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COMPARISON OF MARGINAL BONE LOSS AND STABILITY IN LOCATOR AND BALL AND SOCKET ASSISTED MANDIBULAR OVERDENTURE AFTER IMMEDIATE IMPLANTATION AND LOADING

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Aim: This study aimed to estimate the effect of using two different attachments (locator and ball and socket) on the marginal bone height changes and implant stability of immediately placed and immediately loaded implant in mandibular overdenture cases.

Materials and methods: Twenty male patients were selected to share in this study from the out-patient clinic of prosthodontic department, faculty of Dentistry, 6th of October University with age range between 55-65 years, having two standing mandibular canines with compromised prognosis and opposing completely edentulous maxilla. The patients were randomly divided into two groups according to the type of attachment, Group I: Patients of this group were rehabilitated with two immediately placed implants in bilateral canines, immediately loaded and retained with ball and socket attachments, Group II: Patients of this group were rehabilitated with two immediately placed implants in bilateral canines, immediately loaded and retained with locator attachment. Implant stability was measured using Osstell mentor. Radiographic evaluation using parallel technique (Digora software) was done to evaluate the amount of vertical bone loss throughout the follow–up period (0, 3, 6 and 12 months). The data was collected and statistically analyzed.

Results: On comparing the two groups using Mann Whitney test there was statistical non significance difference in the marginal bone loss throughout the follow up period ($P>0.05$). While there was statistical significance difference for each group using Friedmans test between the time intervals ($P<0.001$). In addition, on comparing the two groups regarding implant stability there was statistical non significance difference immediately postoperative and through the follow up period ($P>0.05$). While, for each group there was statistical significance difference between the time intervals ($P<0.001$)

Conclusion: Within limitation of this study, it could be concluded that both types of attachment (ball and socket and locator attachment) are effective attachments for immediately placed and immediately loaded implants as a line of treatment of mandibular overdenture. Where there was statistical insignificance difference regarding marginal bone loss and implant stability between the two attachments.

Keywords: IMPLANT OVERDENTURE, BALL AND SOCKET, LOCATOR, IMMEDITE LOADING, IMMEDIATE PLACEMENT

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Introduction

Complete edentulism is a difficult case for every prosthodontist and has an impact on the health and quality of life of all edentulous patients. The prosthetic rehabilitation of patients with mandibular edentulous arch has modified as a result of the high success rate of dental implants.

Clinical studies have shown the high success rate of intra-foraminal dental implants. Dental implants osseointegration has been studied using a variety of loading protocols, depending on the clinical situation and bone quality. Initially, Branemark advised waiting 4-6 months healing period before loading the implants.[1,2,3] An implant-supported restoration that has been placed and is functioning with the opposing dentition within 48 hours of the implant's placement is referred to as immediate loading. These days, an effective treatment option for completely edentulous patients is an implant-retained overdenture.[4]

Recent advances in surgical protocols include immediate implant placement and loading. The immediate implantation is justified by the fact that it requires less therapeutic interventions, takes less time to treat patients, and does not require a removable prosthesis during interme healing phase. However, because immediate implant placement can make it difficult to obtain good primary implant stability, the risk of failure and complications may be higher.[5,6] Immediate loading of dental implants promotes bone remodelling and bone regeneration at the implant-bone interface, as well as the potential for new bone formation. In this method, healing is accelerated, and treatment duration is reduce.[7]

Since their introduction in 2001, Locator attachments have been used successfully.[8,9,10] When the IODs opposed maxillary complete dentures; delayed or early loading of implant-retained mandibular overdentures displayed equal success rates.[11] Numerous studies have reported high success rates on immediate functional loaded and splinted implant-supported overdentures.[12,13]

Locators are popular attachments because of the ability to self-align, which can correct up to 40° of implant angulations, their low level of thickness (2.5 mm height).[14] They are indicated in narrow inter-arch space.[15] Locators provide high retention and stability. However, the periodic replacement of the male nylon part is required. There are studies discussing complications related to locator. One study reported 34 prosthetic complications and a locator housing requiring replacements. To overcome complications, locator attachments necessitate periodic repair and higher maintenance.[16,17]

The immediate loading of dental implants has been accused of affecting the osseointegration, but the dogma of the 3- to 6-month healing without loading was based on pragmatic data.[18]

