suppl 16): 255–269

26. Kinaia BM, Ambrosio F, Lamble M, Hope K, Shah M, Neely AL: Soft tissue changes around immediately placed implants: a systematic review and meta-analyses with at least 12 months of follow-up after functional loading. J Periodontol 2017; 88: 876–886

27. Kronstrom M, Davis B, Loney R, Gerrow J, Hollender L: Satisfaction and clinical outcomes among patients with immediately loaded mandibular overdentures supported by one or two dental implants: results of a 5-year prospective randomized clinical trial. Int J Oral Maxillofac Implants 2017; 32: 128–136

28. Lang NP, Pun L, Lau KY, Li KY, Wong MC: A systematic review on survival and success rates of implants placed immediately into fresh extraction sockets after at least 1 year. Clin Oral Implants Res 2012; 23 (Suppl 5): 39–66

29. Lee J, Park D, Koo KT, Seol YJ, Lee YM: Comparison of immediate implant placement in infected and non-infected extraction sockets: a systematic review and meta-analysis. Acta Odontol Scand 2018; 76: 338–345

30. Lemos CAA, Verri FR, de Oliveira Neto OB et al.: Clinical effect of the high insertion torque on dental implants: a systematic review and meta-analysis. J Prosthet Dent 2020; 08 Sep 2020, doi: 10.1016/j.prosdent.2020.06.012

31. Malo P, Lopes A, de Araujo Nobre M, Ferro A: Immediate function dental implants inserted with less than 30 N.cm of torque in full-arch maxillary rehabilitations using the All-on-4 concept: retrospective study. Int J Oral Maxillofac Surg 2018; 47: 1079–1085

32. Matarasso S, Salvi GE, Iorio Siciliano V, Cafiero C, Blasi A, Lang NP: Dimensional ridge alterations following immediate implant placement in molar extraction sites: a six-month prospective cohort study with surgical re-entry. Clin Oral Implants Res 2009; 20: 1092–1098

33. Mericske-Stern R, Worni A: Optimal number of oral implants for fixed reconstructions: a review of the literature. Eur J Oral Implantol 2014; 7 (Suppl 2): S133–153

34. Mitsias M, Siormpas K, Pistilli V, Trullenque-Eriksson A, Esposito M: Immediate, early (6 weeks) and delayed loading (3 months) of single, partial and full fixed implant supported prostheses: 1-year post-loading data from a multicentre randomised controlled trial. Eur J Oral Implantol 2018; 11: 63–75

35. Monje A, Chan HL, Suarez F, Galindo-Moreno P, Wang HL: Marginal bone loss around tilted implants in comparison to straight implants: a meta-analysis. Int J Oral Maxillofac Implants 2012; 27: 1576–1583

36. Pardal-Peláez B, Flores-Fraile J, Pardal-Refoyo JL, Montero J: Implant loss and crestal bone loss in immediate versus delayed load in edentulous mandibles: a systematic review and meta-analysis. J Prosthet Dent 2020;

37. Parvini P, Obreja K, Becker K, Galarraga ME, Schwarz F, Ramanauskaite A: The prevalence of peri-implant disease following immediate implant placement and loading: a cross-sectional analysis after 2 to 10 years. Int J Implant Dent 2020; 6: 63

38. Penarrocha-Diago M, Penarrocha-Diago M, Zaragozi-Alonso R, Soto-Penaloza D: On Behalf Of The Ticare Consensus 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. J Clin Exp Dent 2017; 9: e712–e715

39. Pigozzo MN, Rebelo da Costa T, Sesma N, Laganá DC: Immediate versus early loading of single dental implants: a systematic review and meta-analysis. J Prosthet Dent 2018; 120: 25–34

40. Ragucci GM, Elnayef B, Criado-Cámara E, Del Amo FS, Hernández-Alfaro F: Immediate implant placement in molar extraction sockets: a systematic review and meta-analysis. Int J Implant Dent 2020; 6: 40

41. Sanz-Sánchez I, Sanz-Martín I, Figuero E, Sanz M: Clinical efficacy of immediate implant loading protocols compared to conventional loading depending on the type of the restoration: a systematic review. Clin Oral Implants Res 2015; 26: 964–982

42. Schimmel M, Srinivasan M, Herrmann FR, Müller F: Loading protocols for implant-supported overdentures in the edentulous jaw: a systematic review and meta-analysis. Int J Oral Maxillofac Implants 2014; 29 (Suppl): 271–286

43. Sommer M, Zimmermann J, Grize L, Stübinger S: Marginal bone loss one year after implantation: a systematic review of different loading protocols. Int J Oral Maxillofac Surg 2020; 49: 121–134

44. Soto-Penaloza D, Zaragozí-Alonso R, Penarrocha-Diago M, Penarrocha-Diago M: The all-on-four treatment concept: systematic review. J Clin Exp Dent 2017; 9: e474–e488

45. Stoker GT, Wismeijer D: Immediate loading of two implants with a mandibular implant-retained overdenture: a new treatment protocol. Clin Implant Dent Relat Res 2011; 13: 255–261

46. Tan WL, Wong TL, Wong MC, Lang NP: A systematic review of post-extractional alveolar hard and soft tissue dimensional changes in humans. Clin Oral Implants Res 2012; 23 (Suppl 5): 1–21

47. Thomason JM, Kelly SA, Bendkowski A, Ellis JS: Two implant retained overdentures – a review of the literature supporting the McGill and York consensus statements. J Dent 2012; 40: 22–34

48. Troiano G, Lo Russo L, Canullo L, Ciavarella D, Lo Muzio L, Laino L: Early and late implant failure of submerged versus non-submerged implant healing: a systematic review, meta-analysis and trial sequential analysis. J Clin Periodontol 2018; 45: 613–623

49. Weigl P, Strangio A: The impact of immediately placed and restored single-tooth implants on hard and soft tissues in the anterior maxilla. Eur J Oral Implantol 2016; 9 (Suppl 1): S89–106

50. Wentaschek S, Scheller H, Schmidtmann I et al.: Sensitivity and specificity of stability criteria for immediately loaded splinted maxillary implants. Clin Implant Dent Relat Res 2015; 17 (Suppl 2): e542–549

51. Wittneben JG, Gavric J, Sailer I, Buser D, Wismeijer D: Clinical and esthetic outcomes of two different prosthetic workflows for implant-supported all-ceramic single crowns-3 year results of a randomized multicenter clinical trail. Clin Oral Implants Res 2020; 31: 495–505

52. Zhuang J, Zhao D, Wu Y, Xu C: Evaluation of outcomes of dental implants inserted by flapless or flapped procedure: a meta-analysis. Implant Dent 2018; 27: 588–598

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