# The Stability of Immediate Implant Placement in Mandibular Posterior Region: A Preliminary of Case Clinical Trial

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## Abstract

This study aims to evaluate the stability of immediate implant placement in the lower posterior region. Ten patients with mandibular hopeless prognosis teeth were recruited. Ten dental implants were placed immediately in fresh sockets with alloplastic bone substitute material. The appointments of the follow-up were made for recording the implant stability quotients (ISQ) values immediately after the implant placement (W0) and one week (W1), two weeks (W2), four weeks (W4), six weeks (W6), eight weeks (W8), ten weeks (W10), and 12 weeks (W12) after the implant placement. At six months after the implant placement, the final restoration was delivered. Multivariate tests were used to analyze the relationship of the ISQ values at different points in time. The confidence interval was set at 95%, and P-value < 0.05 was interpreted as statistically significant. All mandibular implants were successfully integrated. The mean ISQ value after the implant insertion was 73.85 ± 5.11. The ISQ value was dipped at four weeks at 72.95 ± 5.26. There were statistically significant differences between each point of experimental time (p=0.039). In this preliminary study, the implant installation in a fresh mandibular socket with a regular diameter implant found favorable outcomes. The posterior region's immediate implant placement was challenged because of socket morphology, limited space of site preparation below root apex, and anatomical structure. Hence, the cone-beam computed tomography (CBCT) would help to reduce these complications. It provided critical information prior implant surgery. The implant stability is time-dependent. The ISQ value of one-stage immediate implant placement in the mandibular posterior teeth could be achieved over 60 in both primary and secondary stability. It gradually decreased into the minimum point at the fourth week and then continuously increased until the 12$^{th}$ week.

***Keywords*****:** *dental implant, immediate implant placement, implant stability, mandible*

## 1. Introduction

At present, implant placement immediately after tooth removal surgery tends to get more attention. It had been introduced into publication in 1978 (Schulte et al., 1978). A surgical protocol was then developed from the submerged implant with guided bone regeneration technique (Becker & Becker, 1990; Nyman et al., 1990) to single-stage surgery with a digital customized healing abutment technique (Finelle & Lee, 2017). The superiorities of this approach were reduced amount of surgical procedure, shortened timing of surgical phase, preservation of soft tissue and hard tissue structure, and patient satisfaction (Chen, Wilson & Hammerle, 2004; Kois, 2001; Lang et al., 2012). Besides, Lang and colleagues (2012) reported a systematic review on 98.4% survival rate of the implant placement in the fresh socket after two years of follow-up. It presented favorable outcomes compared with the conventional protocol in healed sites (Lang et al., 2012).

Implant stability was one of the critical requirements for good osseointegration and implant success. There were various measurement techniques for assessing implant stability. The resonance frequency analysis (RFA) was one of those methods. It identified implant stability as the stiffness of the bone-implant interface throughout the healing process. It displayed as implant stability quotients value (ISQ value) from 1 to 100 (Sennerby & Meredith, 2008). A higher ISQ value indicated higher implant stability.

However, the majority of the immediate implant placement had been previously studied in the esthetic zone. The posterior region was scant because there was a limited bone preparation area below the root apex, an anatomical structure such as a mandibular canal or submandibular concavity, and socket morphology. In consequence, many clinicians and researchers attempted to develop novel techniques and investigations. Some prospective case series revealed that the immediate implant placement at the lower

posterior region was a predictable treatment of choice. It showed promising survival rates of 100% (Cafiero et al., 2008; Hayacibara et al., 2013) and 99.1% ((Fugazzotto, 2008). Most of the clinical parameters were intraoral radiographic assessment, probing depth, keratinized gingiva's width, plaque scores, bleeding index, and patient satisfaction. The implant stability evaluation with resonance frequency analysis was lack of evidence.

## 2. Objectives

To evaluate the stability of immediate implant placement in the lower posterior region.

## 3. Materials and Methods

The ethic of this study was affirmed by the institutional review board at the Faculty of Dentistry/Faculty of Pharmacy, Mahidol University. COA 2020/011.2801.

Subjects were recruited from the patients who had un-restorable mandibular posterior teeth and needed immediate implant placement at the Faculty of Dentistry, Mahidol University, between February 2020 and August 2020. All patients were provided informed consent about all research processes, advantages and disadvantages of the immediate implant placement, complications, expenditures, and amount of total visits. The inclusion criteria of this study were as followed:

- Healthy patient aged more than 18 years old.
- The patients could undergo oral surgical procedures under local anesthesia.
- The lower posterior teeth represented a hopeless prognosis due to an un-restorable condition, root fracture, and failure of endodontic treatment.
- The tooth socket had intact buccal and lingual walls after tooth removal.

