Assessing stability of Neodent Morse taper implants through reverse torque technique testing: a preliminary study in rabbits

Abstract / Introduction: *Several types of implants are available on the market, including internal or external hexagonal connections and the Morse Taper connection. The latter provides better distribution and transmission of forces throughout the implant. Implant osseointegration can be measured and assessed by reverse torque.* Objective: *The objective of this study is to test, in Morse Taper implants installed in rabbits' tibia, the feasibility of a new reverse torque assessment method.* Methods: *Neodent Morse Taper WS implants were installed in rabbits' tibia. The animals were sacrificed at different periods of time. The bone blocks containing the implants were cut, and a corresponding mounting device was attached to the implant, forming a single pillar. Reverse torque was simulated using a universal testing machine EMIC DL 1000. Compressive force was applied to the arm of the ratchet.* Results: *The values obtained with the test were: Rabbit 1 (immediate) = 1.8 Kgf, Rabbit 2 (7 days) = 7.6 Kgf, Rabbit 3 (15 days) = 17 Kgf, Rabbit 4 (30 days)=27Kgf, and Rabbit 5 (45 days) = 36 Kgf.* Conclusion: *Results were promising as they indicated an increase in the value of reverse torque over time.* Keywords: *Torque. Dental implants. Osseointegration.*

Michelly Lima Moro ALVES
Masters student in Orofacial Cleft and Associate Anomalies, Hospital for Rehabilitation of Craniofacial Anomalies/USP (HRAC/USP).

Liogi IWAKI FILHO
Professor, Department of Dental Surgery, State University of Maringá (UEM).

Sérgio SÁBIO
Professor, Department of Dental Prosthesis, State University of Maringá (UEM).

Edson Virgilio ZEN FILHO
Masters student of Applied Dental Sciences, School of Dentistry — University of São Paulo/Bauru.

Simone SOARES
Professor, Department of Prosthesis, School of Dentistry — University of São Paulo/Bauru.

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Contact address: Michelly Lima Moro Alves
Rua Joaquim Fidelis, 8-55, apto. 61N – CEP: 17.012-180 – Bauru/SP – Brazil
E-mail: michelly_lma@hotmail.com

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INTRODUCTION

Rehabilitation of edentulous areas with osseointegrated implants has increased because it improves patients' quality of life, particularly in terms of comfort, function, esthetics, and self-image.[1-4]

Implant success rate not only depends on the placement site, but also on the patient. Factors such as material biocompatibility, implant design and surface, surgical technique, patient, bone density, and remaining bone may influence implant osseointegration and success rate.[5,6]

Several types of implants are available on the market, including internal or external hexagonal connections and the Morse Taper connection. The latter provides a stronger implant-abutment connection. The cold weld joining these elements together reduces the microgap between them and consequently offers decreased risk of bacterial invasion, absence of micro movement, better distribution of force on the implant axis and bone tissue, and absence of loose screws.[7,8,9]

Osseointegration can be measured by reverse torque, which also determines implant anchorage. Thus, the greater the torque value, the stronger the influence of factors such as healing time, loading protocol, and study design.[10,11,12]

The literature reports a number of devices developed to perform reverse torque test, including digital and/or manual devices, such as Tohnichi (Japan), Hicksville (New York), and Detektor AB (Sweden) torque gauges. Nevertheless, few articles describe the methods used in detail, especially how the device was used.[5,13,14]

Thus, the objective of this study is to test, in Morse Taper implants installed in rabbits' tibia, the feasibility of a new reverse torque assessment method.

MATERIAL AND METHODS

The present study was reviewed and approved by State University of Maringá Institutional Review Board, process #46/2008, protocol #020/2008.

Five Neodent Morse Taper WS implants 4.1 mm in diameter and 6 mm in length were used to assess the feasibility of a device used to test reverse torque.

Animal selection and anesthesia

This study used five female New Zealand rabbits, aged between 6 to 8 months, and ranging in weight between 3.5 and 4.0 kg. An implant was installed in the tibia of each animal.

The animals were kept in cages for eight days prior to surgery, so that they could adapt to the study environment. During the experimental period, the animals were on a solid diet and water, remained without food during six hours before the surgery, and were allowed to eat two hours after the procedure.

