Oral health-related quality of life of patients using single or two-implant mandibular overdentures with immediate loading protocols: A randomized controlled trial

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Aim: Single implant-retained mandibular overdentures (1IMO) is a viable alternative to 2 implant-retained overdentures (2IMO) in edentulous patients. However, literature lacks in the quality of life (QoL) of these patients when treated with immediate loading protocols. The purpose of this study was to compare oral health-related QoL (OHRQoL) of patients using 1IMO or 2 IMO with immediate loading protocols at 1 month and 1 year.

Settings and Design: Randomized Controlled Trial.

Materials and Methods: Fifty-two edentulous participants treated with mandibular overdentures using either single implant (n = 26) or two implants (n = 26) with immediate loading protocol by a single operator. The low-profile stud-attachments (LOCATOR; Zest Anchors) were attached to the implants and female attachments were picked up within 0–7 days of implant placement. The OHRQoL was recorded using Oral Health Impact Profile-14 (OHIP-14) questionnaire either in English or in the Malay language before treatment and 1 month and 1 year after treatment.

Statistical Analysis Used: Kruskal Wallis test was used to find out significant difference amongst 3 timepoints and 7 OHIP-14 domains and Mann-Whitney-U test to compare 1IMO or 2IMO groups.

Results: Compared to baseline OHIP-14 scores, participants had a statistically significant decrease in total OHIP-14 at 1 month and 1 year after-treatment time points in both 1IMO and 2IMO groups (P < 0.05). The difference between 1 month and 1 year after-treatment total and subscale scores were also found to be statistically significant (P < 0.05). The overall QoL improvement was comparatively higher in 2IMO group than 1IMO group. The OHIP-14 scores were statistically different within seven domains (P < 0.05). Overall total scores between 1IMO and 2IMO groups were also found to be statistically significant (P < 0.05) at baseline and insignificant (P > 0.05) at 1 month and 1 year.

Conclusions: Mandibular single and 2IMO improve the QoL of elderly edentulous Malaysian participants at 1 month of immediate loading and 1 year of recall. 1IMO may provide comparable QoL with the elderly patients using 2 implants.

Keywords: Mandibular overdenture, patient-reported outcomes, quality of life, single implant overdenture
INTRODUCTION

Edentulism is a physical impairment due to compromised ability to perform essential life tasks, such as speaking and eating. Conventional complete dentures are one of the most widely used treatment modalities. However, lack of retention and stability result in decrease in chewing ability in denture users. The clinically stable mandibular denture is the most important determinant of patients’ satisfaction. Dental implants have provided varieties of fixed and removable attachment systems in restoring completely edentulous arches.

Numerous clinical studies reported a significant improvement in the quality of life (QoL) of the patient using the 2-implants retained mandibular overdentures (2IMO) (13,14). However, the concept of 1 (single) implant-retained mandibular overdenture (1IMO) is not new. The 1IMO reduces the patient’s initial treatment cost, minimize postsurgical trauma, and provides lesser maintenance cost as compared with the 2IMO. The 1IMO concept was introduced by Cordioli and later published the 5-year results with 100% implant success rate. In recent years, 1IMO has been proved to be the clinically viable alternative option to 2IMO.

Timing of the prosthetic loading on the success of implant overdentures has been researched extensively and categorized as immediate, early, and delayed (or conventional) loading. Results of all the systematic reviews revealed no significant difference in peri-implant tissue outcome, marginal bone loss, implant stability, and QoL outcomes among the loading protocols. The immediate loading protocols, however, gained popularity because patients can enjoy immediate esthetics and function and it also helps reduce postoperative pain and discomfort, as the masticatory load on the healing tissues is reduced.

Many clinicians have successfully attempted immediate loading protocols with 1IMO. Most of these studies were retrospective or prospective clinical studies and very few randomized controlled trials (RCTs). These studies evaluated the marginal bone levels, implant stability, complications, maintenance, and patient satisfaction on visual analogue scale. The impact of implant overdentures on the QoL was identified as an essential outcome. However, the literature lacks the information on oral health-related QoL (OHRQoL) of the patients using 1IMO with immediate loading protocols. Oral Health Impact Profile (OHIP) is one of the most valid and reliable tools used to evaluate the OHRQoL. A recent systematic review of 17 studies (9 RCTs and 8 prospective studies) evaluated the effect of the 1IMO on patient-reported outcome measures and masticatory function in the edentulous patients. Improved patient satisfaction and OHRQoL were evident when compared with conventional complete dentures, however conflicting results were observed in OHRQoL when compared with 2IMO.