Besides, in case the patients could not meet the research protocol due to the following exclusion criteria, they would be kept out.

- Heavy smokers
- Pregnancy
- Alcoholic or chronic drug abuse
- Bone pathology (benign/malignant)
- Regional radiation therapy in head and neck area
- Insertion torque less than 10 Ncm after the implant placement

Before surgery, all enrolled subjects were taken by Cone-beam computed tomography (CBCT) to determine the socket morphology, bone quantity, and inferior alveolar nerve. The surgical treatment was done by the same operator. The patients had been injected with 2% Mepivacaine with 1.8 ml 1:100,000 epinephrine for one cartridge. The mandibular posterior tooth was removed under the atraumatic extraction technique. The guided surgical stent was checked for fitting to the adjacent teeth. The osteotomy was operated in sequence as recommended by the company. The implant (Dentium, SuperLineII implant, Dentium, Gyeonggi-do, Korea) was inserted. Then, the SmartPeg (Type 7, OsstellAB, Gothenburg, Sweden) was tightened to the implant. The ISQ device (Mega ISQ™, MEGA'GEN, Korea) was handled 90 degrees to the tip of the SmartPeg in 4 directions; buccal, lingual, mesial, and distal, consecutively. Each site was reproduced three times to find the average ISQ value. Afterward, the alloplastic bone substitute material (OSTEON™ III, synthetic bone graft material, Genoss Co., Korea) was filled to the gap between alveolar sockets and the implant fixture. The customized healing abutment was placed as a one-stage surgery procedure as shown in Figure 1. Then, the periapical film was taken to confirm the implant's position and seating of the customized healing abutment, as shown in Figure 2a.

For the post-operative procedure, every patient was prescribed post-operative instructions and drugs, including antibiotic drugs (500 mg of amoxicillin, three times a day for one week from the day of surgery or 300 mg clindamycin, three times a day for one week in case of penicillin allergy), analgesic drugs (500 mg acetaminophen, to be taken as necessary, every 6 hours and 400 mg ibuprofen, to be taken as necessary, every

8 hours), and 0.12% chlorhexidine gluconate mouthwash (twice daily for two weeks from the day after surgery). The appointments of follow-up were made for recording the ISQ values at one week (W1), two weeks (W2), four weeks (W4), six weeks (W6), eight weeks (W8), ten weeks (W10), and 12 weeks (W12) afther the implant placement. At six months after the implant placement, the final restoration was delivered.