Ball and socket is one of the commonly used attachments for retention. It has many benefits such as; the provision of a wide range of movement, maintenance, the provision of good retention, hygiene maintenance, cost-effectiveness, ease of use and good patient satisfaction.[19] However, parallelism between the implants is a must, and the loss of parallelism will lead to difficulty in the insertion and removal of the prosthesis and fracture of the abutment might occur. Also, the O-ring requires to be frequently replaced because wear is a common prosthetic complication.[20]

Studies on the use of an immediate loading protocol for two implants and 17 patients with ball-retained overdentures showed encouraging outcomes.[21] Flapless surgery and the immediate loading of two implants containing bar-retained mandibular overdentures have been combined in a study by Cannizzaro and colleagues. A cohort of 60 patients received immediate implant loading

on 30 and early implant loading on the remaining 30. Only two implants in the early loading group and none in the immediate loading group had been lost a year after surgery. During the one-year follow-up period, 19 patients experienced 19 postoperative complications.[22]

When it comes to long-term prognosis, survival is the most important criterion, so attachment behavior under axial and nonaxial stresses must be studied during follow-up. The survival of attachment is determined from tissue reaction, peri-implant mucosal changes, bone resorption, and loss of attachment. The most important factors for determining whether or not the attachments were successful are the eventual patient response in terms of compliance with placing and removing the prosthesis, oral hygiene, and overall satisfaction.[23]

Implant stability is the physical relationship between the implant surface and the surrounding bone.[24] The ability of implants to withstand loads in axial, lateral, and rotational directions without mobility can be used to realize the effective clinical outcome of implants.25,26Primary and secondary stability are two categories of implant stability. By limiting excessive micromotion at the bone-implant interface, which could fracture regenerating bone and inhibit osseointegration, primary stability is obtained at the time of implant insertion.[27] A number of parameters, including surgical technique, implant type, clinical measurement, and surgical expertise, as well as patient age, gender, bone density, length, and width, are known to affect the stability of primary implants.[28]

There are many factor affecting primary implant stability, bone density, length, width, patient age and gender which are patient related factors, also surgical technique, type of implant, clinical measurement and surgical experience which are procedure related factors.[28] Only a few studies have discussed the outcomes of immediately loaded implants placed in post extraction sockets in mandibular supported overdenture using different attachments.[29-31] Thus, our study is concerned with this point. The null hypothesis for this study was there is no difference between the ball and the locator attachment regarding marginal bone loss and implant stability.

Materials and Methods

Twenty male patients were selected to share in this study from the out-patient clinic of prosthodontic department, faculty of Dentistry, 6th of October University with age range between 55-65 years, Patients were chosen according to this inclusion criteria: Patients have two standing mandibular canines with compromised prognosis and opposing completely edentulous maxilla (figure 1A). Patients with adequate bone quality and quantity; bone height (5-6mm) beyond the apex of the canines was needed and sufficient restorative space, patient with normal maxilla-mandibular relationship. Patients in need of bone grafts or bone regeneration, medically compromised patients (corticosteroid therapy, uncontrolled diabetes, immunocompromised cases), smokers, and patients with periodontal disease and periapical lesions were excluded from the study. Primary stability within range of 55 ISQ and more was mandatory as inclusion criteria.

Precise medical and dental history were taken from all patients through direct interviews and a questionnaire sheet. Clinical examination was made to fulfill the predetermined criteria: intra and para-oral examination. Intra-oral examination for the mandibular residual alveolar ridge exhibited adequate height and width and was covered with firm fibrous mucoperiosteum free from any signs of inflammation, ulceration or flabbiness.

Pre-operative CBCT radiographs were taken for each patient (figure1B), to exclude the presence of any pathologic lesion related to the tooth to be extracted, the length and width of the tooth was measured for proper selection of the suitable implant length and width required for the surgery, mesio-distal and labio-lingual dimensions was noticed as adequate labial plate of bone and adequate bone support of the retained canines is necessary to avoid the need of bone grafting and augmentation. Also, to evaluate the available bone height from crest of the ridge to the inferior border of the mandible in the canine area as it should have at least 3mm of bone beyond the apex of the canine root apically to provide adequate primary stability of the implants.

