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RESEARCH ARTICLE

EVALUATION OF POST-OPERATIVE BITE FORCE IN MANDIBLE FRACTURES TREATED WITH OPEN AND CLOSED REDUCTION

Dr. Kuldeep Pal, Dr. Sushmitha R, Dr. G.V. Mitra, Dr. Tejas Motivale and Dr. Swati Tiwari.

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Key words:-

Maximum bite force, Open reduction and internal fixation, Closed reduction, Gnathodynamometre, Mandible fracture.

Abstract

Background: Mandible fractures lead to loss of masticatory function and therapeutic goal of any fracture management is to restore original anatomic form and function. For this, maximal bite force could be considered as a major factor for evaluating the success of treatment. The objective was to measure the bite force post-operatively in patients with mandible fractures treated with open reduction and internal fixation and close reduction and compared with normal healthy group.

Methodology: Normal bite force of control group was calculated bilaterally and compared with patients with mandible fractures treated with open and closed reduction in the region of incisors and molars at 5th, 7th and 12th week post-operatively using a customised Gnathodyanamometre .

Results: Post-operative bite force in incisor region is significantly reduced (1.86kg) for the first 5-6 weeks and gradually increases (5.42kg) later while in molars, it gradually increases(5.67kg) from 5 weeks and significantly increases after 7 weeks and reaches its maximum range(25.14kg) in a span of 12 weeks.

Conclusion: Both modes of treatment are equally popular among the surgeons, having different indications. As seen in the study after three months open reduction and internal fixation shows significantly better results than the closed reduction

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Introduction:-

Bite force is the result of the coordination between different components of the masticatory system (muscles, bones and teeth). Its determination has been considered important in the diagnosis of disturbances of the stomatognathic system. Maximum bite force is understood as the capacity of the mandibular elevator muscles to perform a maximum strain of mandibular teeth against the maxillary teeth, under favorable conditions.[1] Gnathodynamometers and force transducers are some of methods for the evaluation of bite force.[2]

Every species has a definite value of bite force which falls in a range due to various factors like age, sex, dental status, temporomandibular joint status , strength of the muscle, condition of the jaw bone etc. Anyone of these factors can affect the power of the jaws and ability of an organism to chew the food which can gradually deteriorate the normal health status of an organism and can also hamper the quality of life. Similarly when a human being is in a healthy state he or she bears a bite force which helps to chew the food. But any physiologic or pathologic change which occurs in the maxillofacial region can affect the bite force. The treatment aims to restore the same force in the bite what the patient had earlier what he or she was in normal and healthy state. With the help of this study we are

trying to evaluate the variations in the bite force of the patients both pre-operatively and post-operatively of mandibular fractures and comparing it with his or her normal and healthy group.

Maximum bite force is a useful indicator of the functional state of the masticatory system and the loading of the teeth[3]. Bite force results from the action of the jaw elevator muscles which is determined by the central nervous system and feedback from muscle spindles, mechanoreceptors and nociceptors modified by the craniomandibular biomechanics[4]. Bite force is influenced by muscle efficiency and development of masticatory function. Maximum bite force increases with the number of teeth present. The number of occlusal tooth contacts is an important determinant for the maximally attainable bite force[5,6].

The etiology of facial bone fractures included mainly assaults and road traffic automobile accidents. Other common causes include accidental falls, sports injuries. Considering its incidence, mandibular fracture is the second most commonly occurring fracture next to nasal bone fractures when considering facial fractures. It is the tenth most commonly occurring fractures when considering frequency of bone fracture of the whole body. Majority of mandibular fractures were found in males and it contributes to around 61% of all facial bone fractures. Mandibular fractures outnumbered zygomatic and maxillary bone fractures by a ratio of 6:2:1 respectively.[7] The therapeutic goal of any fracture management is to restore the original anatomic form and function as soon as possible without any morbidity. For this the maximum voluntary bite force could be considered as a major factor for the evaluation of the success rate of the treatment provided. Although there are methods which are near to accuracy and convenient to determine voluntary maximum bite force which requires sophisticated instrumentation, intervention, investigation of many physiological parameters. However, it is difficult to establish exact mathematical model to estimate individual bite force[8].