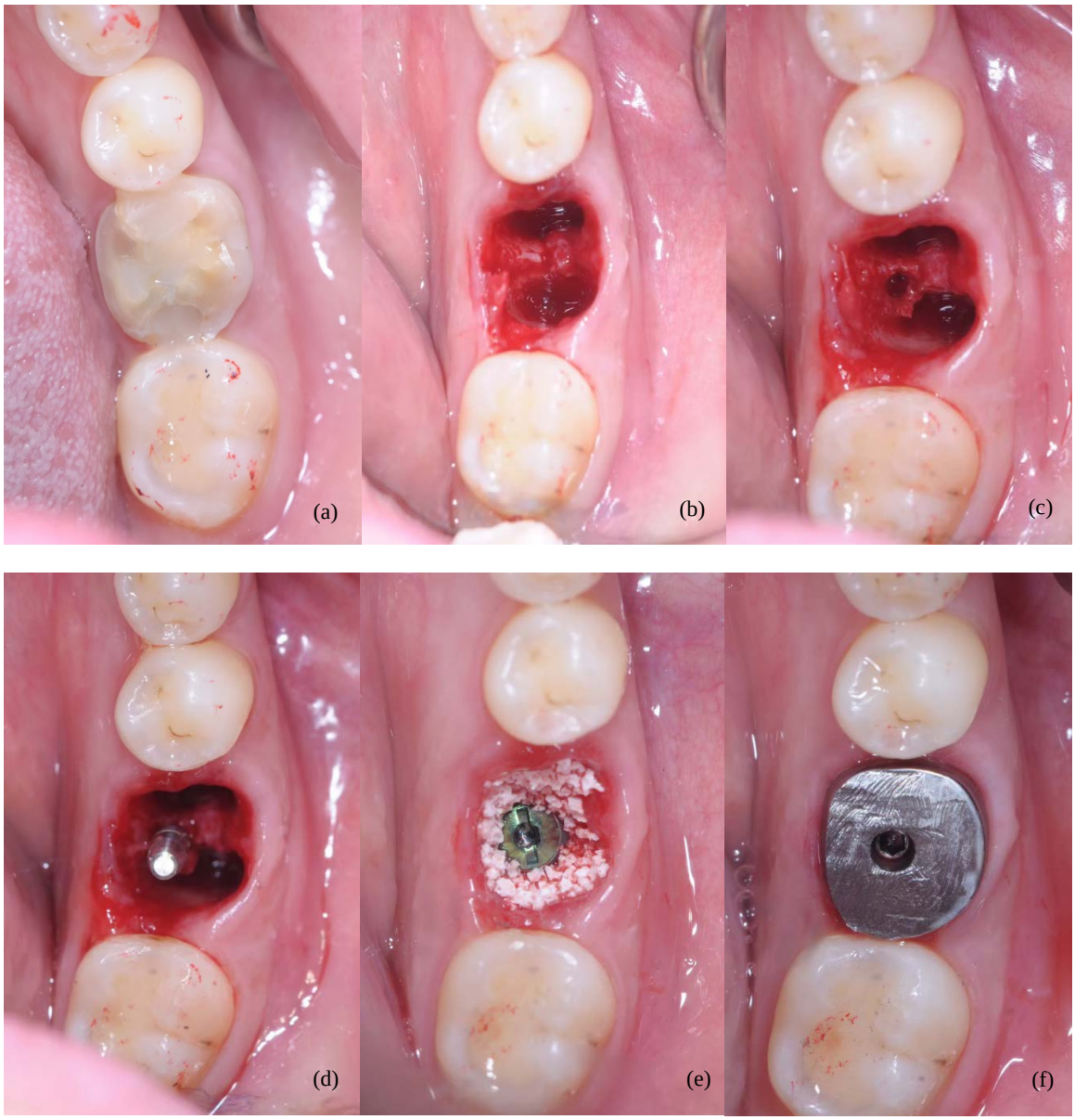


**Figure 1** shows immediate implant placement procedure (a) Pre-operative tooth #36 needed extraction due to endodontic failure, (b) Post extraction socket with atraumatic technique, (c) Initial osteotomy was performed at the septal bone for ideal restorative implant position, (d) Parallel pin was placed to confirm implant position, (e) Implant placement with alloplastic bone material, and (f) The customized healing abutment was inserted.

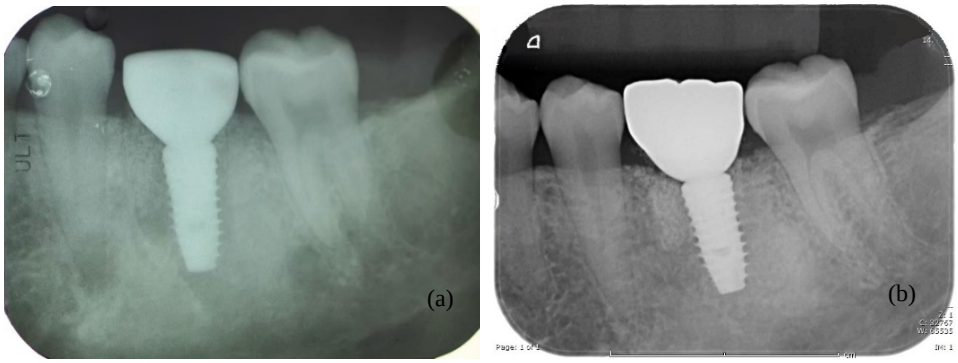


**Figure 2** The radiographic evaluation of tooth #36 (a) Immediate postoperative radiograph with a customized healing abutment and (b) Post-prosthetic radiograph with the final restoration.

*Statistical analysis*

Statistical analysis was achieved using PASW Statistics 18.0 (SPSS Inc. Chicago, IL, USA). The Shapiro-Wilk test was applied to calculate if the parameters assemble the normal distribution assumption. The results represented that the data were normally distributed. Multivariate tests were used to analyze the relationship of the ISQ values at different points in time. The confidence interval was set at 95%, and P-value < 0.05 was interpreted as statistically significant.