Before surgery, all animals underwent trichotomy of the internal surface of the leg. They were weighed, and had the necessary dose of anesthetics carefully calculated on the proportion of 0.1 ml for every 200 g of live weight. The mixture of the general anesthetic ketamine was combined with a liquid solution of water and 2% xylazine in equal parts, and ministered by means of deep inter-muscular application. Ten minutes before anesthetic application, the animals received a 0.08 mg/kg dose of atropine via subcutaneous application, with the aim of preventing potential bradycardia triggered by most anesthetics.

Experimental surgery

Experimental surgical procedures took place in an operating room. The surgical technique was based on a protocol similar to that

described by Johansson and Albrektsson,[15] and carefully carried out as follows:

A 10% polyvinylpyrrolidone solution was used for local antisepsis. Skin and subcutaneous incisions were made with blade #15, 2 cm long, placed on the middle third of the internal surface of the animal leg.

After divulsion of the anatomical parts, the periosteum was also incised, and bone was kept away with retractors. Bone perforations were done with surgical burs, and the drill was set at 1000-rpm rotations and 36-Ncm² torque, according to the manufacturer's recommendations (Figs 1 and 2).

The surgical site was irrigated to remove remaining pieces of bone. Subsequently, the implants were installed. The flap was closed with a nonresorbable wire. The animals remained under observation during recovery from anesthesia and were then kept in their cages until the time of sacrifice. Antibiotic drugs were administrated immediately (enrofloxacin – 5 mg/kg) in order to prevent infection. Painkillers (dipyrone – 1ml/kg) were also administered after surgery in order to prevent pain.

Experimental design

Five implants were installed in the rabbits' tibia, and the animals were sacrificed at different periods of time. Rabbit number one was sacrificed immediately after surgery;

Figure 1. Bone perforations.

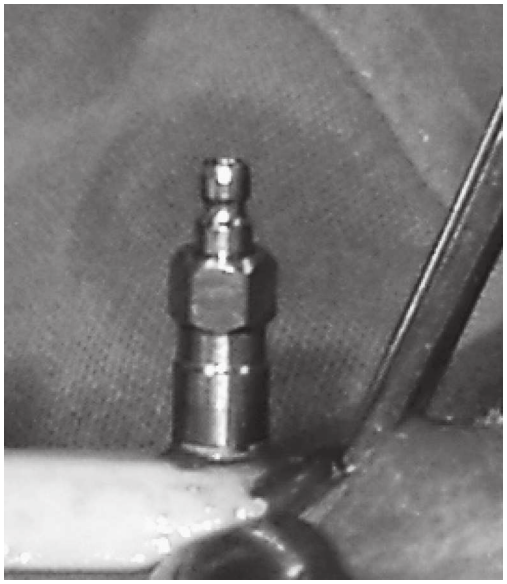

Figure 2. Implant and mount installed, showing parallelism.

whereas number two was sacrificed 7 days after surgery; number three, 15 days after surgery; number four, 30 days after surgery; and number five, 45 days after surgery.

This method was chosen to observe whether reverse torque value would increase as healing time increased.

Animal sacrifice

The rabbits were sacrificed via a triple dosage of the anesthetic mixture of ketamine and rompun. After sacrifice, the bone block containing the implant was removed and kept in a 10% formaldehyde solution for preservation until testing time.

Reverse torque test and results

To perform this test, five specimens were manufactured with the bone block of each animal.

The blocks containing the implants were cut into 5 mm x 5 mm pieces and the corresponding Morse Taper device was attached to the implant, forming a single and continuous pillar (Fig 3).

Samples were enclosed in acrylic resin and kept in water during polymerization so as to avoid bone overheating. After 10 minutes, specimens were kept in normal saline solution.

Reverse torque was simulated using a universal testing machine EMIC DL 1000 – TESC VIRMAQ Version 3.05 (2007) to assess the capacity of an osseointegrated implant to resist rotation inside bone tissue. Compressive force was applied on the arm of the ratchet (Neodent) joined with the ratchet connector and the implant mount. A base situated under the ratchet prevented vertical implant movement. The only movement allowed was of the arm of the ratchet in a reverse way, which determined the torque necessary to remove the implant from the rabbits' tibia (Fig 4).

Maximum compressive strength was registered, and the test finished when bone allowed free movement of the implant. The scaling laws state that torque varies with distance; thus, a distance of 3 cm from the fixation center of the device was established (Figs 5 and 6).[16]

After test completion, bone blocks were analyzed. Should there be no fracture in any wall, the test was considered successful (Fig 7).

