

# Clinical trend of retention for mandibular single implant overdentures using locator attachment

## Abstract

**Purpose:** The purpose of this preliminary clinical research is to investigate the changes of retention in mandibular single-implant overdentures (S-IOD) retained by locator attachment, within ten months.

**Materials and methods:** After single symphyseal implants were inserted in twenty-one edentulous mandibular patients, their complete dentures were modified as S-IOD, retained by locator (15 blue and 6 pink nylon patrices). Retentive force of S-IODs were measured by portable force gauge monthly till to 10 months, but some patients needed to replace nylon patrices during 10 months. The condition of alveolar ridge was assessed by ACP classification of edentulous jaw, for correlations. The retentive force was analyzed by Steel Test with control, and the correlations were analyzed by Spearman's rank correlation coefficient.

**Results:** The baseline median retentive force was 11.7 N for blue Patrices and 21.9 N for pink. P values comparing retention of each month with the baseline showed no significance throughout 10 months. The Spearman's correlation coefficient for the changes of retention and initial retention was -0.49 ( $p=0.03$ ), those and condition of ridge was -0.35 ( $p=0.13$ ).

**Conclusion:** The initial retention of Locator is higher than the amount stated by manufacturer. The trend of retention of locator in S-IOD using over 10 months showed no significant changes. The correlation between changes of retention and initial retention, and also with the condition of ridge was negative and weak.

**Keywords:** retention, locator, nylon patrices, implant overdenture, S-IOD, edentulous ridge

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**Abbreviations:** IOD, Implant Overdenture; S-IOD, Single Implant Overdenture; 2-IOD, Two Implant Overdenture; ACP, American college of Prosthodontists

## Introduction

Retention is a key for successful removable prosthodontics, therefore the superiority of implant overdentures (IOD) over complete denture became apparent.<sup>1-3</sup> Most of the retention studies were conducted for 2-IOD, then there were no clinical evidence regarding the retention of S-IOD. It might be because of the McGill consensus 2002 and York consensus 2009<sup>4,5</sup> that approved 2-IOD as a standard of choice of treatment for edentulous jaw. Recently there were reports which showed single implant supported overdenture (S-IOD) has comparable results as in patient satisfaction and implant survival rate and are also as satisfactory as 2-IOD treatment.<sup>6-10</sup> The other factors over 2-IOD were that it can save the cost of treatments and time taken 22% than 2-IOD.<sup>11</sup> Therefore, S-IOD should be thought as an alternative treatment option for edentulous mandible, which can yield sufficient retention by one implant only. Clinically, several studies<sup>12-14</sup> used locator successfully in S-IOD and their clinical outcomes showed satisfactory results.

Burns et al.<sup>2</sup> showed that patient preference was more on an IOD with more retentive attachment. Among the own unique features of every attachment system, locator is well known for self-aligning and dual retentive system, in which it is comprised by a Titanium Nitride coated abutment (matrix or female part), and a nylon patrix (male part) placed in a metal cap. The frictional retention gained by the patrix, where the head is bigger than the matrix compartment, and the mechanical retention gained by undercut, secures the outer and inner

surface of matrix in order to get dual retention. Then the cylindrical shape of attachment create parallel surface as retentive area.<sup>15</sup> Two main group of locator nylon Patrices are divided for the parallel implants and inclined implants up to 40°. The nylon Patrices for parallel implant has different retention coded by different colors; Blue nylon patrix 6.67N, Pink nylon patrix 13.35N and Clear nylon patrix 22.24N for individual attachment.<sup>16,17</sup> Over long time of use, wear and deformation of nylon Patrices can cause the changes of retention (decreasing or increasing), since nylon patrices are made of ordinary nylon (Dupont Zytel 101L NC-10 Nylon), which is an unreinforced polyamide 66 resin for injection molding.<sup>18,19</sup>