## 4. Results and Discussion

*4.1 Results*

All 10 patients (7 females and 3 males), with a mean age of 44.6 ± 16.97 years (ranged between 24 to 69 years), were enrolled in this study. The immediate implant procedures were operated on in 2-second premolars, 4-first molars, and 4-second molars teeth. Most of the teeth were extracted from the endodontic failure problem (40%), followed by non-restorable teeth (30%), root fracture (20%), and external root resorption (10%), respectively. Ten implants were inserted equally 10 and 12 mm in length with regular diameter implants, as shown in Table 1.

**Table 1** Demographic data of the patients

| Parameters | |
|---|---|
| Gender | |
| Male | 3 (30%) |
| Female | 7 (70%) |
| Age (Mean ± SD) | 44.6±16.97 |
| Implant size | |
| 4.0 x 12 mm | 1 |
| 4.5 x 10 mm | 3 |
| 4.5 x 12 mm | 4 |
| 5.0 x 10 mm | 2 |
| Implant sites | |
| Second premolar | 2 |
| First molar | 4 |
| Second molar | 4 |

All mandibular implants were successfully integrated. Neither implant mobility nor post-operative complications such as infection, neurosensory disturbance, or active bleeding were found (Figure 3). The definitive restorations were completed at 6 months (Figure 4d).

**Figure 3** shows a great adaptation of gingiva from the customized healing abutment at a follow-up visit and no signs and symptoms of complications.

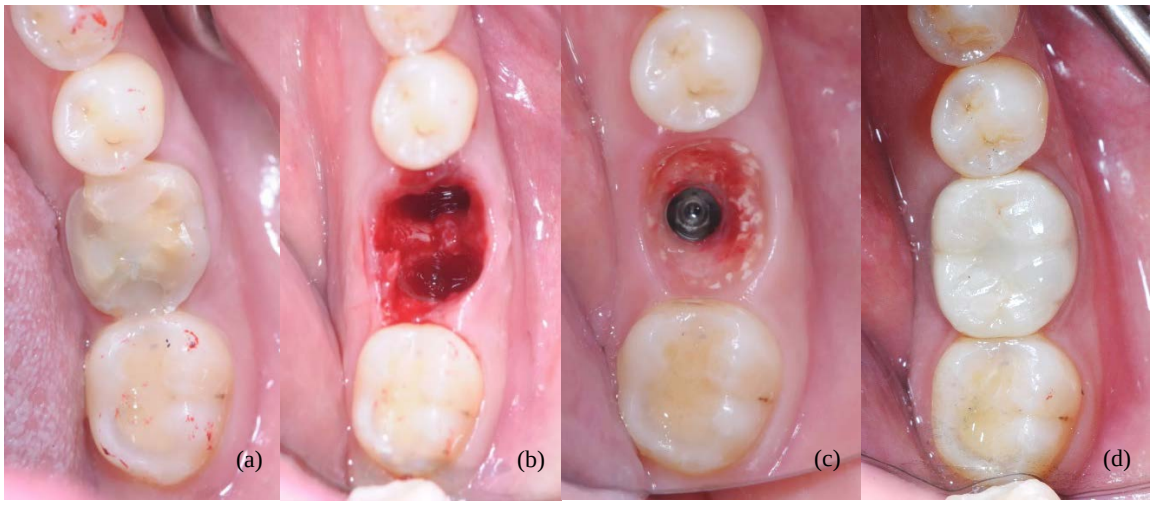


**Figure 4** shows the overall process of the immediate implant placement from surgical to prosthodontic stages (a) Pre-operative tooth #36, (b) Fresh socket of tooth #36, (c) Postoperative follow-up at 3 months, and (d) Final prosthesis at 6 months.