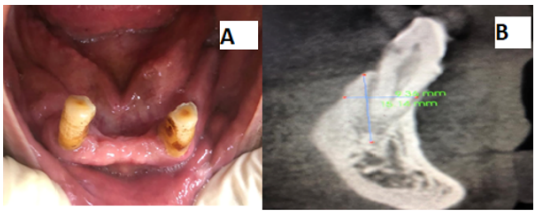

Figure 1A: Edentulous mandible with two standing canines.
Figure 1B: Cone beam radiograph for the remaining canine.

Mounted diagnostic casts using provisional jaw relation records to insure adequate restorative space (10-12 mm). Complete dentures were constructed for all patients following the conventional procedures after that, patients were prepared before surgical phase as regarded to oral hygiene maintenance and diet. Medication was prescribed to patients including Augmentin (Amoxicillin 875mg.)
& Clavulanic acid (Clavulanic acid 125mg manufactured by Glaxowellcome.co) twice daily one day before surgery.

Patients grouping

The patients were randomly assigned using random number generator and checker into (www. psychicscience.org/random.aspx) into two equal groups according to the attachment used for rehabilitation into:

Group I: Patients of this group were rehabilitated with two immediately placed implants with immediate loading for the bilateral canines retained with ball and socket attachments

Group II: Patients of this group were rehabilitated with two immediately placed implants with immediate loading for the bilateral canines retained with locator attachment.

For allocation of the participants, a randomization sequence with 1:1 allocation ratio using twenty small papers written in half of them L standing for locator attachment and the other half O standing for ball attachment and put in sealed similar envelops. Where at the morning of the surgical visit, blindly one of these papers was drawn to enroll this participant on the selected group.

Surgical phase

Extraction of remaining canine on each side using set of manual periotomes. The periotome applied around the tooth to be extracted to cut and tear the periodontal ligaments. Appropriate forceps utilized with slight twisting movement and care should be taken to sustain the facial and palatal walls of the socket virtually intact. The socket thoroughly degranulated by careful curettage using small curette and proper irrigation with saline solution to remove any connective tissue tags or periodontal ligaments remnants (Figure 2A). After canine extraction, the implant drill was used to make the osteotomy site for immediate implant placement, the osteotomy was performed on the lingual aspect of the alveolus to maintain the integrity of the labial plate of bone. Sequential drills of gradual increased diameter were used under copious irrigation with saline until reach the suitable dimensions for the selected implant. The ratchet wrench was used for the final stage of the implant placement with the insertion torque not less than 35N. The length and width of implant (CMI implant Neobiotech,

Seoul, South Korea) was according to each case separately, taking into consideration the implants were stable within the osteotomy with no mobility. The implant should be as wide as permissible to allow maximum bone engagement with minimum thickness of facial and lingual walls not less than 1 mm. The implant is placed 2-3 mm beyond the apex of the extracted canines. Implant primary stability was measured to insure at least 55ISQ or above.

Prosthetic procedures

For group I: Placement of the Ball and socket attachment intraorally over the integrated implant using its driver, the screwing torque was not more than 20 Ncm. Areas in the denture corresponding to the two inserted abutments were marked on the fitting surface of the denture. Acrylic abrasive stone was used to relieve the marked areas and create enough space to accommodate the abutment. The denture was tried in the patient's mouth to ensure complete seating.

The implant positions were marked on the fitting surface of the mandibular denture by marking the heads of the O-balls by a marker. A relief area was created on the fitting surface of the lower denture opposite the implant heads using an acrylic bur. The O-Ring attachments enclosed in the female metal housings were placed over the implants (Figure 2B). The lower denture was then tested intra-orally to confirm complete seating without interfering with the original fit of the denture while in maximum intercuspation. An elastomeric block out shim (spacer) was placed over the vertical half of the implant head (to block out undercuts) while permitting
the O ball half of the abutment to protrude uncovered, this was performed to prevent any lock with the permanent hard pick-up material* (Hard Pick Up Material, 3MESPE, Germany)

For group II: Locater attachment (3.5 diameter and gingival height 2.0 mm) was used, and the same procedures were carried out for fixing the attachment female part in the complete overdenture fitting surface (Figure 2C). The finished over denture for both groups were inserted and delivered to the patients after occlusal adjustment for radiographic evaluation after, 0,3,6, and 12 months.

