

**Evaluation of Bite Force in Hybrid Implants****<sup>1</sup>Dr. N. V. V. Satya Bhushan, <sup>2</sup>Dr. Amrita Patnaik, <sup>3</sup>Dr. Varghese Mani, <sup>4</sup>Dr. U. Sivakalyan, <sup>5</sup>Dr. K. C. Chiang**

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**Abstract**

**Introduction:** The number of teeth in the oral cavity and the contact between them are the most important factors which determine the masticatory efficiency. Hence replacement of missing tooth has been a challenge to dentists.

**Objective:** To measure the maximum bite force when the replacement of the missing teeth was done with hybrid implants.

**Materials and Methods:** In this prospective study maximum bite force was recorded in 10 patients rehabilitated with hybrid implants using Bite force meter. Maximum bite force values were recorded in all the 10 patients during the follow ups such as immediate, 10th day & 3 months post operatively. Maximum bite force was also recorded Immediate & 3 months post loading.

**Results:** The rehabilitation with hybrid implants has increased the bite force on both the sides (i.e the rehabilitated and the opposite side) from preoperative to

3months postloading when the missing tooth was replaced with hybrid implants.

**Conclusion:** Replacement of maxillary or mandibular missing posterior tooth with hybrid implant showed a marked increase in the bite force from preoperative to 6months postoperative period.

**Keywords:** Maximum bite force, Hybrid implant, Masticatory efficiency.

**1. Introduction**

Bite force is an important variable to investigate masticatory function where muscle force and the number of functional teeth are the determinant factors. Measuring maximum bite force is an attempt to quantify the masticatory efficiency. Determination of individual bite force level has been widely used in oral and maxillofacial surgery as a parameter of normality. Bite force can be measured with various devices such as strain gauge transducer, customised bite force meter, piezoelectric film, gnathodynamometer, quartz force transducer,

pressure sensitive sheet or force sensing resistors.<sup>2</sup> Good quantity and quality bone is the basic requirement of endosseous implants for their success.<sup>4</sup> In the maxillary sinus region the reduction of bone height due to the post extraction pneumatization and the position of the neurovascular bundle in the mandibular region have been the hindering factors for the placement of endosseous implants.<sup>5</sup> To overcome the above said disadvantages, maxillary sinus lift and mandibular nerve repositioning procedures are performed respectively. These procedures are associated with complications and are technique sensitive. This has led to the development of newer replacement modalities such as hybrid implants which are fixed extraosseously with screws.<sup>12</sup>

## **2. Patients and methods:**

A prospective study was done to evaluate maximum bite force in 10 patients who reported to the Department of Oral & Maxillofacial Surgery of GITAM Dental College & Hospital, Visakhapatnam for replacement of the missing tooth with hybrid implants. The nature and design of the clinical study was explained to all 10 subjects and an informed consent was obtained for their participation. Once the subjects fulfilled the inclusion criteria, hybrid implants were placed under local anaesthesia and their maximum bite force measurements were recorded.

### **2.1. Method of collection of data:**

Partially edentulous patients who were eligible for hybrid implants were enrolled in this study.

### **2.2. Inclusion criteria:**

Healthy adult patients who need replacement of single or multiple teeth in the posterior region of maxillae and mandible & Patients who are willing to participate in the study by signing the informed consent.

### **2.3. Exclusion criteria:**

Medically compromised patients, Syndromic patients & Patients who are not willing to participate in the study.

The Maximum bite force of hybrid implants with bite force meter for a follow up period of:

PRE LOADING: Immediate, 10<sup>th</sup> day & 3 months post operatively.

POST LOADING: Immediate & 3<sup>rd</sup> month post loading.

For follow ups such as preoperative, Immediate, & 3months postoperatively (post loading) an Orthopantomogram was advised. All the routine blood investigations were advised for the patient.

### **2.4. Procedure of HYBRID Implant Placement:**

After giving a chlorhexidine rinse, intraoral operative site is wiped with gauze and local anaesthesia 2% lignocaine with adrenaline 1:80,000 is administered. A crevicular incision continued with a crestal incision followed by a vertical release incision in the anterior region is given. The mucoperiosteal flap is elevated and the alveolar bone is exposed. The implant is molded to the contour of the exposed alveolar bone in such a way that the abutment is projecting into the oral cavity in the direction of the tooth to be replaced. In cases of knife-edge ridge patterns a small crestal portion of the alveolar bone is shaved to make the surface of the alveolus flat. This will aid in the submerging of the hybrid implant plate into the alveolar bone. After proper adaptation, the implant is fixed to the alveolar bone using titanium screws of size 2x6 and 2x8 mm into the predrilled holes prepared by using 1.5mm titanium drill bit. There is a high chance of plate exposure if the plate is very superficial. To prevent exposure a groove should be prepared on the crest deeper than the thickness of the plate and as wide as the width of the plate. If the plate is dipped properly the chances of plate exposure is avoided. This aids in the implant remaining below the crest. Three screws are placed in the buccal arm and two screws in the palatal arm of the hybrid implant. The closure is done by simple interrupted sutures with 3-0 silk. The abutment will be the exposed part of the implant