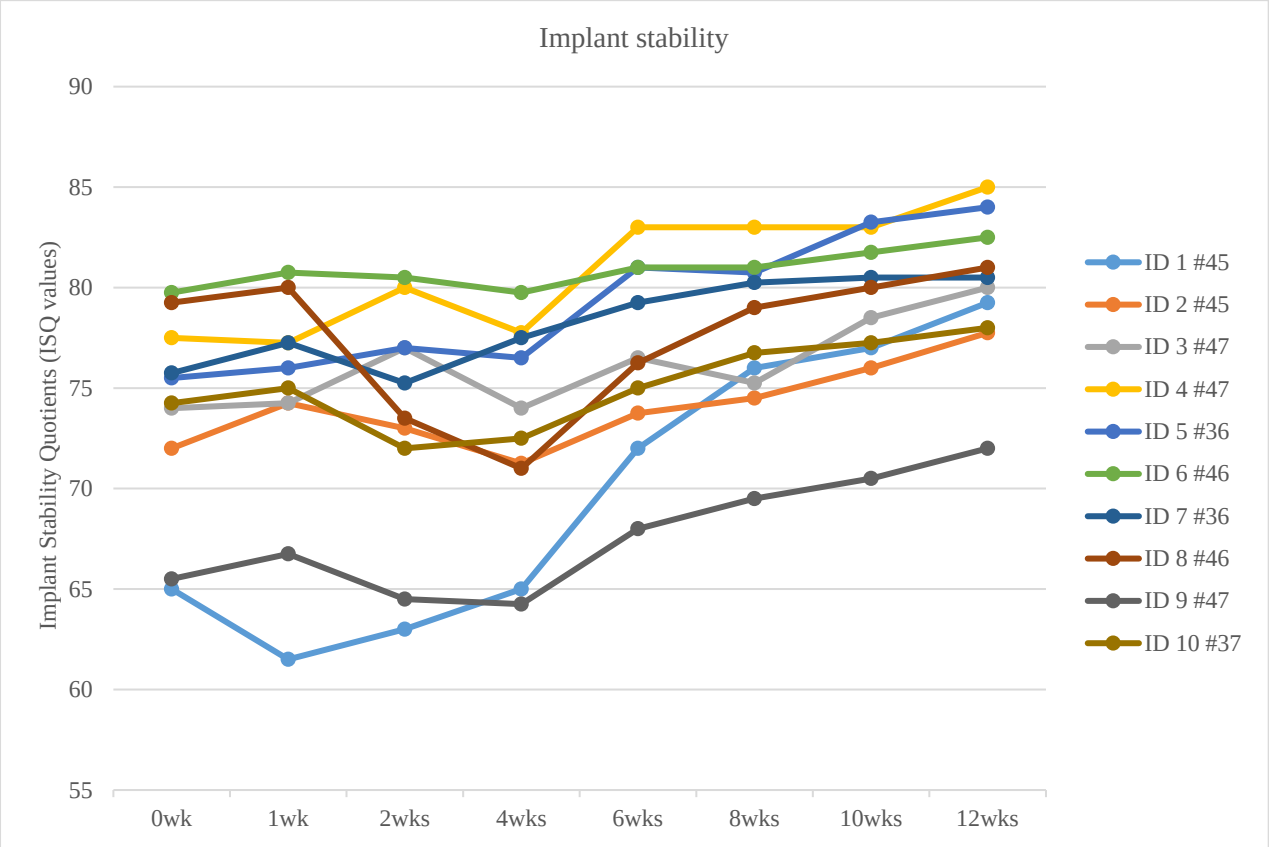


**Figure 5** The graph presents the individual relationship between ISQ values and the observational period in each tooth.

Figure 5 shows the details of the implant stability (ISQ values) in each tooth throughout the follow-up period in 3 months. The primary stability after the implant placement was ultimately more than 60 in every case. The lowest ISQ value was detected in the second premolar and second molar teeth (ISQ = 65). The entire stability tended to dip between 1 week and 4 weeks. Then, they increased gradually up to 12 weeks (ISQ >70).

In brief, Figure 6 summarizes the overall trending linear graph of the implant stability from the implantation day to the 12$^{th}$-week follow-up. The lowest point was at 4 weeks. Additionally, the mean implant stability quotients (ISQ) value after the implant insertion was 73.85 ± 5.11, which increased to 74.30 ± 5.92 at week 1. Then, the ISQ value was gradually declined at 2 weeks and 4 weeks after the implant placement, which was the minimum point (72.95 ± 5.26). After 4 weeks, the mean ISQ value steadily improved until the 12$^{th}$ week at 80.00 ± 3.68 (Table 2). There were statistically significant differences between each point of experimental time (p=0.039).