Figure 2A: sockets after canines' extraction.
Figure 2B: Implant insertion with ball and socket attachments in place.
Figure 2C: Implant insertion with locator attachments in place.

Prescriptions for postoperative antibiotics amoxicillin (amoxicillin 500 mg, Ranbaxy Laboratories) and a nonsteroidal anti-inflammatory drug ibuprofen (ibuprofen 800 mg, BASF Corporation) were given to each patient along with instructions. The patients were also instructed to remove the overdenture every other day to clean it. An oral rinse (Peridex, Zila Pharmaceuticals) was used twice a day for the first 2 weeks after implant placement. A postoperative examination was performed 1 week following the procedure.

Method of evaluation

Marginal bone loss measurement

At the day of prosthesis delivery (day of pick up) standardized peri-apical x-rays were recorded for the two groups of patients and then at the following intervals; at the day of pick up (baseline), at 3,6,9 month follow up and then 12 month follow up. Peri-implant crestal bone level changes were assessed using intraoral radiographs with the standardized long cone paralleling technique using a custom-made acrylic template and the GXS-700- DIGITAL*system (GXS-700-DIGITAL intraoral sensor-GENDEX-USA).

Acquisition of digital intraoral radiographs by the GXS-700 was performed and used for radiographic assessment of implants in both groups. Serial standardized; reproducible digital periapical radiographs were obtained at follow-up appointments. The bone height was measured mesial and distal surface of each implants using the software rule's liner measurement systems. The GXS-700 is a digital USP-driven sensor to acquire dental intraoral radiographic images. It was used in a combined customized special positioning device XCP (Rinn XCP manufactures C. Ligin, III, USA) supplied with the system to facilitate reproducible positioning and alignment The linear measurement in mm. was made at a follow-up visit following the liner measurement systems supplied with the particular software of the GSX-700.

Two horizontal lines at the alveolar bone crest and the implant apex were drawn; the software automatically gives the measurements in millimeters on the screen between the two lines. Then the difference in bone height was calculated by subtraction. The mean value of both mesial and distal readings was taken. The software automatically gives the measurements in millimeters on the screen between the two lines. The significance of linear measurements was recorded in the patient's chart at every follow-up visit, and from this data, the mean value of bone height change was calculated.

Implant stability

Implant stability was examined using Osstell Mentor (Osstell, Integration Diagnostics, Goteborg, Sweden). Immediately at time of loading, three, six and twelve months after implant loading. A compatible Smart Peg was mounted on each implant and tightened by hand using rubber smart peg holder. Resonance frequency (RF) values are represented by a quantitative unit called the implant stability quotient (ISQ) on a scale from1 to 100. The RF value was measured four times in four directions (every 90°) for each implant surface (Labial, Lingual, Mesial, and Distal), and the results were tabulated.

Results

The results of this study are shown in tables (1, 2, 3 and 4).

All the data was collected and tabulated. Data was analyzed using Statistical Package for Social Science software computer program version 26 (SPSS, Inc., Chicago, IL, USA). Shapiro-wilk test was used to detect normal distribution of data. Quantitative data was non-parametric and presented in median & interquartile range (IQR). Mann Whitney was used for comparing two different groups of non-parametric data while Friedmans was used for comparing more than two related groups of non-parametric data. P value less than 0.05 was considered statistically significant. P-value > 0.05: Non significant; P-value < 0.05: Significant; P-value < 0.001: Highly significant

I-Measured marginal bone loss at different time intervals:

As shown in table 1, Upon comparing the two groups regarding the marginal bone height changes all over the follow up periods, there was statistically non- significant difference P1-value > 0.05 between the group I (ball and socket group) and II (locator group) by using Mann Whitney test for comparing two different groups of non-parametric data. During the first 3 months period was 1.00, and (0.7, 07, 1.00) for (6, 9, 12) months respectively. While comparing within the same group there was statically significance difference P2<0.001*

Table (1): Comparison of marginal bone loss between Group I & Group II and within different time intervals: 3 months, 6 months, 9 months & 12 months. Level of significance between the two groups was expresses as P1(horizontally) and within the same group (vertically) as P2. Data expressed as Median (IQR). Superscripts different alphabetical letters indicate significance difference.

