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Real Time Management of Temporomandibular Joint Disorder

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ABSTRACT: *Temporomandibular Disorders (TMDs) are one of the dental conditions that involve the masticatory musculature and/or temporomandibular (TM) joints along associated structures examined from a biopsychosocial or illness perspective with many common chronic pain conditions. Functional disturbances of the masticatory system can be as complicated as the system itself. Although numerous treatments have been advocated, the complex nature of TMD requires a multidisciplinary treatment protocol.* T-Scan records the pattern of occlusion having advantages of being dynamic viewing and timed analysis of force during various positions of teeth with possibility of permanent documentation for monitoring the occlusal condition after carrying on the assorted treatment protocols. Adaptive Correlations Analysis(ACA)algorithm are self- designing filters allowing them to "learn" the initial input statistics track for time varying to estimate the deterministic signal and takeaway the noise correlated with the deterministic signal to identify Positions and distance from an another Neighbor Node. AODV (Adhoc on Demand Distance Vector), a loop free routing protocol for adhoc networks at each node to maintain a routing table. self-starting in an environment of mobile nodes withstanding a range of network behaviors like node mobility, link failures and packet losses. Real time treatment for TMDs is conveyed by the dental consultant/ diagnostician to monitor occlusal condition.

KEYWORDS: Myofascial pain, occlusal interferences, temporomandibular disorders(TMJ), AODV, DSR, TScan sensor, NS-2.

1. INTRODUCTION

Communication system plays a vital role in data transfer from Wireless Sensor Networks (WSNs). security and considerable flexibility to the user as an integral part of any communication technique. In hospital environments, TScan sensor applications include the seamless interoperability of wireless medical devices and WSNs in a common communication platform for medical environmental surveillance applied in dentistry.

Temporomandibular disorder (TMD) is a musculoskeletal disorder during mastication presenting with typical signs symptoms of pain, limited mouth opening, joint sounds, mandibular deviation, and chewing disability a very common problem seen in up to 33% of populations worldwide. Pain is the most important symptom of TMD and the etiology of TMD is complex and multifactorial. The role of dental occlusion as an etiological factor for TMD has been hypothesized by several authors. A balanced dental occlusion plays an important role for the healthy functioning of the masticatory system. Premature occlusal contacts and occlusal-articulating interferences cause occlusal trauma that can induce changes in the tooth-supporting tissues (the mucosa, periodontal tissues, and bone), in the muscles of mastication & temporomandibular joint. In dental practice, articulating paper has been established as the most widely used diagnostic aid to mark the contact points between the maxillary and mandibular teeth.

TMD image with diagnostic process as shown in (figure 1).

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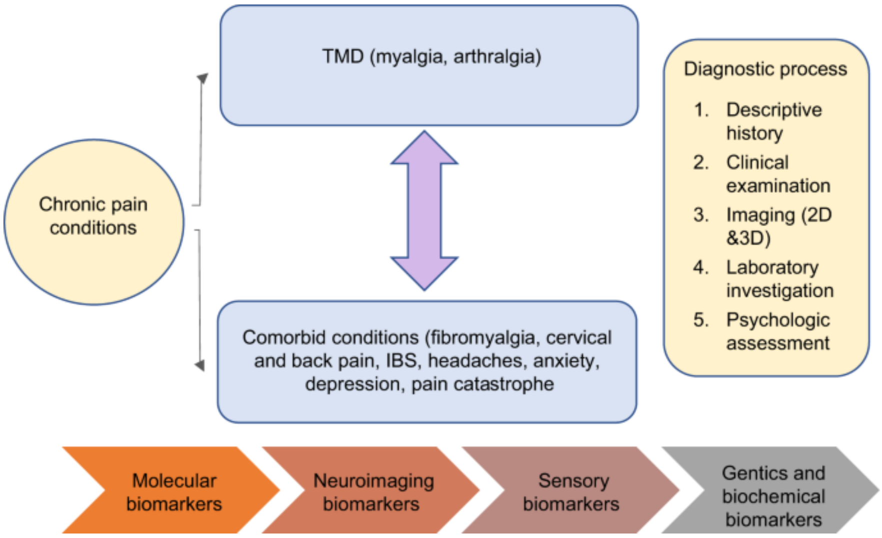