**Table 2** Mean and standard deviation of implant stability quotients (ISQ) values throughout observational time

| | W0 | W1 | W2 | W4 | W6 | W8 | W10 | W12 | P-Value |
|---|---|---|---|---|---|---|---|---|---|
| ISQ | 73.85±5.11 | 74.30±5.92 | 73.58±5.89 | 72.95±5.26 | 76.58±4.63 | 77.60±4.00 | 78.78±3.84 | 80.00±3.68 | 0.039 |

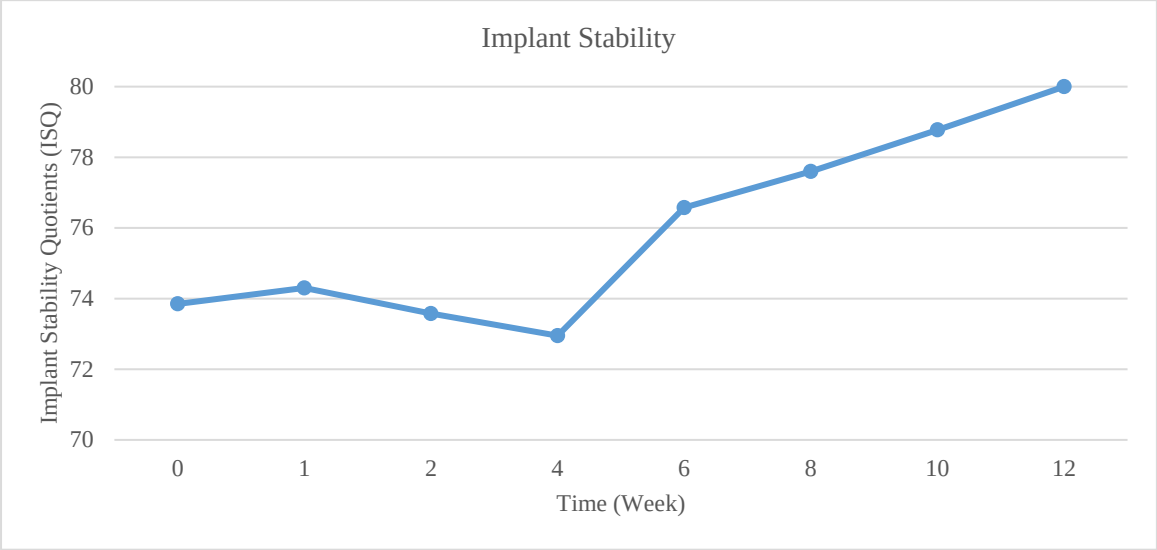


**Figure 6** The graph summarizes the overall relationship between the mean ISQ values and the observational period.

**Table 3** Multiple comparisons with Bonferroni correction test comparing the ISQ values between points of observational time

| | W0 | W1 | W2 | W4 | W6 | W8 | W10 | W12 |
|---|---|---|---|---|---|---|---|---|
| W0 | x | 1.000 | 1.000 | 1.000 | 0.418 | 0.128 | 0.022* | 0.01* |
| W1 | x | x | 1.000 | 1.000 | 1.000 | 1.000 | 0.310 | 0.133 |
| W2 | x | x | x | 1.000 | 0.156 | 0.282 | 0.041* | 0.016* |
| W4 | x | x | x | x | 0.004* | 0.024* | 0.004* | 0.003* |
| W6 | x | x | x | x | x | 1.000 | 0.005* | 0.024* |
| W8 | x | x | x | x | x | x | 0.140 | 0.006* |
| W10 | x | x | x | x | x | x | x | 0.009* |
| W12 | x | x | x | x | x | x | x | x |

* P-value < 0.05

Furthermore, multiple comparisons with the Bonferroni correction method were significantly different between the point of time ($p < 0.05$). In comparison with different points of time, statistically, significant differences were found between week 4 and week 6 ($p=0.004$), week 4 and week 8 ($p=0.024$), week 4 and week 10 ($p=0.004$), and week 4 and week 12 ($p=0.003$), as shown in Table 3.

*4.2 Discussion*

In this preliminary study, the implant installation in the fresh mandibular socket with a regular diameter implant found favorable outcomes. All dental implants achieved successfully integrated. One significant factor for the success of the immediate treatment is implant stability at the time of implantation. According to our findings, the mean implant stability quotients (ISQ) value after the implant insertion was 73.85 ± 5.11 at the baseline. The ISQ value was dipped at the 4$^{th}$ week and steadily improved until the 12$^{th}$ week at 80.00 ± 3.68. Likewise, it was supported by some previous studies of immediate implant placement in posterior teeth with SLA surface implants. Shoki and Daraeighaddikolaei (2013) also found a similar outcome in the prospective cohort study. For all fifteen mandibular implants, the average ISQ value was reduced at the second week and continuously decreased to the same fourth week (72.13 ± 5.69). After that, it started to increase until the eleventh week (Shokri & Daraeighadikolaei, 2013). Besides, there was another study of implant stability alteration during 6 months with resonance frequency analysis. It revealed the same trending, in which the mean value of mechanical stability was at 74.03 ± 5.63, and the minimum point was

71.82 ± 6.17 at the fourth week. They concluded that implant stability was correlated with time (Somraj et al., 2020).