	Group I(Median-IQR)	Group II(Median-IQR)	P1
3months	0.45(.40-.40) [ab]	0.41(0.30-0.40) [ab]	1.00
6 months	0.62(0.55-0.60) [bc]	0.65(0.60-0.60) [bc]	0.7
9months	0.81(0.80-0.85) [cd]	0.80(0.80-0.85) [cd]	0.7
12months	1.10(1.10-1.10) [d]	1.05(0.95-1.10) [d]	1.00
P2	<0.001*	<0.001*	

2-Marginal bone loss changes at different time intervals:

As shown in table 2, comparison of marginal bone loss between Group I & Group II within different time intervals change as data expressed as Median (IQR), and P means Probability by using Mann Whitney test. After comparing the above results of the two studied groups it was showed that the probability of bone height changes between two groups in intervals (1, 2, 3 and 4) was (0.2, 0.3, 0.5 and 0.2) which showed non-significant difference where P-value > 0.05

Table (2): Comparison of marginal bone loss changes between Group I & Group II within different time intervals change

	Group I(Median-IQR)	Group II(Median-IQR)	P
Interval 1 change	0.45(0.40-0.40)	0.41(0.30-0.40)	0.2
Interval 2 change	0.22(0.15-0.20)	0.25(0.20-0.20)	0.3
Interval 3 change	0.25(0.25-0.25)	0.25(0.25-0.25)	0.5
Interval 4 change	0.25(0.25-0.30)	0.22(0.10-0.25)	0.2

3-Measured implant stability at different time intervals:

As shown in table 3, the values of the Resonance frequency analysis measured immediately postoperative and after each 3 months for a period of 12 months was calculated and tabulated. Comparison between both groups regarding implant stability was done by using Mann Whitney test and Friedman's (Superscripts different alphabetical letters indicate difference in significance) and all data expressed as Median (IQR), it was shown that the probability P1 was (1.00,0.2,0.9, 0.85,0.09) during (insertion and 3,6,9,12) months which showed non-significance differences between group I (ball and socket) and group II (locator). While comparing within the same group there was statically significance difference P2<0.001*.

Table (3): Comparison of stability between Group I & Group II within different time intervals insertion, 3 months, 6 months, 9 months& 12 months. Data expressed as Median (IQR). Superscripts different alphabetical letters indicate difference in significance.

	Group I (Median-IQR)	Group II (Median-IQR)	P1
Insertion	72.00(72.00-72.00) [a]	72.00(72.00-72.00) [a]	1.00
3months	72.50(72.50-72.50) [ab]	73(72.50-72.50) [ab]	0.2
6 months	73.50(73.50-73.50) [bc]	73 (73.50-73.50) [bc]	0.9
9months	74.00(74.00-74.00) [cd]	74.5(74.00-74.00) [cd]	0.85
12months	76.00(75.50-76.00) [d]	76.00(75.50-76.00) [d]	0.09
P2	<0.001*	<0.001*	

4- Implant stability changes during different time intervals:

As shown in table 4, comparison of implants primary stability between Group I & Group II within different time intervals change, data expressed as Median (IQR). After comparing the above results of the two studied groups it was showed that the probability of implants primary stability changes between the two groups in intervals (1, 2, 3 and 4) was (1, 0.7, 0.97 and 1) which showed non-significant difference where P-value > 0.05

Table (4): Comparison of implant Stability changes between Group I & Group II within different time intervals change

	Group I (Median-IQR)	Group II (Median-IQR)	P
Interval 1 change	0.50(0.50-0.50)	0.50(0.50-0.50)	1.0
Interval 2 change	1.00(1.00-1.00)	1.5(1.00-1.00)	0.7
Interval 3 change	.50(0.50-0.50)	1(0.50-0.50)	0.97
Interval 4 change	2.00(1.50-2.00)	2.00(1.50-2.00)	1.0

Discussion

In this study, the null hypothesis was accepted. The locator was chosen because of its self-aligning capability, which can correct up to 40° of implant angulations, and low level of thickness (2.5 mm height). Locators are common attachments for implant-retained or implant-supported overdentures. In contrast, the ball and socket have an easy manufacturing process, have a large range of movement, and are economical.[32] Immediate implant insertion and loading were encouraged in an effort to

shorten the duration, expense, and number of operations associated with treatment.[33,34] High success rates for the initial loading of various implant-supported restorations have been reported in numerous clinical studies.[35,36]