The articulating paper can readily highlight the occlusal contacts that can neither accurately quantify the intensity nor measure the magnitude of the generated occlusal forces. T-scan computerized occlusal analysis technology eliminates the process of subjective interpretation of occlusal contacts obtained using articulating paper marks, precisely pinpoints the excessively forceful contact locations and displays for analysis in a colorful three-dimensional view thus helping the diagnostician to understand the overall occlusal force distribution.
Historical Insight into Temporomandibular Disorders Knowledge about TMD has grown throughout the ages. In general, treatment philosophies have moved from a mechanistic dental approach to a biopsychosocial medical model with the integration of neuroscience.

The temporomandibular joint connects the lower jaw, called the mandible to the bone at the side of the head the temporal bone and can detect by placing a finger in front of ears during opening of mouth. The TMJ helps in jaw movement smoothly because of its flexibility and the Muscles attached to the jaw and surrounding the jaw joint controls the position and movement. The condyles slide back to their original position as mouth is closed. The disc lies between the condyle and the temporal bone absorbs shocks to the jaw joint from chewing and other movements. The combination of hinge and sliding motions makes this joint among the most complicated in the body. Also, the tissues that make up the temporomandibular joint differ from other load bearing joints. As it is complex movement and unique makeup, the jaw joint and its controlling muscles can pose a tremendous challenge to both patients and health care providers.

Millstein et al., reminds the occlusal factors acting on the teeth are examined by articulation paper marks, waxes, pressure indicator paste, etc. are the tools available to assess the forces of the occlusion and also to evaluate the occlusal contacts [5,6]. However, the disadvantages of these methods do not detect simultaneous contact nor quantify time and force. There is no scientific correlation between the depth of the colour of the mark, its surface area, amount of force or the contact timing sequence that results as the articulation paper marks.

Arcan and Osborne et al., on the combination of dental articulating paper and patient feel. Commonly used quantitative occlusal approaches include a computer aided video system, a photo occlusion method and the T– Scan system [7]

Bio Research Associates, Inc and Tekscan Inc corporations, developed a commercially available system (T-Scan) that overcomes the known limitations of articulation paper marks It quantifies and displays relative occlusal force information, so that the clinician can minimize repeated errors of incorrect occlusal contact selection [8] There are many upcoming computers based treatment modalities, but many clinicians have not overcome the traditional methods for examining the occlusion. This study was conducted to evaluate the distribution of occlusal loading forces and correction of any occlusal discrepancies using TScan.

Mizui et al., measured the timing and force of occlusal contacts in normal subjects and patients with an unspecified craniomandibular disorder (CMD) using T-scan system and found that in normal subjects the timing and force of occlusal contacts were symmetrical and the centre of effort was located in the first molar region[9]

Hiranoet al., vitro study on accuracy and repeatability of the T-Scan II system conducted by reported that T-Scan force recordings were acceptably precise, especially for the moderately high level and default level.[11]

Koos et al., reported that the level of accuracy is acceptable and no interferences arouse from change in foil or repeated measuring was detected with T-Scan III. The author didn't find any inaccuracy as mentioned in the past, which may be due to an upgrade in T-Scan III[12]

O' Brien et al., explains balancing ramps may promote denture balance through the smooth sliding between the prosthesis. Besides the excellent esthetics due to the anterior overjet, it is possible to have more stability during the food bolus interposition than in the classical balanced bilateral occlusion pattern[23]

Profitt etal., describes individual's occlusal status is generally described by two major characteristics: a) intra-arch relationship i.e. the relationship of the teeth within each arch to a smoothly curving line of occlusion and b) inter-arch relationship i.e. the pattern of which occlusal contacts between the upper and lower teeth.[27]