Hence, the present randomized controlled clinical study was designed to evaluate the OHRQoL of patients receiving 1IMO or 2IMO restored with immediate loading protocols. The null hypothesis was that no difference would be found in patients’ OHRQoL using either 1IMO or 2IMO when loaded immediately.

MATERIALS AND METHODS

Study design

This was a single-center, prospective, randomized, controlled, clinical trial that aimed to compare OHRQoL between groups of patients receiving 1IMO or 2IMO. The study was conformed to the CONSORT 2010 statement and in compliance with the Declaration of Helsinki (version, 2008). Institutional ethical approval was obtained from the joint committee on research and ethics (No. R148/2014). The trial was prospectively registered with the National Medical Research Register (NMRR-15-19-23859) of the authors’ country. This project was supported by a grant from the International Team for Implantology Foundation, Switzerland (Grant Number: 927_2013). The study site was the oral health center of the authors’ university.

Participants

A total of 52 participants were treated (between August 2015 and October 2020) with immediately loaded implant overdentures using the low-profile self-aligning attachments (LOCATOR; Zest Anchors) and followed up for 1 month and 1 year. Written informed consent were obtained from all the participants. The improvement in QoL of 1IMO after 1 year as the primary endpoint of the study was a binomial random variable. The sample size was calculated for two parallel-sample proportions using following webtool: https://www2.ccrb.cuhk.edu.hk/stat/proportion/tspp_sup.htm. The success probability was assumed to be 95% in the control group (2IMO) and 85% in the experimental group (1IMO). Under these assumptions, a power of 80% reveals the noninferiority of the 1IMO if the sample size is 40 (20 per group) with 1:1 allocation ratio in each group. Twelve (30%) additional participants were added to make a total of 52 participants to compensate for possible dropouts or losses to follow-up.
Inclusion criteria
Male or female with completely edentulous mandible, aged between 40 and 80 years, with 3 months of complete denture wearing experience, adequate bone height in the anterior mandible for standard implants, agree to receive intervention, and agree to attend planned recall appointments.

Exclusion criteria
Patients having medical conditions including a history of bisphosphonate therapy, anticoagulant therapy, chronic illness, head-and-neck radiation, any systemic condition that may contra-indicate implant treatment or habit of smoking more than 10 cigarettes per day. A person smoking more than 10 cigarettes was considered a heavy smoker and classified as a high-risk patient for implant treatment according to the SAC classification system.

Patients’ existing complete dentures were considered for attachment pick-up after expert evaluation for its functionality and acceptability. All the denture-related clinical and technical aspects were evaluated including denture border extension, occlusion, retention, and stability. A new set of dentures were fabricated only for those patients who need to change their denture and allowed them to use for minimum 3 months before undergoing the implant treatment. The mandibular bone was evaluated for suitability of implant placement with intraoral periapical radiograph and bone-sounding method or with a cone-beam computed tomography as per the set protocols.

Intervention
Both the authors performed initial screening process and selection of the participants based on the inclusion and exclusion criteria. The participants were then randomly allocated to the test (1IMO) and control (2IMO) groups using the sealed opaque white envelopes with an allocation ratio of 1:1. The patient’s identity was protected using a secret code number given to each patient. All the surgical and prosthetic procedures were performed according to the set protocols, by a single experienced implant clinician (primary author) to minimize the risk of inter-operator skill bias. The dental implants (Roxsolid SLActive; Straumann) with 3.3 mm or 4.1 mm diameter and 10 mm or 12 mm length were used based on the available bone volume in the anterior mandible. The implants were placed under local anesthesia by raising a full-thickness flap at the osteotomy site with primary stability of 35 NCm.