The results of several systematic reviews[37,38] on the immediate loading of dental implants supporting various types of restoration have been confirmed. The survival rates will be similar to early or conventional loading if the inclusion and exclusion criteria are followed.[37] Studies revealed that the immediate abutment connection, the mobility of the resultant restoration, and early contact with oral microbial plaque could all have an impact on the initial healing of implants with immediately loaded mandibular overdentures.[39-41] However, the studies found no discernible difference between the groups' rates of marginal bone loss around immediately loaded implants and delayed loading, which is in line with the findings of some previous systematic reviews.[34] This might be because the immediate loading protocol didn't include second-stage surgery and there was early mechanical strain.

In ILP, mechanical loading from the overdentures may promote bone formation and result in high bone fractions. Early mechanical strain on the surface of the bone-to-implant contact had a beneficial impact on the initial phase of bone healing.[42,43]

The peri-implant health is impacted by various prosthetic factors and attachments.[26,44] According to a review by Aldhohrah et al.[45], all attachment systems applied in two-implant-retained mandibular overdentures including bar, ball, locator, resilient telescopic, and magnet attachments had the same impact on marginal bone loss. Additionally, Chaware and Thakkar[26] discovered that compared to other attachments, the bar attachment demonstrated considerable gingival inflammation and bone resorption, making it more difficult to maintain peri-implant tissue health. The best overdenture attachments for the immediate-loading protocol are the bar, ball, and magnet because they are resilient and keep bone loading within physiologic limits. Additionally, additional bone loss could occur with delayed loading as a result of the stress associated with the second-stage surgery.[46]

MBL usually starts in the first year and then repeats every year at a rate of 0.2 mm.[47] In resilient telescopic attachments and the ball, the mean MBL was 1.5 mm and 1.6 mm, respectively, according to Krennmair et al[48], but all other investigations found MBLs of less than 1.5 mm after a year of follow-up.[45,46,49] This is consistent with the findings of this investigation, which show overall losses of 1.10 mm and 1.05 mm, respectively.

In addition, with immediate loading, the evaluation of implant stability is essential for the prognosis of implant treatment.[50,51] The degree of implant stability at installation and its change over time must therefore be accurately measured. Resonance frequency analysis (RFA) is a simple, reproducible, and non-invasive method to measure implant primary stability.

In order to decide on treatment protocols, it is necessary to continuously monitor the stability of the implant over time. Resonance frequency analysis is a diagnostic tool for identifying implant stability as a function of the stiffness of the bone-implant interface, both during implant insertion and during the healing process.[52,53]

Studies show that the first three weeks after implant installation, the ISQ measurements significantly decline before reverting to their initial values eight weeks later.[54,55] Since modern surgical methods allow for the drilling of small osteotomies, which results in large insertion torques, surgical kits allow for high ISQ values at the moment of implant placement, suggesting good primary

stability.[56] One of the goals of this study was to evaluate stability because there aren't many clinical studies that look at implants in newly extracted sockets. The survival percentage of implants implanted in recently extracted sockets is very high, ranging from 93.9% to 100%.[57] The ISQ readings from our investigation were relevant to another study that used implants in an overdenture immediately following extraction.[57,58] Our stability results are in line with previous studies on initial loading in overdentures held with locators and ball and socket .[59-61]

The results of this study showed insignificance difference between ball and locator attachment, which may be contributed to patient compliance, proper patient selection, and precise preparation of osteotomy and post-operative instructions. Within limitation of follow up period and number of selected patients, the results of this study proved that precise patient selection, surgical and prosthetic procedures are more important than the type of attachment in immediately placed and immediately loaded implant retaining mandibular overdenture. Further long-term studies are needed, and future studies are needed to compare splinted versus non splinted attachment for rehabilitation of patients with immediately placed and immediately loaded implant overdenture

Conclusion

Within limitation of this study, it could be concluded that both types of attachment (ball and socket and locator attachment) are effective attachments for immediately placed and immediately loaded implants as a line of treatment of mandibular overdenture. Where there was statistical insignificance difference regarding marginal bone loss and implant stability between the two attachments.

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