There were many evidences that showed the gradual loss of retention of locator attachment effected by various simulated intra-oral natures by in vitro studies. An in vitro study, Alsabeeha et al.<sup>20</sup> tested laboratorically three colors of locator patrices for S-IOD by 10 times pulling, the retention of blue was 3.8N, pink 9.4N and white 12.39 N which seemed to be sufficient to maintain S-IOD. Then, also an in vitro study showed blue nylon patrix had (66.4-77.6 N), pink nylon had (71.4-74.8N) and clear nylon had (83.8-101.32 N) depending on implant angulations initially. After 2160 cycle of dislodging, retention became changed as Blue (14.7-25.8N), Pink (27.7-31.3N) and Clear (30.2-35.1 N) (59-74% reductions). The significant reduction of retention was found before 720 cycles in all three models. The effect of mastication on locator was tested and baseline retention of locator is 66.4N, then 65.7N at 100,000 cycle, 46.6N at 200,000 cycles, 28.1N at 300,000 cycles and 21.6N after final load (400,000) of masticatory simulation. The retention force rapidly and obviously fell down within 100,000 to 300,000 loads significantly (>60%).<sup>15</sup> Another study tested 1,000,000 cycle of simulated masticatory loading (same

as 3 to 5 months of use) on blue, pink and clear locator on 2-IOD model and reported that the retention at the baseline were around 10N, 15N and 42 N respectively and changed to 6N, 14N and 38N respectively after simulated mastication.<sup>21</sup> Although clear and pink did not show significant decrease, blue locator showed significant loss (-37%) after loading. The effect of moisture with temperature was tested on pink locator in which water at 20°C, 37°C, 60°C and dry condition were tested on it under 5 years simulated dislodging. Although the initial retention showed 15-25N, it was fallen down to 4-9N with the 59-78% of percentage of reduction. Then there were severe crack in nylon patrices due to temperature of water and that was concluded as, it has effect on locator.<sup>19</sup> A similar study of pink nylon patrices soaked in different denture cleansers were reported that the initial retention 13-22N and fallen down to 7-16 N after 6 months of simulated use<sup>10</sup>. From the reports of in vitro studies, the reason for the reduction of retention is the wear, deformations, loading, water and denture cleaners.

As clinical evidences, Geckili et al.<sup>22</sup> investigated 22 ball and 33 locator in 2-IOD patients for 2 years and reported that the momentary retention after 2 years was 0 to 18 N in all samples with mean 10.39N. Almost all previous studies supported that the retention of locator was gradually reduced over time, and rapidly within initial months. Actually, clinical retention itself is gained not only by attachment but also by complete denture retention mechanisms by comprising denture bearing area, seals and saliva meniscus. Most of in vitro studies emphasized only on attachment but simulations of the tests were still different from complete IOD setting in intraoral nature and also actual using time length. That's why the results were in wide range of variation and limited clinical relevance or significance.<sup>23,24</sup> Therefore, the retention of S-IOD was interestingly needed to investigate in actual clinical condition especially in S-IOD. The present preliminary clinical study was designed to investigate the actual clinical changes in retention of single implant overdenture using locator attachment.

## Materials and methods

This study was done as prospective clinical study in Tokyo Medical and Dental University with approval of University Ethical Committee (reference No. #1162). The study protocol was published in our previous protocol paper.<sup>25</sup> Twenty-one patients (10 men and 11 women; age, 61-93 years) edentulous patients with mandibular complete dentures who were eligible for implant surgery, were recruited for this S-IOD study in 2015-16. Implant surgery was done with one implant (SLA BLT Loxim Ti implant, 4.1 mm in diameter, 10 mm in length, Straumann) at the mandibular midline, while patients were being used the new mandibular dentures well. After 3 or 5 months of healing period, the implant was used with an overdenture by a locator attachment (Straumann). Locator nylon Patrices (male part) were individually selected by the strength of denture-retention as well as patient's ability and feeling on wearing and removing the denture.

## Measurements of retention

On the date of installation of locator attachment, the retention will be measured as baseline (0 month) by using the portable force gauge (Lutron FG-5005, Lutron Electronic Enterprise Co. Ltd) for 5 times and calculating average value. For every time, IOD was placed in original position in the mouth and allowed to be bitten to fit properly as in functional status. After that, patient will be recalled monthly (every 4 weeks) to measure retention till to 10<sup>th</sup> month (40<sup>th</sup> week). During 10 months of observation periods, the principal operator decided time

to replace new nylon Patrices according to clinician's satisfaction and also patient's satisfaction on retention.

The clinical condition of intra oral status in combining with the least height of residual alveolar bone in panoramic X ray were evaluated to classify the class of alveolar ridge by American college of Prosthodontists' (ACP) classification on edentulous jaw<sup>26</sup> as class 1-developed ridge, class 2-moderately developed ridge, class 3-resorbed ridge and class 4-severely resorbed ridge.