For the 2IMO group, both implants were placed in the canine region and for the 1IMO group, the implant was placed in the mid-symphysial region. The male LOCATOR attachments (Zest Anchors) (2, 3, 4, or 5 mm height) were placed immediately after implant placement depending upon the tissue thickness and the female attachment units picked up in the denture chairside within 0-7 days of implant placement. Either blue or pink female attachments were used in the patients according to the needs. Postsurgical analgesics were prescribed to all the participants for 3–5 days. The data processor and statistician were blinded. The study participants and the implant clinicians could not be blinded.

Quality of life measurements
The OHIP-14 was used in English or Malay language based upon patients’ language preference and understanding at three different time points: Baseline (before implant placement), 1 month, and 1 year after implant placement. Malay version of the OHIP-14 was validated by Saub et al.

The OHIP-14 consisted of 14 items grouped into 7 domains or subscales containing 2 questions each and named as: Functional limitation, physical pain, psychological discomfort, physical disability, psychological disability, social disability, and handicap. The five response categories for each item were never, seldom, sometimes, often, and always. The items were scored on 5-point scales ranging from “0” = “never” to “4” = “always.” Achievable OHIP-14 scores range from 0 to 56 for 14 questions. The scores were presented by adding the scores of both questions of each domain. As the OHIP-14 is the questionnaire of frequency of the problems that occurred and the lower scores depict the lesser frequency of the problems and thus interpreted as higher OHRQoL.

The patients’ responses using the OHIP-14 questionnaire were used at baseline, at 1 month, and 1 year after the treatment.

Statistical analysis
The data were analyzed with statistical software IBM SPSS Statistics, v25.0; IBM Corp., New York, USA. The test of normality of the data was carried out using Shapiro–Wilk. Since the data were not normally distributed, the nonparametric Kruskal–Wallis test was used to find out significant differences among 3 time points and 7 OHIP-14 domains and Mann–Whitney-U test to compare 1IMO or 2IMO groups at the significance level of 0.05 and 95% confidence interval.

RESULTS
Of the 52 participants included, 21 were men and 31 were women with an average age of 63.5 years ranged between 42 and 80 years (Table 1). Seventy-eight implants were placed in 52 participants, of which 4 implants were failed in 1IMO group (2 exfoliated in 1 month due...
to failed osseointegration, 2 removed in 1 year due to peri-implantitis) and 1 implant failed in 2IMO group due to peri-implantitis [Figure 1]. Another 3 participants lost to follow-up appointments [Figure 1]. Hence, responses of total 44 participants were analyzed (20 from 1IMO and 24 from the 2IMO group). Total mean OHIP-14 score at baseline for 1IMO was 14.55 and for 2IMO was 19.25. At 1 month after treatment, it was reduced to 8.65 in 1IMO and 9.58 for 2IMO group and at 1 year after treatment, it was further reduced to 3.35 in 1IMO and 5.25 in 2IMO group. The highest baseline scores were observed with the subscale “physical pain” in both 1IMO (4) and 2IMO (4.1) groups and the lowest scores were observed with the subscale “social disability” for both 1IMO (0.55) and 2IMO (1.58) groups [Table 2]. Only “psychological discomfort” domain showed higher change in scores with the 1IMO group (1.2 at 1 month, 1.9 at 1 year) compared to 2IMO group (1.17 at 1 month, 1.38 at 1 year).

Overall mean and standard deviation of OHIP-14 scores at three-time points were recorded [Table 3]. The test of normality indicated that the data were not normally distributed ($P < 0.05$) [Table 3]. Compared to baseline scores, the participants had a statistically significant decrease in total OHIP-14 at 1 month and 1 year after-treatment time points in both 1IMO and 2IMO group ($P < 0.05$) [Tables 4, 5 and Figure 4a-d]. The difference between 1 month and 1 year after treatment, the total and subscale scores were also found to be statistically significant ($P < 0.05$) [Table 5 and Figure 4c, d]. All subscale
and total scores indicated consistently decreasing trend in both groups at 1 month and further at 1 year. The remaining all 6 subscales and the total scores indicated lower changes in 1IMO group than 2IMO group. The overall QoL improvement was comparatively higher in 2IMO group than 1IMO group. The OHIP-14 scores were statistically different within 7 domains \((P < 0.05)\) [Table 6]. Pairwise comparison among different domains indicated statistical differences between following different pairs of domains 6-1 \((P = 0.000)\), 6-4 \((P = 0.000)\), 6-2 \((P = 0.000)\), 7-1 \((P = 0.002)\), 7-4 \((P = 0.000)\), 7-2 \((P = 0.000)\), 5-4 \((P = 0.007)\), 5-2 \((P = 0.000)\), 3-2 \((P = 0.001)\). The remaining all pairs indicated \(P > 0.05\).

