The Effect of Thermocycling on the Retention of Ball and Locator Attachments

ผลของขบวนการเทอร์โมไซคลิ่งต่อการยึดอยู่ของสิ่งยึดชนิดบอลและโลเคเตอร์

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ABSTRACT

This in vitro study was to examine the effect of thermocycling on the retention of ball and Locator attachments. Ten yellow clix insert ball attachments and ten pink Locator attachments were used in this study. Each attachment was subjected to 5 consecutive pulls at 0, 5000 and 10000 cycles after thermocycling. The retention values were averaged. The results of this study demonstrated that the retention of yellow clix insert ball attachments was not significantly affected by thermocycling. On the contrary, the mean retention values of pink Locator attachments increased significantly after 5000 and 10000 cycles of thermocycling. It could be concluded that yellow clix insert ball and pink Locator attachments offered acceptable levels of retention and were not susceptible to retention loss from thermocycling.

บทคัดย่อ

การศึกษานี้ทดสอบผลของขบวนการเทอร์โมไซคลิ่งต่อการยึดอยู่ของสิ่งยึดชนิดบอลสีเหลืองและโลเคเตอร์สีชมพู โดยทดสอบสิ่งยึดชนิดละ 10 ชิ้น ดึงทดสอบ 5 ครั้ง ก่อนผ่านขบวนการเทอร์โมไซคลิ่ง หลังผ่านขบวนการเทอร์โมไซคลิ่ง 5000 และ 10000 รอบ คำนวณค่าเฉลี่ยการยึดอยู่และวิเคราะห์ค่าทางสถิติ ผลการทดสอบพบค่าเฉลี่ยการยึดอยู่ของบอลสีเหลืองไม่ได้รับผลกระทบจากขบวนการเทอร์โมไซคลิ่ง ในทางตรงกันข้ามค่าเฉลี่ยการยึดอยู่ของโลเคเตอร์สีชมพูเพิ่มขึ้นอย่างมีนัยสำคัญหลังผ่านขบวนการเทอร์โมไซคลิ่ง 5000 รอบ และคงที่จนถึง 10000 รอบ จึงสามารถสรุปได้ว่าสิ่งยึดชนิดบอลสีเหลืองและโลเคเตอร์สีชมพูมีค่าการยึดอยู่ในระดับที่ยอมรับได้และขบวนการเทอร์โมไซคลิ่งไม่ทำให้การยึดอยู่ลดลง

Key Words: Thermocycling, Retention, Attachment

คำสำคัญ: เทอร์โมไซคลิ่ง การยึดอยู่ สิ่งยึด

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Introduction

More than a third of population over age 70 and more than a quarter of the population older than 65 are completely edentulous (Weintraub & Burt, 1985). Among edentulous denture wearers, lack of retention and stability of the mandibular denture is a common problem (Attard & Zarb, 2004). Edentulous patients with severely resorbed mandibles may experience problems with conventional dentures due to deteriorated load-bearing capacity. Problems include pain during mastication, as well as instability and retention of the denture (van Waas, 1990). The most significant biological condition associated with loss of stability and retention of complete mandibular dentures is physiological alveolar ridge resorption. This also results in diminished oral tissue volume for denture support (Redford et al., 1996). Deteriorating muscle strength and coordination in elderly patients may lead to problems in fabricating complete dentures, as well as difficulty in achieving and maintaining acceptable denture stability and retention. Moreover, elderly patients often have difficulty in adapting to new complete dentures and have problems in attaining comfortable and efficient denture function (Chung et al., 2004).

Overdentures have been shown to improve the quality of life for edentulous patients (Wismeijer et al., 1992) and contribute significantly to the patients' psychological well-being (Kent & Johns, 1994). An overview of reported clinical trials suggests superior functional performance and patient satisfaction with implant retained complete mandibular overdentures when compared to conventional ones (Trakas et al., 2006). Patients find the implant overdentures to be significantly more stable, and rate their ability to chew various foods as significantly easier. In addition, they are more comfortable and speak more easily with implant overdentures (Feine et al., 2002).