## Statistical analysis

The sample size for each month was not equal for data collection due to the preterm replacement of nylon Patrices in some patients until 10<sup>th</sup> months. Therefore, non-parametric analyses were performed in JMP (version 13.0) software. Significance level was set at 0.05. Retention values of every month (4 weeks) were analyzed by Steel Test with control by recognizing the baseline (initial) retention as control. Correlations between the outcomes were analyzed by Spearman's rank correlation coefficient. Power of each test was analyzed by post hoc test in Gpower statistical software (3.0.10).

## Results

Twenty-one patients (10 males and 11 females) participated in this study. The oldest age in the group was 91 and youngest was 61 years. The median retention at baseline of blue nylon Patrices was 11.7 N and Pink was 21.9 N and at tenth month were 20.6N (+55%) and 16.5N (-22.32%) respectively. According to Steel test there was no significant difference between the baseline retentive force and monthly retentive force for both blue nylon Patrices and pink nylon Patrices with statistical power 0.37 and 0.85 respectively, as shown in Table 1 and 2. Figure 3 showed the trend of retention of S-IOD using locator attachments. Pink nylon Patrices showed decreasing percentages of retention from baseline over 10 months while blue showed increasing natures as the median line. The Spearman correlation coefficients tested between the differences from retentive force at baseline and final month (amount of changes retention) and the amount of initial retention was -0.49 (P=0.03), then those with ACP classes of edentulous ridge was -0.35 (P=0.13) with the statistical power 0.69 and 0.37 respectively.

## Discussion

The original retention value stated by the manufacturer of locator were seem to be tested only on attachment while actual clinical retention was depending upon the quality of denture and biological factors. The initial retention of S-IOD with locator in present study (Blue 11.7N and Pink 21.9N) were higher than the values manufacturer stated. In this study, clear nylon patrix was not used because of its strong retention that may make the elder patients to be difficult in wearing IOD. The oldest participants were over 90 years old and their skill in handling denture was weak. The initial retention of this study showed higher than the value of Alsabeeha et al.,<sup>12</sup> which were tested in in vitro for S-IOD. Then the retention of pink locator in S-IOD model of Scherer et al.,<sup>27</sup> 5.51 to 9.34 N on various types of dislodgement laboratorically, was also lower than this study.<sup>27</sup> But the present value were in accordance of the retention of Tehini et al.,<sup>21</sup> Chiu et al.,<sup>19</sup> You et al.<sup>28</sup> which were tested for effect of mastication, water temperature and denture cleanser. These factors may influence on the attachment largely and in which, simulations were more similar to intraoral nature. Although the result of statistical analysis for both nylon Patrices comparing monthly retention with

baseline did not show significant difference, the median retention of S-IOD using blue nylon Patrices (Table 1 & 2) showed increasing feature over 10 months. There was no evidence about the increasing retention of locator over use, while almost all evidences supported gradual decreasing. The median percentage of changes for blue nylon Patrices at tenth month (Figure 3) was (+55%), after decreasing 0.41%, 21.04% and 5.13% at 3<sup>rd</sup>, 4<sup>th</sup> and ninth months. But in the study of retention of bar-clip attachment, there was the report from Pigozzo et al.<sup>29</sup> about increasing in retention over use of time. They reported that the polymer and nylon clip showed retention at the

baseline from (22-29N) and became increase over 40N (~80%) after 5500 cycle of dislodgement in wet environment.<sup>29</sup> Also Botega et al.<sup>30</sup> reported that the same condition on two brands of plastic clips tested in wet condition as the baseline retention (16.3, 36.9 N) became (20.2, 52.1 N) respectively after 5500 cycle of dislodgement.<sup>30</sup> Then, Saito et al.<sup>31</sup> reported that the metallic bar and clip attachment of CoCr, and Titanium Round bar with platinum-added gold alloy (PGA) clip showed slight increase in retention after 7200 cycle of dislodgement because of the friction of wear debris.<sup>31</sup>