projecting into the oral cavity in the place of missing tooth. A course of antibiotics and analgesics is given for five days. Patient is recalled after 10 days for suture removal. The implant is loaded after 3 months.

## 2.5. Bite force meter



Recording the bite force with the bite force meter is the simplest, non invasive and can be carried out in a chair side procedure. Such instruments are more accurate and precise for the measurement of bite forces in patients. The bite force meter consisted of a Wheatstone bridge assembly, instrument amplifier and a digital panel meter. An adjustable button is incorporated on the instrument for resetting the instrument reading to zero, at the start of each recording. This electronic device was connected to the bite force pads. The high precision load cell and electronic circuit provide precise measurements. The procedure was comfortable for both the operator and the patient.<sup>6</sup>

## 2.6. Design of the hybrid implant:



Hybrid implant consists of a long malleable plate having a length of 30-45mm, thickness of 0.4-1mm and breadth of 3-5mm with screw holes and a stump called abutment, projecting from the flat surface of the plate. The abutment

part of the implant is in three diameters- 2.5, 3 and 3.5 mm. Using 2 x6 and 2 x8 mm screws, the arms of the hybrid implant plate can be fixed.<sup>12</sup>

The distinguishing features of the Hybrid implant system are:

1. The implant is a plate which is malleable, with an abutment projecting from its central area. The plate has got screw holes on the two arms extending from the abutment. The arms can be of variable length, width and thickness.
2. The abutment is projecting from the central part of the plate. The height, width, taper and slots on the abutment are variable according to the requirement.
3. The implant design overcomes the height and width problem of alveolar bone, as it hugs the bone and is fixed to the cortical bone using screws.
4. The implant system overcomes the risk of nerve damage as it is placed subperiosteally and fixed by screw of variable lengths to the bone. As the screw holes are multiple one can select the screw hole which is not in proximity to the nerve.
5. In the sinus area of the maxilla the thickness of the bone between the sinus and oral cavity at the alveolar crest is often less to support the endosteal implant. This is overcome by the proposed implant as it is subperiosteal and hugging the bone and is fixed to the cortical bone. This avoids sinus lift bone grafting which is a very technique sensitive major surgical procedure.<sup>12</sup>

## 3. Results

Statistical analysis was done using paired t-test in this study. Comparisons of bite force (pre op to follow ups) of patients rehabilitated with hybrid implants on the right & left sides were done. In both the cases, it was observed that there is no statistical significance of bite force on both the right side and left sides but there is increase of bite force from the preoperative to 3<sup>rd</sup> month post loading on

both the sides where as the rehabilitation with hybrid implants has increased the bite force on both the sides (i.e. the rehabilitated and the opposite side).

#### **4. Discussion**

Bite force is one indicator of the functional state of the masticatory system that results from the action of jaw elevator muscles modified by the craniomandibular biomechanics. The number of teeth in the oral cavity and the contact between them are the most important factors which determine the masticatory efficiency. Hence replacement of missing tooth has been a challenge to dentists as loss of teeth can be likened to an amputation, and spaces in between the teeth are perceived as physical imperfections, like missing body parts. Adult patients with varying severity of tooth loss can be rehabilitated either by removable or fixed prosthesis. Rehabilitation is custom made according to the needs of the individual. This helps in providing adequate masticatory, phonetic and esthetic in function, simulating the natural dentition that does not jeopardize the remaining teeth, ranging from a single crown or a long span fixed dental prosthesis to a full mouth rehabilitation.<sup>5</sup>

Out of many advantages with the endosteal implants there are few demerits such as in medically compromised patients (for example: uncontrolled diabetes, autoimmune diseases, any bone pathologies) they may end up in failure. Endosseous implants are also unsuccessful in patients with history of chronic periodontitis, bruxism or other parafunctional habits, smoking, tobacco use, low bone volume and bone type (type 3 & 4).<sup>31</sup> Most authors agree that mandibular implants have a greater chance for success than those placed in the maxilla. The difference in the bone quality and presence of sinus is the reason for difference in the success. When the patient presents deficient alveolar ridges particularly in the maxillary posterior region either because of alveolar bone loss or

increased maxillary sinus pneumatization, endosteal implants fail at this juncture.