The implant should be engaged in an intact bone to accomplish primary stability. In anterior teeth, the tooth socket could sustain the implant apically and palatally due to the single-rooted shape. On the contrary, fresh molar extraction sites were more competitive due to the socket morphology, limited space of site preparation below root apex, and anatomical structure. Firstly, the socket morphology in the molar teeth, which there were 3 types based on the shaping of septal bone. Type A socket had an adequate septal bone for a complete engagement of implant. Type B socket had septal bone within socket but not enough to circumferentially containing the implant. Type C socket did not have a septal bone (Smith & Tarnow, 2013). In this study, the second premolar (ID1) and the second molar teeth (ID9) had the lowest primary stability. Because their sockets were prone to Type C, which the septal bone did not exist to stabilize the implant, the implant had to engage with the socket's surrounding walls. In this category, the preservation of the buccal and lingual plate was essential. If no buccal nor lingual plate remained, the delayed protocol should be the treatment option. The lower second molar tooth had 9 mm in buccolingual width (Scheid & Weiss, 2020). A wide diameter or ultra-wide diameter implant (7-9 mm) might be an alternative for improving the primary stability in the mandibular molar area.

Secondly, the limited space of apical bone below the tooth socket is concerned with the anatomical structure. The mandible has an inferior alveolar nerve and submandibular fossa, which could lead to nerve injury and lingual plate perforation, resulting in a sublingual or submandibular hematoma (Chan et al., 2011; Misch & Resnik, 2010). Some studies presented a high risk of lingual plate perforation in the molar region (Demircan, 2020; Froum et al., 2011) and mandibular nerve perforation (Lin et al., 2014). It is speculated from the results that two subjects (ID1 and ID9) had different lower implant primary stabilities comparing with others. This finding may partially be a result of periapical lesions presented in both subjects, which reduced the residual bone height below the alveolar socket. In consequence, the final implant planning would be modified into a longer length in ID1 and a wider diameter in ID9 to improve more primary stability. It seemed that the periapical lesion might be the factor that disturbed the implant stability in this study. Therefore, the cone-beam computed tomography (CBCT) would help to reduce these complications. It provided critical information prior to the implant surgery. Besides, it predicted the primary stability before the implantation and the probability of immediate or early loading (Salimov et al., 2014).

The limitation of this study consisted of small sample sizes, a short follow-up period, and variation of the experimental area. The authors suggested greater sample sizes, a longer follow-up term, and localized molar teeth for further study.

## 5. Conclusion

The implant stability is time-dependent. The ISQ value of one-stage immediate implant placement in mandibular posterior teeth could be achieved over 60 in both primary and secondary stability. It gradually decreased into the minimum point at the fourth week and then continuously increased until the 12$^{th}$ week.

## 6. Acknowledgements

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## 7. References

Becker, W., & Becker, B. E. (1990). Guided tissue regeneration for implants placed into extraction sockets and for implant dehiscences: surgical techniques and case report. *Int J Periodontics Restorative Dent, 10*(5), 376-391.

Cafiero, C., Annibali, S., Gherlone, E., Grassi, F. R., Gualini, F., Magliano, A., . . . Italia, I. T. I. Study Group. (2008). Immediate transmucosal implant placement in molar extraction sites: a 12-month prospective multicenter cohort study. *Clin Oral Implants Res, 19*(5), 476-482. doi:10.1111/j.1600-0501.2008.01541.x

Chan, H. L., Benavides, E., Yeh, C. Y., Fu, J. H., Rudek, I. E., & Wang, H. L. (2011). Risk assessment of lingual plate perforation in posterior mandibular region: a virtual implant placement study using cone-beam computed tomography. *J Periodontol, 82*(1), 129-135. doi:10.1902/jop.2010.100313

Chen, S. T., Wilson, T. G., & Hammerle, H. F. (2004). Immediate or early placement of implants following tooth extraction: Review of biologic basis, clinical procedures, and outcomes. *International Journal of Oral & Maxillofacial Implants, 19*, 12-25.