Figure 3. Bone blocks containing implants and the corresponding Morse Taper device.

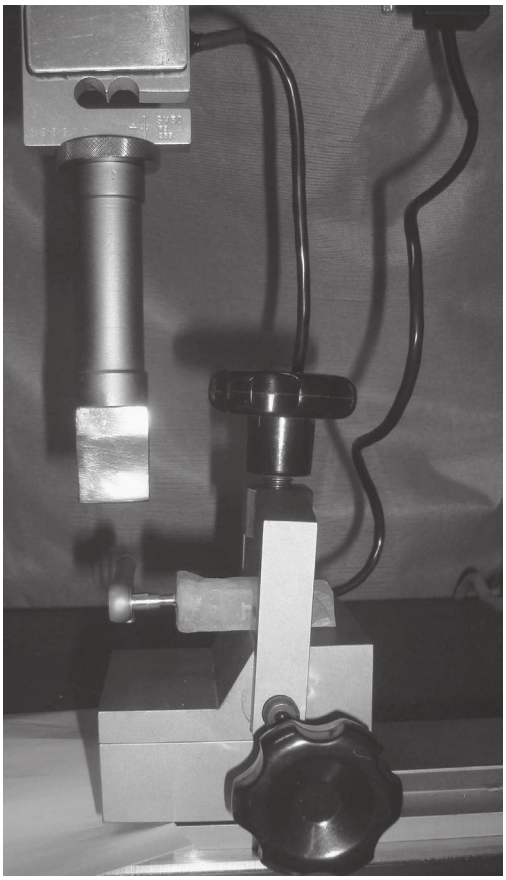

Figure 4. View of the universal testing machine EMIC DL 1000 with samples in position to be tested.

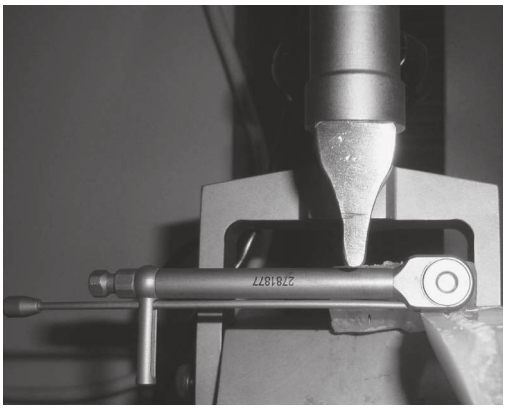

Figure 5. Ratchet on initial position to receive compressive force.

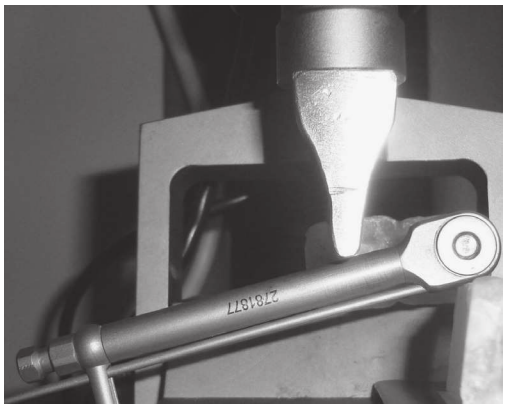

Figure 6. Ratchet movement on reverse. Note the base for connection.