Materials & Method:-

Data collection – patients with mandibular fractures reporting to the casualty and interdepartmental referral patients of our institute were calculated. A customized Gnathodynamometre is used giving digital values in kilograms.



For the study sixty patients of mandibular fractures are included and divided into two groups. GROUP-A contains 30 patients of mandible fractures, treated with open reduction and internal fixation. GROUP-B contains 30 patients treated with closed reduction. For the comparison a control group, GROUP-C with 80 healthy individuals with Class-I molar relationship bilaterally were included between the age group 12-75 yrs containing 40 males and 40 females and bite force was evaluated. All the patients of mandibular fractures were evaluated clinically with detail case history. Bite force was calculated with respect to incisors and molars. Post-operatively the bite force was calculated and was compared with the control group. Follow up was done at 5 week, 7 week, 12 week interval and was compared with normal healthy group.

All patients with mandibular fractures were evaluated. Both males and females of all age group were studied. The medically compromised patients, patients with missing or loss of posterior teeth, pan-facial trauma, temporomandibular disorder. Patients unable to follow instructions or unable to comprehend information about the study were also excluded, from the study.

Results:-

Measurements of control group (cg):-

To evaluate and compare the bite force measurements, a study was done on a group of healthy individuals (n=80) which was considered as Control Group (CG), with 40 males and 40 females in the age group of 12 – 75 yrs. Bite force of the individuals in the CG on the right molar region ranged from 14 kg to 42 kg with a mean of 27.2 kg (std. dev +/-6.48). On the left molar region the bite force ranged from 15 kg to 44 kg with a mean of 27.6 kg (std. dev +/- 6.84). On the incisor region the bite force ranged from 5 kg to 17 kg with a mean of 10.5 kg (std. dev +/-2.49).

The measurements of the MALE individuals showed a bite force in the right molar region ranging from 19 kg to 42 kg with a mean of 29.8 kg (std. dev +/-6.661), on the left molar region ranging from 17 kg to 44 kg with a mean of 30.4 kg (std. dev +/-7.181) and at the central incisor region from 5 kg to 17 kg with a mean of 11 kg (std. dev +/- 2.689).

The measurements of the FEMALE individuals showed a bite force in the right molar region ranging from 14 kg to 34 kg with a mean of 24.6 kg (std. dev +/- 5.217), on the left molar region ranging from 15 kg to 37 kg with a mean of 24.7 kg (std. dev +/- 5.221) and at the central incisor region from 6 kg to 17 kg with a mean of 10.12 kg (std. dev +/- 2.232).

In the CG the males showed greater mean bite force when compared with females in all age groups.

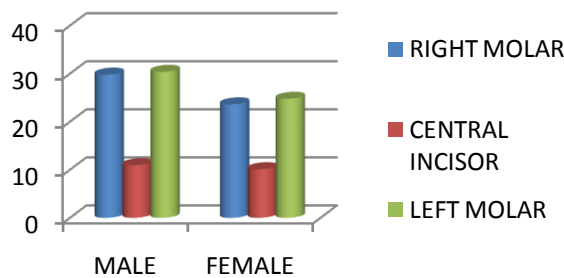


Fig:- Maximum bite force of males and females individuals of CG at right molar, central incisor and left molar

Measurements of group- 1 (surgically treated):-

The mean of bite force measurement on right molar region at 5th, 7th and 12th week were found to be 7.09 kg, 13.24 kg and 25.14 kg respectively. On the central incisor region the mean of bite force measurement at 5th, 7th and 12th week were found to be 2.17 kg, 3.52 kg and 5.42 kg. whereas over the left molar region the bite force measurement at 5th, 7th and 12th week were found to be 5.67 kg, 10.90 kg and 18.48 kg.