Investigators have found that a direct relationship exists between prosthesis retention and patient satisfaction (Petropoulos & Smith, 2002). Retention and stability are the major determinants of success for mandibular two-implant overdentures (Burns et al., 1995) and are a function of the specific attachment system selected to connect the implant to the overdenture. The retention force is gained from mechanical and frictional contacts, or from magnetic forces of attraction between the patrices and matrices of various attachment systems (Preiskel, 1996). Some investigators have proposed a rough estimate of 20 N of retention force is required to be adequate for mandibular two-implant overdentures (Setz et al., 1998), similar to those reported by Maeda and Walmsley (2005) that the minimal amount of retention that provides patient satisfaction has been studied and reported to be around 8 N to 20 N for a removable prosthesis. At present, numerous types of connectors have been designed to provide adequate attachment between the implants and the base of the removable prosthesis that at the same time allow simple retrieval of these restorations (Awad et al., 2003). The ultimate choice of attachment type should be based on scientific evidence related to the clinical performance of the attachments.

One of the attachments which considered to be the simplest type for clinical application with tooth- or implant-supported overdentures is ball attachment. It is indicated for non-splinted restorations in mandible. It has a special design of the clix attachment. The clix metal housing is cured into

the denture and custom retention is achieved with the plastic insert, snapped into the housing. The clix inserts are available in three different strengths, offering optimal retention for every individual situation. The clix attachment is designed to virtually eliminate wear on the ball abutment and minimize the need for maintenance. The clinical process is quick and easy, changing the clix inserts to alter the retention is done easily. In recent years, ball attachments have gained popularity over bars, as they are easier to manage in limited prosthetic space, more economical, easily cleansable, and less technique sensitive (Sadowsky, 2007).

Locator is a newly introduced connector design which provides accurate seating and adequate retention of implant supported overdentures (Sadig, 2009). It is used on non-splinted, free-standing implants. According to the manufacturer (Zest Anchors, Escondido, CA), Locator is classified as universal hinge, resilient overdenture attachments for endosseous implants. It has a low-profile height of 2.5 mm, with a diameter of 4.1 mm at their seating surface. Locator can compensate for angle corrections of up to 40 degrees. It has a skirt around the denture components that permits easy location of the permanent mating component on the implant. The nylon inserts come with five different retention holding force levels. The self-aligning feature of Locator aids patient by providing a guide plane for the removable overdenture. As a result, patient can easily align and seat the prosthesis, allowing simple and quick insertion. The Locator has extra advantages in complex cases, because it can compensate for severe angle misalignment. Previous study found that Locator provided the highest retention and stability of implant supported overdentures, followed by ball connectors and magnets, which could be advantageous in cases where the retention is compromised by other factors such as reduced residual ridges, parafunctional habits, tongue and cheek movements, and implant location and angulation (Sadig, 2009). Therefore, the Locator is claimed an ideal attachment for all overdenture patients.

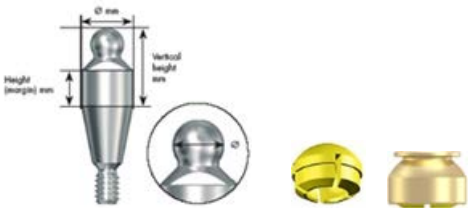
To date, change in retention values of the ball and Locator attachments from thermal variations in the oral cavity has never been investigated. Therefore, the aim of this study was to investigate the effect of thermocycling and type of attachments (ball, Locator) on the retention. The null hypothesis of the present study was that there would be no influence of thermocycling on the retention of two-type attachments.

Materials and methods

Fabrication of testing acrylic resin block with demo implant and attachments

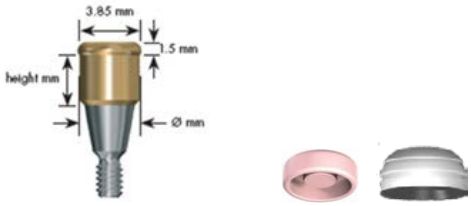
A silicone mold (Dentsply, Milford, DE) was shaped into a rectangular box (7x7x20mm) to fabricate acrylic resin blocks, with a handle (7x4x10mm). A demo implant (4.5x11mm) (Astra Tech AB, Mölndal, Sweden) with wax guide pin was set in the middle of the silicone mold, perpendicular to the floor, using a surveyor (Dentsply, Bloomfield, CT). Autopolymerized ortho clear acrylic (Lang Dental Manufacturing Co., Inc., Wheeling, IL) was poured into the silicone mold to fabricate implant block. The top of the implant was set at the same level as the top of the block. The ball (Astra Tech AB, Mölndal, Sweden) and Locator abutment (Zest Anchors, Escondido, CA) (Fig.1) were screwed into the demo implant with torque wrench at 25 Ncm.