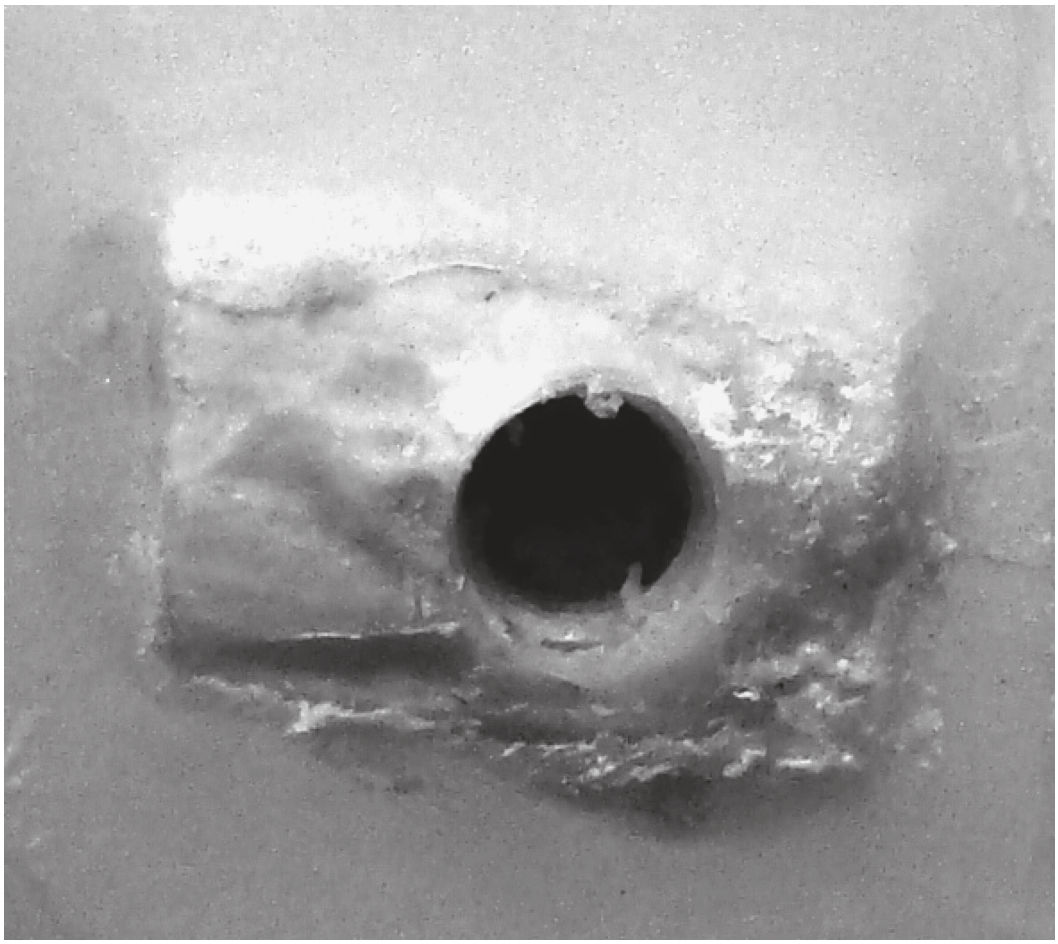

Figure 7. Final bone block. No fractures on the wall.

Test results were as follows:

» Rabbit 1 (immediate) = 0.18 Kgf or 1.76 N

» Rabbit 2 (7 days) = 0.76 Kgf or 7.45 N

» Rabbit 3 (15 days) = 1.7 Kgf or 16.67 N

» Rabbit 4 (30 days) = 2.7 Kgf or 26.48 N

» Rabbit 5 (45 days) = 3.6 Kgf or 35.30 N

It can be noted that reverse torque value increased with additional healing time.

DISCUSSION

Existing literature describes the reverse torque test as a feasible method to assess dental implants osseointegration. Most studies use New Zealand rabbits whose tibia is normally chosen for surgery because it offers simple and direct access, two cortical and a medullary bone similar to the mandible, and enough tissue to cover implants.[5,13,17]

However, the literature reveals that few studies describe the methods of reverse torque test accurately. Some studies detail the technique and the device used, but do not describe which type of implant was used (Morse Taper, external or internal

hexagon), how the device was attached to the implant, how the test was carried out, whether it is an electronic or manual device, and whether the device is accessible.[5,13,15,17]

Another point that favors this methodology is the selection of a device that has been used in numerous researches and different areas, thus offering a great deal of information of high precision.[18,19,20,21,22]

More precise information about the technique and the device used in the studies would help researchers to develop further studies in the area, thereby enriching the literature. Hence, this study was conducted so that researchers could perform the reverse test on Morse Taper implants safely and effectively.

Because the mount comes with the implant, the ratchet is included in the surgical kit, and most colleges have the universal testing machine, no additional expenses are incurred. Thus, this methodology is viable both practically and financially.

Despite having a limited sample, the present results are promising, particularly because reverse torque values increased over time, which is in agreement with the literature.[8]

Presently, this technique has proved to be practical and, in the future, it can be associated with histological and histomorphometric studies of implant areas so as to confirm its reliability in establishing a parallel between reverse torque values and the degree of osseointegration.

CONCLUSION

The method and the device described herein are easily obtainable not only by students, but also by professionals. Moreover, they proved useful to measure reverse torque values.

The present results are positive and encourage the continuity of similar research to obtain more accurate information about this technique.

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