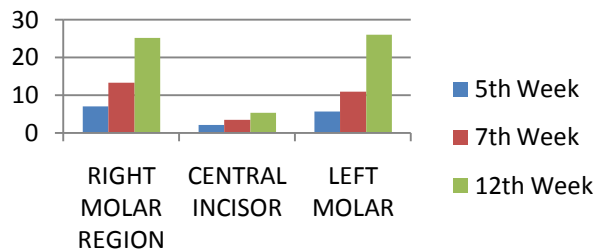


Fig:- Maximum bite force of GROUP-1 at right molar, central incisor and left molar.

At 12th week the bite force of the MALES of GROUP- 1 at the right molar region ranged from 16.2 kg to 32.2 kg with a mean of 25.4 (std.dev +/-4.01)kg whereas on the left molar region from 21.5 kg to 37.6 kg with a mean of 26.5 kg (std.dev +/-4.29) and on the central incisor region it is 2.2 kg to 9.3 kg with a mean of 5.4kg (std.dev +/- 2.31).

At 12th week the bite force of the FEMALES of GROUP- 1 at the right molar region ranged from 17.2 kg to 29.1 kg with a mean of 23.4 kg (std.dev +/-5.02) whereas on the left molar region from 18 kg to 26 kg with a mean of 22.6 kg (std.dev +/-3.26) and on the central incisor region it is 3.2 kg to 9.8 kg with a mean of 5.7 kg (std.dev +/-2.86). In the Group- 1 the males had a significantly higher bite force as compared to females at the end of 12th week.

Comparison of group- 1with control group:-

The bite force of the patients in Group- 1 at the end of 12th week is lesser than the bite force of the healthy individuals of the control group. At the end of 12th week –At right molar Mean bite force of Group- 1 is 25.1 kg, mean bite force of the control group is 27.2 kg. At central incisor Mean bite force of Group- 1 is 5.4 kg, mean bite force of the control group is 10.5 kg. At left molar Mean bite force of Group- 1 is 26 kg, mean bite force of the control group is 27.6 kg. This data indicates that after surgical treatment bite force is almost restored to the values obtained in a normal healthy individual.

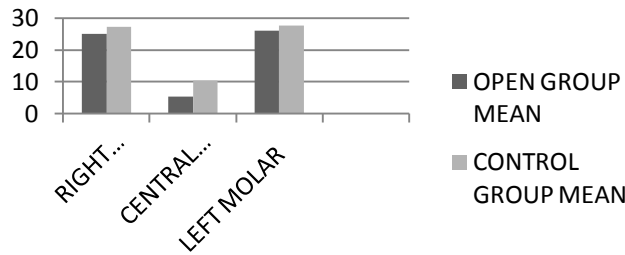


Fig:- Maximum bite force of GROUP-1 and CONTROL GROUP at right molar, central incisor and left molar

Measurements of group- 2 (conservatively treated):-

The mean of bite force measurement on right molar region at 5th, 7th and 12th week were found to be 6.16 kg, 11.24 kg and 18.78 kg respectively. On the central incisor region the mean of bite force measurement at 5th, 7th and 12th week were found to be 1.86 kg, 3.42 kg and 4.19 kg. whereas over the left molar region the bite force measurement at 5th, 7th and 12th week were found to be 5.67 kg, 10.90 kg and 18.48 kg. (fig. -)

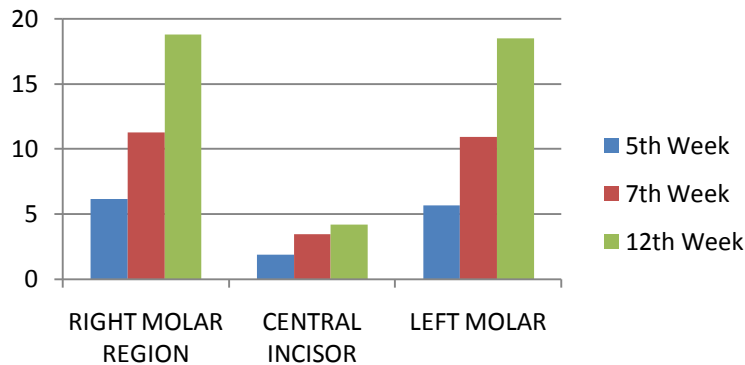


Fig:- Maximum bite force of GROUP-2 at right molar, central incisor and left molar

At 12th week the bite force of the MALES of the GROUP- 2 at the right molar region ranged from 9.6 kg to 24.2 kg with a mean of 19.14 kg (std.dev +/-3.18) whereas on the left molar region from 7 kg to 27.5 kg (std.dev +/-3.74) with a mean of 18.64 kg and on the central incisor region it is 3.2 kg to 11 kg with a mean of 4.39 kg (std.dev +/-1.58).