**Table 1** The retentive force of S-IOD using locator attachment with blue nylon for 10 months.

| Quartiles/ Month | 0 (Baseline) | 1    | 2    | 3    | 4    | 5    | 6    | 7    | 8    | 9    | 10   |
|------------------|--------------|------|------|------|------|------|------|------|------|------|------|
| First Quartile   | 9.6          | 7.6  | 9.2  | 8.9  | 5.7  | 7.8  | 8.9  | 10.9 | 12.2 | 10.2 | 15.0 |
| Median           | 11.7         | 11.2 | 13.7 | 12.0 | 10.5 | 12.9 | 14.5 | 17.8 | 13.7 | 16.9 | 20.6 |
| Third Quartile   | 15.4         | 14.4 | 18.0 | 20.4 | 16.2 | 15.6 | 21.2 | 22.1 | 19.5 | 23.6 | 22.7 |
| P values         | Control      | 0.99 | 0.99 | 0.99 | 0.99 | 1    | 0.99 | 0.9  | 0.87 | 0.99 | 0.29 |

The P value for steel test with control (comparing baseline values with other monthly values)

**Table 2** The retentive force of S-IOD using locator attachment with pink nylon for 10 months.

| Quartiles/ Month | 0 (Baseline) | 1     | 2    | 3    | 4    | 5    | 6    | 7    | 8    | 9    | 10   |
|------------------|--------------|-------|------|------|------|------|------|------|------|------|------|
| First Quartile   | 15.2         | 8.36  | 8.4  | 7.2  | 6.3  | 6.5  | 5.7  | 5.1  | 11.3 | 11.4 | 10.8 |
| Median           | 21.9         | 11.7  | 9.0  | 8.5  | 7.5  | 8.3  | 8.2  | 13.6 | 11.4 | 16.2 | 16.5 |
| Third Quartile   | 26.8         | 14.6  | 18.0 | 11.9 | 10.0 | 15.0 | 16.3 | 21.4 | 17.2 | 21.0 | 22.2 |
| P values         | Control      | 0.10? | 0.35 | 0.11 | 0.11 | 0.25 | 0.25 | 0.74 | 0.52 | 0.88 | 0.99 |

The P value for steel test with control (comparing baseline values with other monthly values)



**Figure 1** Single symphyseal implant with locator abutment to retain implant overdenture.

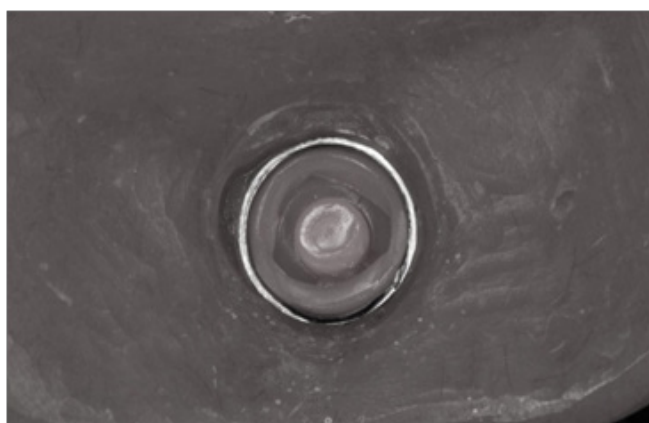
S-IOD using pink locators showed steadily decreasing retention which was not obvious and was stables more or less (Figure 3). It followed the previous studies as Sultana et al, where reported that pink locator in parallel model showed gradual decreasing in retention from 108.9 N for baseline to 20.2 N for 10,000 cycles by losing

81.5% when testing 2-IODs model with ball and locator attachment with different divergence for 10,000 cycle. And also Chiu et al.<sup>19</sup> reported that reduction of retention of pink locator up to 78% after 5,500 cycles of dislodgement. Then the study of You et al.<sup>28</sup> supported the result with percentage of reduction was 29 to 53%. In this study, the retention of pink locator changed from 21.9 to 16.6 N after 10 months with 22.23% of reduction. But the most reduced percentage was 63.46% at 4<sup>th</sup> month. Both of the median line of locator showed prominent decreasing in retention after 4 months of use. Although almost all in vitro studies showed reduction of retention over time of simulated use, the actual clinical condition made different, in which it was believed to be effected by deformation of locator due to intra-oral effects. Within the first 4 months, the changes of retention either increasing or decreasing was possible generally. A clinical evidence Kleis et al.<sup>32</sup> reported that there were 4 case of complaints with excessive high retention to replace the nylon, which are in accordance of this result. Then, locator nylon patrices were ready made color coded nylon insert and nonadjustable. In the case of the least retentive (Blue) one, it is no lesser retentive one to replace when the retention became higher.