A plethora of researchers have evaluated different maxillary sinus grafting procedures. The two most commonly used maxillary sinus grafting procedures for occlusal rehabilitation with prosthetic appliances placed over the dental implants in the posterior maxilla are indirect and direct sinus lift.<sup>21</sup> In 1983 Misch observed the most predictable intraoral region to grow bone height is on the maxillary sinus floor once the sinus mucosa has been elevated, this statement still holds true today.<sup>32</sup> There are a few contraindications for maxillary sinus procedures such as presence of purulent material in the sinus, acute & chronic maxillary sinusitis, severe osteoporosis, age, patients with the history of diabetes mellitus, recent radiation therapy in the maxilla, heavy smoker, severe allergic rhinitis, presence of tumor or cyst in the maxillary sinus and history of oroantral fistula.<sup>30</sup> The most common complications with the sinus lift graft surgeries is tearing or creation of opening in the sinus membrane which can be due to pre existing perforation, tearing during scoring of the lateral window, and existing of the previous pathological condition. Another disadvantage of sinus lift procedure is the anatomical variations of antral septa (of buttresses, webs, and struts). Acute sinusitis is the most serious complication and is frequently caused by infection of the augmentation material. Postoperative haematoma has an annoying effect on esthetics.<sup>30</sup> Keeping in mind such difficulties a search for an implant system, which would be cost effective, less technique sensitive, obviate sinus lift and mandibular nerve repositioning procedures and has adequate strength to support prosthesis has become the order.

The present study is to evaluate such an implant system namely the Hybrid implant: A Novel Implant System developed by Dr. Varghese Mani. The hybrid implant

consists of long malleable plate with screw holes and a stump called abutment projecting from the flat surface of the plate which can be fixed with screws on the buccal and palatal/lingual cortical plates.<sup>12</sup> This invention is a piece of art, which is a combination of both sub periosteal and endosseous implant. The difficulty in removing titanium plates and screws, which were used for open reduction and internal fixation according to the inventor, served the purpose of inventing such an implant. More over the hybrid implant derives its support from the strong cortical bone accords an additional advantage of strong anchorage.<sup>12</sup> Hybrid implant is a combination of subperiosteal and endosteal implant. Endosteal fixation is achieved through the screws. Since it involves reflecting the flap a little more than usual, placing of the implant has to be considered technique sensitive and could be done by people with surgical experience. Though the implant is intended for the maxillary posterior region to avoid sinus lift, it can be safely and more predictably used in the mandible also. Hybrid implant is an ideal in mandible, where the crestal height is less for conventional root form implant. The implant is ideally used in the posterior region for both maxilla as well as mandible but in the anterior region it is difficult to adapt and also to fix the screws from lingual and palatal aspect.<sup>12</sup>

Maximum bite force is an objective and quantitative measure for evaluating masticatory performance, which verifies the effectiveness of incising, crushing, and pulverizing food by the number of functional teeth. Masticatory performance is a cumulative contribution of various factors like bite force, severity of malocclusion, occlusal contact area, body loss of teeth, restorations, facial forms and other motor activities. Factors including bite force and occlusal contact area, suggest that higher the bite forces and the larger the occlusal areas, the more efficient the mastication is.<sup>22</sup> Bite force has also shown to

be affected by a number of physiological and morphological variables such as craniofacial morphology, age, gender, periodontal support of the teeth, height and body weight, tempo-mandibular disorders pain, and dental status.<sup>20</sup> Other variables reportedly affecting the bite force are the type of recording devices, technique employed to measure the bite force, position of the sensor in the oral cavity, patient position, unilateral or bilateral measurements and magnitude of mouth opening during measurements.<sup>4</sup> As Bite force capacity has been tested in a wide array of vertebrates (mammals, birds, lizards, turtles, crocodiles) it can provide a reliable measure of bite performance in human beings.<sup>18</sup> Determination of individual bite force level has been widely used in dentistry, mainly to understand the mechanics of mastication for evaluation of the therapeutic effects of prosthetic devices and to provide reference values for studies on the biomechanics of prosthetic devices. In addition, bite force has been considered important in the diagnosis of the disturbances of the stomatognathic system. Bite force varies in different regions of the oral cavity. The more posteriorly the bite pads are placed in the dental arch, the greater is the bite force. Greater bite forces can be better tolerated at the posterior tooth region due to the larger occlusal surface area and its support from the periodontal ligament from each root of the posterior tooth. Different position of the bite pads influence the different muscles that are involved in the force production.<sup>7</sup>