At 12th week the bite force of the FEMALES of the GROUP- 2 at the right molar region ranged from 14.4 kg to 20.1 kg with a mean of 17 kg (std.dev +/-2.27) whereas on the left molar region from 12.24 kg to 21.5 kg with a mean of 17.7 kg (std.dev +/-3.43) and on the central incisor region it is 2.2 kg to 3.9 kg with a mean of 3.2 kg (std.dev +/-0.62).

In Group- 2 the males had a significantly higher bite force as compared to females at the end of 12th week.

Comparison of group- 2 with control group:-

The bite force of the patients in closed group at the end of 12th week is lesser than the bite force of the healthy individuals of the control group. At the end of 12th week – At right molar Mean bite force of closed group is 18.9 kg, mean bite force of the control group is 27.2 kg. At central incisor Mean bite force of closed group is 4.2 kg, mean bite force of the control group is 10.5 kg. At left molar Mean bite force of closed group is 18.5 kg, mean bite force of the control group is 27.6 kg.

This data indicates that after conservative treatment bite force restored was significantly less than normal healthy individual.

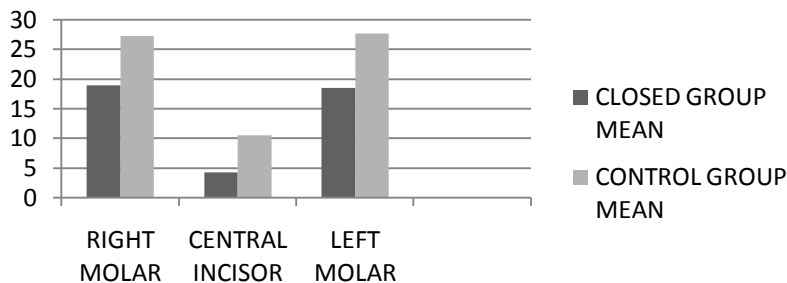


Fig:- Maximum bite force of GROUP-2 and CONTROL GROUP at right molar, central incisor and left molar

Discussion:-

Adequate mastication is known to give stimulus and proper function to the normal development of the maxilla and mandible. Any traumatic injury to the mandible may lead to disruption in the balance between the masticatory muscles which results in decrease in the bite force which is one of the most important functional aspect of the mandible and its musculature. Since ages various surgeons have suggested numerous modes of treatment for the fractured mandible. The objective of all these treatment modalities is to restore complete functional ability of the mandible. So with our study we have tried to quantify the restoration of the functional ability of mandible as a part of the masticatory unit in the post-operative phase after trauma.

A study was done on healthy individuals of the Indian population by Rajesh Kshirsagar et al on a group of 60 volunteers (male and female) and the mean bite force on the right molar was found to be 36.2 kg, on the left molar region it was 35.96 kg and 14.83 kg on the incisor region. The disadvantage of this study is that the age group of the volunteers involved in the study was not mentioned. A study conducted by Veena Jain et al on a group of 358 subjects (mean age group being 26.66 yrs). In their study the males showed a higher mean bite force of around 45.76 kg and of females around 30.23 kg. [9]

In our study we realized the importance of age related changes of the jaw and the associated musculature. Therefore our volunteer group were divided into four, based on age. Further the data was analyzed separately for males and females. With reference to the literature in the third decade in our study the males showed a mean bite force measurement as 32.28 kg and 23.53 kg for females which is lower than the measurements as per the study by Veena Jain et al[10]. This difference in measurements can be attributed to the different kind of customized bite force device that was used. We found that the maximum voluntary bite force of the CG at three different sites in the oral cavity ie at the right molar was of 27.2 kg, on the left molar region was 27.6 kg and on the incisor region was 10.5 kg. In all the above studies though different modalities of bite force measurements have been employed, females have always shown less bite forces when compared with males. This indicates that the bite force is influenced by gender.