Demircan, S. (2020). Prosthetically driven immediate implant placement at lower molar area; an anatomical study. *Eur Oral Res, 54*(1), 25-30. doi:10.26650/eor.20200059

Finelle, G., & Lee, S. J. (2017). Guided Immediate Implant Placement with Wound Closure by Computer-Aided Design/Computer-Assisted Manufacture Sealing Socket Abutment: Case Report. *Int J Oral Maxillofac Implants, 32*(2), e63-e67. doi:10.11607/jomi.4770

Froum, S., Casanova, L., Byrne, S., & Cho, S. C. (2011). Risk assessment before extraction for immediate implant placement in the posterior mandible: a computerized tomographic scan study. *J Periodontol, 82*(3), 395-402. doi:10.1902/jop.2010.100360

Fugazzotto, P. A. (2008). Implant placement at the time of mandibular molar extraction: description of technique and preliminary results of 341 cases. *J Periodontol, 79*(4), 737-747. doi:10.1902/jop.2008.070293

Hayacibara, R. M., Goncalves, C. S., Garcez-Filho, J., Magro-Filho, O., Esper, H., & Hayacibara, M. F. (2013). The success rate of immediate implant placement of mandibular molars: a clinical and radiographic retrospective evaluation between 2 and 8 years. *Clin Oral Implants Res, 24*(7), 806-811. doi:10.1111/j.1600-0501.2012.02461.x

Kois, J. C. (2001). Predictable single tooth peri-implant esthetics: five diagnostic keys. *Compend Contin Educ Dent, 22*(3), 199-206; quiz 208.

Lang, N. P., Pun, L., Lau, K. Y., Li, K. Y., & Wong, M. C. (2012). 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, 23 Suppl 5*, 39-66. doi:10.1111/j.1600-0501.2011.02372.x

Lin, M. H., Mau, L. P., Cochran, D. L., Shieh, Y. S., Huang, P. H., & Huang, R. Y. (2014). Risk assessment of inferior alveolar nerve injury for immediate implant placement in the posterior mandible: a virtual implant placement study. *J Dent, 42*(3), 263-270. doi:10.1016/j.jdent.2013.12.014

Misch, C. E., & Resnik, R. (2010). Mandibular nerve neurosensory impairment after dental implant surgery: management and protocol. *Implant Dent, 19*(5), 378-386. doi:10.1097/ID.0b013e3181effa92

Nyman, S., Lang, N. P., Buser, D., & Bragger, U. (1990). Bone regeneration adjacent to titanium dental implants using guided tissue regeneration: a report of two cases. *Int J Oral Maxillofac Implants, 5*(1), 9-14.

Salimov, F., Tatli, U., Kurkcu, M., Akoglan, M., Oztunc, H., & Kurtoglu, C. (2014). Evaluation of relationship between preoperative bone density values derived from cone beam computed tomography and implant stability parameters: a clinical study. *Clin Oral Implants Res, 25*(9), 1016-1021. doi:10.1111/clr.12219

Scheid, Rickne C, & Weiss, Gabriela. (2020). *Woelfel's dental anatomy*: Jones & Bartlett Publishers.

Schulte, W., Kleineikenscheidt, H., Lindner, K., & Schareyka, R. (1978). [The Tubingen immediate implant in clinical studies]. *Dtsch Zahnarztl Z, 33*(5), 348-359.

Sennerby, L., & Meredith, N. (2008). Implant stability measurements using resonance frequency analysis: biological and biomechanical aspects and clinical implications. *Periodontol 2000, 47*, 51-66. doi:10.1111/j.1600-0757.2008.00267.x

Shokri, M., & Daraeighadikolaei, A. (2013). Measurement of primary and secondary stability of dental implants by resonance frequency analysis method in mandible. *Int J Dent, 2013*, 506968. doi:10.1155/2013/506968

Smith, R. B., & Tarnow, D. P. (2013). Classification of molar extraction sites for immediate dental implant placement: technical note. *Int J Oral Maxillofac Implants, 28*(3), 911-916. doi:10.11607/jomi.2627

Somraj, B., Panyayong, W., Chuenjitkuntaworn, B., Amornsettachai, P., & Suphangul, S. (2020). The Stability of Immediate Implant Placement in Posterior Region: a Six-Month Study. *Khon Kaen University Dental Journal*, *23*(2), 22-30.