The bite force is the ratio of the distance from the jaw joint which is the fulcrum or pivot point to the point of application, i.e. the biting versus the distance from the jaw joint to the muscle attachment which is the force required to close the jaw. In humans the larger bite forces are observed in the posterior teeth (the molar region).<sup>5</sup> This region is closest to the pivot point of the jaw and the



muscles associated with the jaw strength. At the incisors or anterior point, the bite forces are lower with less action of the jaw muscles.<sup>18</sup> A strong bite force in humans is expected due to the shorter jaw, and the point force of the bite is localized on the molars and premolars.<sup>6</sup> The bite forces range from 55 lbs to 280 lbs, averaging 162 lbs and in some cases reaching a maximum of over 970 lbs. The force observed for the incisors in the front is lower at 22 lbs to 34 lbs. The force unit most familiar is the pounds.<sup>7</sup> The bite force in the molar region during chewing was found to be 70 pounds per square inch. The force tapers off towards the front of the jaw, because of the shape of the lever being worked by the jaw muscles. The jaws can be consciously clenched to produce a force about twice as strong as chewing.<sup>19</sup> People who unconsciously grind their teeth at night, in a disorder called bruxism, exert even more force, perhaps 6 to 10 times as much, by some estimates.<sup>10</sup> It was observed that, the bite force measured in rural population was higher than that measured in urban population. A mean bite force of about 1500N was recorded in Eskimos, while bite force of 600-750 N were reported in western population. These differences in bite force values could be a result of variations in individual or technique-related issues.<sup>13</sup> Higher bite force values have been reported in square faced than the long-faced and short-faced individuals.<sup>8</sup> Also, increased bite force values with age, height, weight and body mass index (BMI) have been reported. Furthermore males were found to have higher bite force than females.<sup>7</sup> Ferrario et al explained larger tooth size, having larger periodontal areas is responsible for higher bite force in males and people in their prime have stronger bites than the frail elderly. People with false teeth tend to have a much weaker bite force factor.<sup>2</sup> Individual dental status might influence bite force values. Fully dentate individuals were suggested to have higher bite force

values than individuals with complete denture, removable partial denture or fixed partial dentures. Individuals with implant supported over dentures had higher bite force values than with individuals with root-retained over dentures or complete dentures.<sup>8</sup>

If the bite pads are placed more anteriorly between the incisor teeth, the masseter muscle will produce more force together with the medial pterygoid. If the bite pads are placed more posteriorly between the molars, the anterior temporalis becomes active and results in a greater bite force.<sup>15</sup> Studies which apply quantitative methodology to evaluate oral quality of life constitute a relatively new research field. Till date there are few high quality studies of treatment outcomes, so this study was undertaken to evaluate the maximum bite force in HYBRID IMPLANTS with the bite force meter.

The results of this study showed that patients rehabilitated with hybrid implants showed a gradual increase in the bite force from the preoperative to the end of six months on the rehabilitated as well as on the opposite side which is similar to the studies done by Goto et.al and Rosa et al. Goto et.al determined that the bite force occluding area increased after implant treatment.. The mean bite force values before and after placement of implant were 48.6+32.3 and 76+43.6N respectively. Rosa et.al concluded that highest mean maximum bite force values were found in the control group and in the group of individuals rehabilitated with implants and single crowns. All these above studies suggest that there is increase in bite force after the replacement of missing teeth with implants which is in accordance to this study, where the mean bite force values had a marked increase preoperatively from 241.54N to 271.06N post rehabilitation with hybrid implant. This study advocates that the replacement of maxillary / mandibular missing teeth with the hybrid implant has helped in improving the masticatory

performance. Hence, it can be said that hybrid implant can be one of the successful treatment modality for replacement of missing teeth in both maxillary and mandibular posterior region.

## **5. Conclusion**

Replacement of maxillary or mandibular missing posterior tooth with hybrid implant showed a marked increase in the bite force from preoperative to 6months postoperative period. Hence this implant system leads to new prospect in the field of prosthetic rehabilitation by serving as an effective mode of rehabilitation in the replacement of the missing posterior tooth.

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