Overall total scores between 1IMO and 2IMO groups were also found to be statistically significant \((P < 0.05)\) [Table 7 and Figure 5a]. However, further timeline wise analysis indicated that this difference was only statistically significant at baseline \((P = 0.011)\) and insignificant at 1 month \((P = 0.402)\) and 1 year \((P = 0.053)\) [Table 8 and Figure 5b-d].

**DISCUSSION**

The hypothesis was rejected as the results indicated higher OHRQoL (as indicated by lower OHIP-14 scores in all subscales except 1) with the 2IMO group compared with the 1IMO group patients. This randomized controlled clinical study evaluated the OHRQoL using the OHIP-14 questionnaire. A full 49-item version of OHIP is not always practical in a clinical setting and hence a shorter version development by Slade\(^{24}\) was used. Use of the 1IMO could be considered inferior as compared with the minimum standard of care of the 2IMO for the edentulous mandible. However less cost, minimal surgical trauma, and minimal repair or maintenance are few of the advantages of the 1IMO and compared to evaluate the OHRQoL. The OHIP-14 results depict that higher pretreatment total scores for the 2IMO \((19.25)\) and lower for the 1IMO \((14.55)\) [Table 2]. These baseline scores could vary up to certain extent and should not be considered of any relevance as the scoring values are completely depending on the characteristics of the patients being selected in each group. The present study randomly selected all the participants with no specific criteria being applied like age, sex, or ethnicity. All the subscale scores shown a decreasing trend from baseline to 1 month and 1 year. Greater reduction in the scores indicated the improved OHRQoL. The reduction of the scores at 1 month and

### Table 1: Group-wise details of the participants selected, and the implants used in the study

| Category                  | Patient and treatment details | 1IMO | 2IMO | Total |
|---------------------------|-------------------------------|------|------|-------|
| Sex                       |                               | 6    | 15   | 21    |
|                           | Males                         |      |      |       |
|                           | Females                       | 20   | 11   | 31    |
|                           | Total                         | 26   | 26   | 52    |
| Duration of the denture use | Dentures used >1 year        | 11   | 7    | 18    |
|                           | Dentures used from 3 months to 1 year | 15  | 19   | 34    |
| Maxillary arch edentulous status | Maxillary arch completely edentulous | 23  | 24   | 47    |
|                           | Maxillary arch partially edentulous |      | 3    | 2      |
|                           | Smoking                       | 0    | 1    | 1     |
|                           | Smoking >10 cigarettes per day |      |      |       |
| Implant size              | 3.3 mm diameter               | 24   | 45   | 69    |
|                           | 4.1 mm diameter               | 2    | 7    | 9     |
|                           | Total number of implants placed | 26  | 52   | 78    |
| Implant length            | 10 mm                         | 14   | 39   | 53    |
|                           | 12 mm                         | 12   | 13   | 25    |
|                           | Total number of implants placed | 26  | 52   | 78    |

1IMO: Implants retained mandibular overdentures

### Table 2: Domain wise mean oral health impact profile-14 scores for 1 implants retained mandibular overdenture and 2 implants retained mandibular overdentures groups at three different time points at baseline, 1 month and 1 year