Then ten yellow clix insert ball attachment (Astra Tech AB, Mölndal, Sweden) blocks and ten pink Locator attachment (Zest Anchors, Escondido, CA) blocks were made in the same manner, and a hole (Ø 2mm) was drilled on the handle of all attachment blocks (Fig.2).



Height of ball attachment - 2.00 mm

Diameter of ball attachment - 2.25 mm.



Height of Locator attachment - 2.00 mm.

Diameter of Locator attachment - 3.85 mm.

Figure 1 Schematic diagram of structure of ball and Locator abutments

Figure 2 An implant block with an attachment block

After polishing, an implant block and twenty attachment blocks were ready for testing procedure. Ten attachment blocks contained a clix female with yellow clix insert ball embedded in it. And another ten attachment blocks contained a Locator cap with pink nylon.

Thermocycling procedure

Twenty attachments were subjected to thermocycling (Medical & Environmental Equipment Research Laboratory Technology Ladkrabang, Bangkok, Thailand) for 5000 and 10000 cycles between 5°C and 55°C with a 30-second dwell time and a transfer time of 15 s. The temperature range between 5°C and 55°C was chosen that is similar to the temperature of foods ingested during meals without damaging oral tissues (Can et al., 2009)

Retention test

After 0, 5000 and 10000 cycles of thermocycling, each attachment was then removed from the storage container, dried with paper towel, and fixed in a table-top universal tester (Shimadzu EZ-S-500N, Tokyo, Japan) (Fig.3). A tensile load was applied using a crosshead speed of 50 mm/min. Each attachment was subjected to 5 consecutive pulls, with a resting period of 4 minutes between each pull. The retention forces were collected, and mean retention values were calculated.

Figure 3 Attachment was fixed in a table-top universal tester (Shimadzu EZ-S-500N)

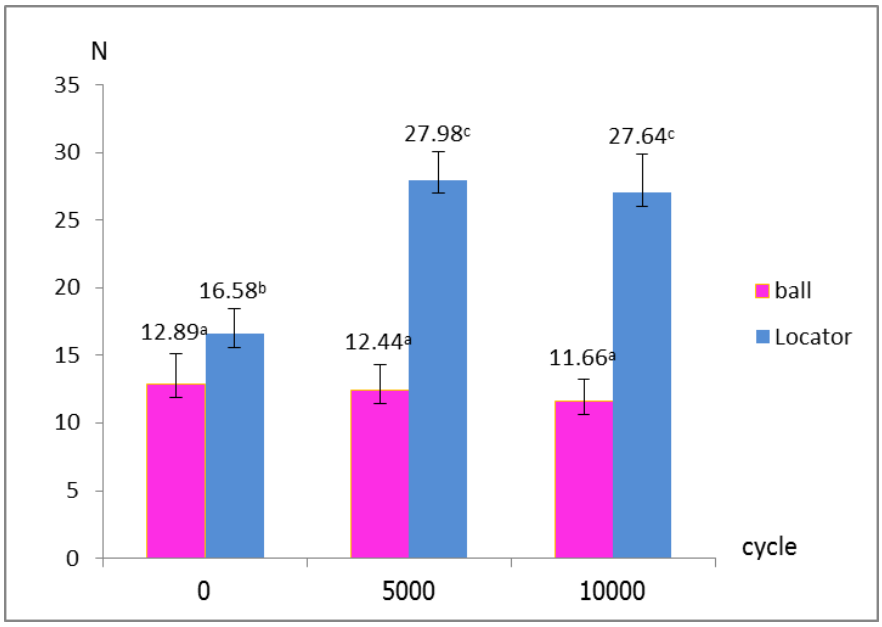


Figure 4 Means and standard deviation of retention values of yellow clix insert ball and pink Locator attachments at different number of cycles of thermocycling. Groups with the same superscript latter were not significantly different (p>0.05)

Statistical analysis

Two-way repeated measures ANOVA and Tukey HSD tests were used to analyze the difference in retention values at p<0.05.