In our study we also found a pattern of increased bite forces with increasing age in males and female till the age of 50 years, but in the age group of 51 – 75 years the bite force was lesser as compared to the younger individuals. The right and left molar regions did not show any significant differences in bite forces. Very few researches have been conducted on measurement of the restoration of the bite force after treatment of maxillomandibular trauma. The

study conducted by Rajesh Kshirsagar involved only six patients of parasymphyseal fracture who all were treated according to surgical protocols. They reported that the bite forces in molar region took six to twelve weeks to regain maximum voluntary bite force and compared to the volunteer group in their study[11]. Gerlach K.L et al reported their results after evaluating maximum voluntary bite force in twenty two patients with mandibular angle fractures. All the patients in the study group were surgically treated with miniplate osteosynthesis. They evaluated the patients from first week to sixth week and at the end of sixth week only 58% of the maximum vertical loading found in the controls were registered. In this study they stated that the normal values did not return until three months postoperatively[12].

In our study we have treated thirty patients in GROUP-1 with surgical protocols and have evaluated the bite force at the end of 5th, 7th and 12th postoperative week. At the end of 5th and 7th post-operative week the maximum voluntary bite force was significantly less than the range of normal bite force, but at the end of 12th post operative week the maximum voluntary bite force was restored towards the normal range. At the end of 12th week the males showed an improvement upto 85.23% on the right molar region, 87.17% on the left molar region and an improvement of 49.09% in the central incisor region was found as compared to the data from the CG. Similarly in the female patients of GROUP-1 has an improvement of 95.12% in the right molar region, 91.49% in the left molar region and 56.32% in the central incisor region with respect to the CG. Among the GROUP- 1 (surgically treated), the number of females were much lesser than the males which shows that the males are more exposed to maxillofacial injuries as compared to females. At the end of 12th post-operative week the maximum voluntary bite force generated by males was more than the females. This difference can be attributed to greater muscular potential of men due to anatomical variations of the type of muscle fibers, which are larger than those of females. As women are known to have a lower pain threshold, it might be a significant factor for lower bite force measurements.

Not many studies have been carried out in the literature regarding the bite force measurement after the treatment of mandibular trauma by conservative protocols. Here we have evaluated equal number of patients in GROUP-2 which underwent conservative treatment following mandibular trauma. Like GROUP-1, all the data for the conservatively managed patients were collected at the same time intervals. Here also, the values of the mean bite force were less in the 5th and 7th postoperative week which gradually increased up to the 12th postoperative week. The improvement at the end of 12th postoperative week in the males of GROUP-2 in relation to the CG at the right molar region was 64.22%, at the central incisors it is 39.9% and at the left molar region it is found to be 61.31%. For the females the percentage improvement at the right molar region is 69.1%, at the central incisors it was 31.62% and at the left molar region it was found to be 71.65% with respect to the CG. At the end of the 12th week though there was considerable improvement since the 5th week it was on the lower side as compared to CG. It is to be noted that even in this group at the end of 12th post-operative week the maximum voluntary bite force generated by males was more than the females.

The data of sixty patients who were treated surgically and conservatively were compared with the measurements obtained from our volunteer group. It is to be noted that the bite force measurement of the patients treated surgically(group-I) was much higher at 85.23% than that of (group II)conservatively treated at 64.22% on the right side. Similarly at the left molar and incisor region the measurements were higher in the group treated surgically than conservatively. This can be attributed to early precise anatomical reduction and rigid fixation which promotes contact healing of the fractured fragments. During conservative treatment though the fragments are immobilized and stabilized in occlusion the gap healing process between the fractured segments might contribute to lesser bite forces and longer time might be required to achieve the complete maximum bite force. . The further scope of this study lies in measuring bite forces after 6 months period allowing complete remodeling of fracture site to take place.

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