| OHIP-14 domains | Domain number | Mean OHIP scores at baseline | Mean OHIP scores 1 month | Mean OHIP scores 1 year |
|-----------------|---------------|------------------------------|--------------------------|-------------------------|
|                 | 1IMO \((n=20)\) | 2IMO \((n=24)\)               | 1IMO \((n=20)\) | 2IMO \((n=24)\) | 1IMO \((n=20)\) | 2IMO \((n=24)\) |
| Functional limitation | 1             | 2.2                          | 3.5                       | 1.35                    | 2.17                    | 0.65                    | 1.08                    |
| Physical pain    | 2             | 4                            | 4.21                      | 2.6                     | 2.33                    | 1.2                     | 1.08                    |
| Psychological discomfort | 3          | 2.35                         | 2.21                      | 1.15                    | 1.04                    | 0.45                    | 0.83                    |
| Physical disability | 4            | 3.35                         | 3.71                      | 1.9                     | 1.88                    | 0.85                    | 0.67                    |
| Psychological disability | 5           | 1.4                          | 2.33                      | 0.8                     | 0.83                    | 0.15                    | 0.75                    |
| Social disability | 6             | 0.55                         | 1.58                      | 0.4                     | 0.58                    | 0                       | 0.42                    |
| Handicap        | 7             | 0.7                          | 1.71                      | 0.45                    | 0.75                    | 0.05                    | 0.42                    |
| Total score     | 14.55         | 19.25                        |                          | 8.65                    | 9.58                    | 3.35                    | 5.25                    |

1IMO: Implants retained mandibular overdentures, OHIP: Oral health impact profile

[Image 315x253 to 558x334]

**Figure 3**: (a) Implant overdenture of single implant-retained mandibular overdentures group at 1 year recall. (b) Implant overdenture of 2 implant-retained overdentures group at 1 year recall.
1 year were greater for 2IMO group (9.67 at 1 month, 14 at 1 year) compared with 1IMO group (5.9 at 1 month, 11.3 at 1 year). All the subscales indicated a similar trend except the “psychological discomfort” which shown a
Table 4: Kruskal–Wallis test with timeline as a grouping variable

| Domain | n | Mean rank | P  |
|--------|---|-----------|----|
| OHIP-14 score | Baseline | 308 | 590.10 | 0.000 |
|         | 1 month | 308 | 458.56 |    |
|         | 1 year  | 308 | 338.84 |    |

OHIP: Oral health impact profile

Table 5: Pairwise comparison with Kruskal–Wallis test with timeline as a grouping variable

| Timeline pairs | Test statistics | SE | Standard test statistics | P  |
|----------------|-----------------|----|--------------------------|----|
| 1 year and 1 month | 119,718 | 20.332 | 5.898 | 0.000 |
| 1 year and baseline | 251,255 | 20.332 | 12.358 | 0.000 |
| 1 month and baseline | 131,537 | 20.332 | 6.470 | 0.000 |

SE: Standard error

Table 6: Kruskal–Wallis test with oral health impact profile-14 domains as a grouping variable

| Domain | n | Mean rank | P  |
|--------|---|-----------|----|
| OHIP-14 score | 1 | 132 | 532.09 | 0.000 |
|         | 2 | 132 | 633.00 |    |
|         | 3 | 132 | 445.01 |    |
|         | 4 | 132 | 550.97 |    |
|         | 5 | 132 | 406.06 |    |
|         | 6 | 132 | 324.00 |    |
|         | 7 | 132 | 346.36 |    |

OHIP: Oral health impact profile

Table 7: Mann–Whitney test with implant groups as a grouping variable for overall oral health impact profile-14 score

| Implant group | n | Mean rank | Sum of ranks | P  |
|---------------|---|-----------|-------------|----|
| OHIP-14 score | 1IMO | 420 | 433.11 | 182,745.50 | 0.003 |
|               | 2IMO | 504 | 489.33 | 244,604.50 |    |

1IMO: Implants-retained mandibular overdentures, OHIP: Oral health impact profile

Table 8: Pairwise comparison with Mann–Whitney test with implant groups as a grouping variable at different time points

| Implant group | n | Mean rank | Sum of ranks | P  |
|---------------|---|-----------|-------------|----|
| OHIP-14 baseline | 1IMO | 140 | 140.66 | 19,693.00 | 0.011 |
|               | 2IMO | 168 | 166.03 | 27,893.00 |    |
| OHIP-14 1 month | 1IMO | 140 | 150.06 | 21,009.00 | 0.402 |
|               | 2IMO | 168 | 158.20 | 26,577.00 |    |
| OHIP-14 1 year | 1IMO | 140 | 145.50 | 20,370.50 | 0.053 |
|               | 2IMO | 168 | 162.00 | 27,215.50 |    |

1IMO: Implants-retained mandibular overdentures, OHIP: Oral health impact profile

greater reduction in the scores with the 1IMO compared with the 2IMO. This could not be explained as why only “psychological discomfort” was improved in greater extend with the 1IMO. Probably, this could be just an overwhelming response from the participants in the 1IMO group toward their treatment response and psychologically they could be feeling more comfortable due to improved retention compared with their previous experiences of wearing conventional complete dentures.