Results

Two-way repeated measures ANOVA revealed significance on two main effects; thermocycling, type of attachment, and interactions (p<0.001). The mean retention values of tested attachments are illustrated in Figure 4. The mean retention values of yellow clix insert ball attachments were 12.89±2.25 N, 12.44±1.87 N, 11.66±1.57 N at 0, 5000, 10000 cycles of thermocycling, respectively. The mean retention values of pink Locator attachments were 16.58±1.86 N, 27.98±2.11 N, 27.64±1.95 N at 0, 5000, 10000 cycles of thermocycling, respectively.

Discussion

The aim of this study was to investigate the effect of thermocycling and type of attachment on the retention. Statistical analysis revealed significant differences of the two main factors; thermocycling and type of attachment and interaction. Therefore, the null hypothesis was rejected.

In the present study, the attachments were artificially aged using thermocycling at 5000 and 10000 cycles, equivalent to 6 months and 1 year of clinical use, respectively (Gale & Darvell, 1999). The crosshead speed was set at 50 mm/min. This speed approximates the actual speed of movement of an overdenture away from its retentive elements in the mouth under a vertical dislodging force (Petropoulos et al., 1997).

The results showed that thermocycling has an effect on the retention of Locator attachments. The component of Locator attachment consists of nylon.

Changes of intraoral temperature may affect the mechanical property and bond strength of nylon to the abutment. Nylon has good abrasive resistance and self-lubricating properties, difficult to wear and tear, therefore no retention loss was found. Moreover, the mean retention values of Locator attachments increased significantly after 5000 and 10000 cycles of thermocycling.

Locator attachment has outer and inner ring peripheries, which is the main areas of frictional contact, and nylon has a strong affinity to uptake water (Alsabeeha et al., 2011). Upon water uptake, it enlarged, the outer and inner ring frictional contact increased. In addition, the mean initial retention value of pink Locator attachments reported by You et al. (2011) (17.44 N) was similar to this study.

In contrast, the retention of ball attachments was not affected by thermocycling. The structure of ball attachment is spherical shape, retention gain from only outer surface friction. And the component of female clix insert ball attachment consists of plastic, a polyoxymetylene copolymer, it is abrasive resistance, high heat resistance, and low water absorption, It did not uptake water with no alteration of form or shape, which is different from Locator attachment.

According to the study of Al-Ghafli et al (2009), implant angulations contribute significantly to the rate of retention loss of the implant attachment system. This study intended to investigate the effect of temperature change on the retention of two attachment systems, therefore one implant was placed at 0 degree.

It is assumed that an estimate of 20 N of retention force is probably sufficient for mandibular two-implant overdentures (Walmsley, 2002). Therefore, yellow clix insert ball (11.50 N of retention holding force level) and pink Locator (13.61 N) attachments were evaluated in this study. Furthermore, pink Locator attachments were tested because they are the most commonly used attachments in practice (You et al., 2011). The results of this study showed that after 10000 cycles of thermocycling, mean retention values of yellow clix insert ball and pink Locator attachment were still sufficient for retaining mandibular two-implant overdentures. However, in clinical situation, there may be other factors that have impact on the retention of attachments, such as mastication, parafunction, insert and removal, number and angulation of attachments, denture cleaning solutions and wear of the attachments.

Conclusions

Within the limitations of this in vitro study, the following conclusions were drawn:

1. The retention of pink Locator attachments was higher than yellow clix insert ball attachments before and after thermocycling ($p<0.05$).
2. The retention of yellow clix insert ball attachments was not affected after 5000 and 10000 thermocycling cycles ($p<0.05$).
3. The retention of pink Locator attachments increased after 5000 thermocycling cycles ($p<0.05$).

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