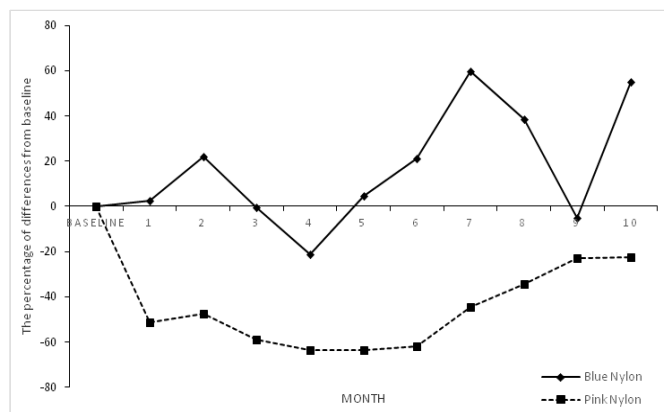
Then there were tested for correlation of the baseline retention of locator with differences from final retention to initial retention (amount of changes retention). Negative value for association showed that there was possibility of much loss of retention if the initial



retention was so high. Also in the study of Abi Nader et al.<sup>15</sup> and Rabbini et al.,<sup>16</sup> the locator showed high initial retention and then it decreased much retention (~3 times) after simulation of use.<sup>15,16</sup> In ACP classification on edentulous jaw, the increasing order of classes indicated poor ridge conditions while class (1) was the best condition. Negative correlation coefficient between amount of changes of retention and class of alveolar ridge was possible to predict that the retention became decreased in higher number of class, in other words, the retention was decreasing in the case of resorbed ridge. Resorbed ridge were seemed to be not retentive for S-IOD well where the stability might be also decreased, and it might make the locator to be loaded more during function. The locator was estimated to be loaded not only in mastication, also in various denture movements due to instability. The anatomy of jaw might have effect on the capability of locator in relation with intra-oral function and the life span as well.



**Figure 2** Deformed locator pink nylon patrix after several months of use.



**Figure 3** The trend of retention of S-IOD using locator blue nylon and pink nylon Patrices.

Clinically, the retention of IODs is influenced by complex factors which were sometimes, uniquely particular to patients. Moreover, locator was reported that patient need more effort to position correctly, and finger pressure to seat properly while only bite force was not enough.<sup>32</sup> That points might be one of the influencing factors on the deformation of locator. In this study, most of the patients were elderly and they were difficult to position the locator correctly even though it was only one implant (S-IOD). Improper seating of the locator and using IOD in that condition caused deformation of locator and preterm loss of function. Then as another consideration though it was not analyzed here, calculus and debris around the implant and in the

locator might cause preterm deformation of locator which was often founded in one patient.

As clinical significance, the retention of locator is difficult to state as decreasing over time of use, because it may increase with or without unexpected deformation rather than wear of abutment. During the first 4 to 6 months, the prominent changes in retention, either increasing or decreasing is usually occurred. The retention of locator is much dependent on the form of patrix and deformation is key point to change the retention. The function of locator nylon and suitable color of nylon were individually specific, especially on anatomy of the ridge, power of masticatory load, force of insertion or removal, correct positioning and wearing time length. This study assisted the evidences for clinical use of locator especially in S-IOD although it has many limitations. Inconsistent edentulous jaw conditions, insufficient samples over groups and lower statistical powers were needed to overcome in the further studies, and then such clinical evidences among different attachments and IOD types were still needed. However, using locator in S-IOD was seemed to be an appropriate option because of its function and periodical maintenance that make both patients and clinician to be feasible for necessary care on prosthesis, attachment, implant, mucosa and alveolar bone as well.

## Conclusion

According to the results,

1. The trend of retention in locator retained SIOD showed no significant changes over 10 months of use clinically.
2. The initial retention of locator in SIOD is higher than the original amount stated by manufacturer.
3. There were negative and weak, correlations between changes of retention and initial retention, and also with the condition of alveolar ridge.

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## Conflicts of interest

There was no conflict of interest regarding the present study.

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