Fu et al. performed a systematic review on 9 RCTs and 8 prospective studies involving 551 participants and observed that the 1IMO showed no significant differences as compared with 2IMO regarding general satisfaction and satisfaction with speech, comfort, chewing ability, aesthetics, and social life. However conflicting results were observed in OHRQoL and satisfaction with retention and stability. Most of these studies have done with conventional loading protocols. The present study results were in accordance with the previous studies indicated comparable OHRQoL between 1IMO and 2IMO groups with immediate loading.

The literature is inconsistent in presenting the measurement of the OHIP scores and subsequently the QoL results. Brennan et al. compared OHRQoL in patients treated with implant overdentures and complete implant fixed prostheses using OHIP-14 and the scores have been mentioned in the percentage. Berretin-Felix et al. studied the consequences of implant-supported fixed oral rehabilitation on the QoL using OHIP-14 and the results were presented using median value. There was no consistency in using the scoring criteria. The few studies used 0–4 and few used 1–5 for “never” to “always” 5-point scoring criteria. There are multiple ways explained in the literature to present the patient's QoL.

This study has not considered individual's demographics and personal details due to limited sample size and can be considered as a limitation of the study. This research was conducted in the Malaysian population and can be carefully interpreted while treating the patients in other geographical locations. The type of food, frequency of diet, differences in the perception of the problems could affect the OHRQoL and studied can be expanded to evaluate such parameters. Future research can be directed comparing the effect of different demographics and personal details with different patient-reported outcomes including patient satisfaction and masticatory performance.

**CONCLUSIONS**

Within the limitations of this randomized controlled clinical study, the following conclusions were drawn. Mandibular single and 2 implant-retained overdentures improve the QoL of elderly edentulous Malaysian patients at 1 month of immediate loading and 1 year of recall. 1IMO may provide comparable QoL with the patients using 2 implants.
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Conflicts of interest
There are no conflicts of interest.

REFERENCES
1. The glossary of prosthodontic terms: Ninth edition. J Prosthodont 2017;17:1-105.
2. World Health Organization. International Classification of Functioning, Disability, and Health (ICF). Geneva: World Health Organization; 2001.
3. Felton DA. Edentulism and comorbid factors. J Prosthodont 2009;18:88-96.
4. van Waas MA. Determinants of dissatisfaction with dentures: A multiple regression analysis. J Prosthodont 1996;5:469-72.
5. Alfadda SA. The relationship between various parameters of complete denture quality and patients’ satisfaction. J Am Dent Assoc 2014;145:941-8.
6. Roccuzzo M, Bonino F, Guadioso L, Zwahlen M, Meijer HJ. What is the optimal number of implants for removable reconstructions? A systematic review on implant-supported overdentures. Clin Oral Implants Res 2012;23 Suppl 6:229-37.
7. Daudt Polido W, Aghaloo T, Emmons TW, Taylor TD, Morton D. Number of implants placed for complete-arch fixed prostheses: A systematic review and meta-analysis. Clin Oral Implants Res 2018;29 Suppl 16:154-83.
8. Kern JS, Kern T, Wolfart S, Heusen N. A systematic review and meta-analysis of removable and fixed implant-supported prostheses in edentulous jaws: Post-loading implant loss. Clin Oral Implants Res 2016;27:174-95.
9. Feine JS,Carlsson GE, Awad MA, Chedade A, Duncan WJ, Gizianni S, et al. The McGill consensus statement on overdentures. Mandibular two-implant overdentures as first choice standard of care for edentulous patients. Montreal, Quebec, May 24-25, 2002. Int J Oral Maxillofac Implants 2002;17:601-2.
10. Das KP, Jahangiri L, Katz RV. The first-choice standard of care for an edentulous mandible: A Delphi method survey of academic prosthodontists in the United States. J Am Dent Assoc 2012;143:881-9.
11. Cordioli GP. Mandibular overdentures supported by a single implant. Minerva Stomatol 1993;42:469-73.
12. Cordioli G, Majzoub Z, Castagna S. Mandibular overdentures anchored to single implants: A five-year prospective study. J Prosthodont Dent 1997;78:159-65.
13. de Souza Batista VE, Vechiato-Filho AJ, Santiago JF Jr., Sonego MV, Verri FR, Dos Santos DM, et al. Clinical viability of single implant-retained mandibular overdentures: A systematic review and meta-analysis. Int J Oral Maxillofac Surg 2018;47:1166-77.
14. Mahoorkar S, Bhat S, Kant R. Single implant supported mandibular overdenture: A literature review. J Indian Prosthodont Soc 2016;16:75-82.
15. Kawai Y, Taylor JA. Effect of loading time on the success of complete mandibular titanium implant retained overdentures: A systematic review. Clin Oral Implants Res 2007;18:399-408.
16. Rutkunas V, Mizutani H, Puriene A. Conventional and early loading of two-implant supported mandibular overdentures. A systematic review. Stomatologija 2008;10:51-61.
17. Ye M, Liu W, Cheng S, Yan L. Immediate vs conventional loading of mandibular overdentures: A comprehensive systematic review and meta-analysis of randomized controlled trials. J Oral Implantol 2020. doi: 10.1563/aid-jo-D-20-00265. Epub ahead of print.
18. Passia N, Att W, Freitag-Wolf S, Heydecke G, von Königsmark V, Freifrau von Maltzahn N, et al. Single mandibular implant study-denture satisfaction in the elderly. J Oral Rehabil 2017;44:213-9.
19. Liddelow GJ, Henry PJ. A prospective study of immediately loaded single implant-retained mandibular overdentures: Preliminary one-year results. J Prosthodont 2007;97:S126-37.
20. Liddelow GJ, Henry PJ. The immediately loaded single-implant-retained mandibular overdenture: A 36-month prospective study. Int J Prosthodont 2010;23:13-21.
21. Kronstrom M, Davis B, Loney R, Gervais J, Hollender L. A prospective randomized study on the immediate loading of mandibular overdentures supported by one or two implants: A 12-month follow-up report. Int J Oral Maxillofac Implants 2011;25:181-8.
22. Patil PG, Seow LL. Crestal bone-level changes and patient satisfaction with mandibular overdentures retained by one or two implants with immediate loading protocols: A randomized controlled clinical study. J Prosthodont 2020;123:710-6.
23. Awad MA, Locker D, Korner-Bitensky N, Feine JS. Measuring the effect of intra-oral implant rehabilitation on health-related quality of life in a randomized controlled clinical trial. J Dent Res 2000;79:1659-63.
24. Slade GD. Derivation and validation of a short-form oral health impact profile. Community Dent Oral Epidemiol 1997;25:284-90.
25. Fu I, Liu G, Wu X, Zhu Z, Sun H, Xia H. Patient-reported outcome measures of edentulous patients restored with single-implant mandibular overdentures: A systematic review. J Oral Rehabil 2021;48:881-94.
26. Dawson A, Chen S. The SAC Classification in Implant Dentistry. Batavia, IL: Quintessence Publishing Co. Inc., 2009. p. 1-172.
27. Saut B, Locker D, Allison P. Derivation and validation of the short version of the Malaysian Oral Health Impact Profile. Community Dent Oral Epidemiol 2005;33:378-83.
28. Geckili O, Bilhan H, Bļgči T. Impact of mandibular two-implant retained overdentures on quality of life in a group of elderly Turkish edentulous patients. Arch Gerontol Geriatr 2011;53:233-5.
29. Brennan M, Houston F, Sullivan M, O’Connell B. Patient satisfaction and oral health-related quality of life outcomes of implant overdentures and fixed complete dentures. Int J Oral Maxillofac Implants 2010;25:791-800.
30. Berretin-Felix G, Nary Filho H, Padovani CR, Machado WM. A longitudinal study of quality of life of elderly with mandibular implant-supported fixed prostheses. Clin Oral Implants Res 2008;19:704-8.