Richard et al., reported Premature occlusal contacts are frequently detected in subjects with chronic periodontitis and are significantly correlated with its severity. The posterior teeth with high occlusal forces in patients with untreated chronic periodontitis may reflect occlusal trauma associated periodontal conditions, that could probably increase the risk of further periodontal break down[28]

Kerstein et al., quantifies and displays relative occlusal force information, so that the clinician can minimize repeated errors of incorrect occlusal contact selection. There are numerous upcoming computer based treatment modalities, but many clinicians have not overcome the traditional methods for examining the occlusion. study was conducted to evaluate the distribution of occlusal loading forces and correction of any occlusal discrepancies using Tekscan[33]

II. T-SCAN SENSOR IN TMJ DISORDER

TScan Sensor is the complete digital occlusal analysis sensor helps clinicians to detect premature contacts, high forces, and interrelationship of occlusal surfaces. The T-Scan Sensor is used to produce the high resolution and repeatable accuracy and Wafer-thin, with the flexibility to resist 15-25 closures, High resolution Sensels for precise data, Reusable, Cold sterilize between visits.

T-scan system:
A balanced occlusion is one of the cornerstones of a successful treatment. Whether in orthodontics, restorative, prosthodontics, or periodontics an unbalanced occlusion can lead to delays in the treatment plan and unsatisfactory results. Conventionally, a strip of paper with a dye wax layer called Articulating paper, is used to obtain occlusal data. However recent researches have shown the inaccuracy of conventional techniques of measuring the occlusion. Articulating papers, though inexpensive, have proven to be inaccurate time and time again, as they depend more on the "patients feel" and the dentist's subjective opinion. The wax cans sometime wash off with saliva that would lead to inaccuracies in determining the low and high contact points. They also fail to familiarize the patient with occlusion as it cannot visualize it to the patient.
The T-Scan II records and measures tooth contact force and timing data in real-time by embedding 1370 .05 in2 pressure measurers (known as "sensels") into a dental arch-shaped recording sensor. Each sensel is scanned for occlusal contacts 100 times per second. The recorded data is imported into the T-Scan II software and hardware by a handle that holds the sensor in place intraorally. The software and hardware combine to measure the order, duration, and force content, of the

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recorded occlusal contacts. The occlusal data is then displayed graphically for analysis in 2 or 3 dimensions as a dynamic movie that can be played forwards or backwards incrementally.
T-Scan III is a device developed by Tekscan Inc. that measures, analyses, and animates the occlusal data in a fast and reliable way for the dentist and the patient. It consists of a handheld device that has an ultrathin disposable sensor that maps the forces and their timing as the patients bite on them. This data is then analyzed by the device and it then animates them in a way that the data can be viewed and studied on a computer or tablet. This allows the dentist to keep records, provide accurate modifications to occlusion, decrease the number of recall visits, and decrease the number remakes in prosthodontic appliances. and more. All of this can be achieved by an innovative and attractive handheld tool.

Fig.1.Showing computer system attached to sensor handle

T-Scan is a computerised occlusal force analysis device comprising of three parts.

- **a.** A sensor and support
- **b.** Handle assembly
- **c.** system unit,computer software and a printer

TSCAN Sensor

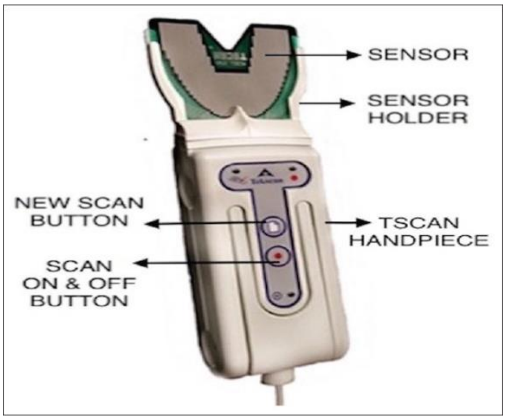

Fig: Tscan device

This computerized system, named T-scan, consists of a recording handle, sensor holder, HD sensors, and USB port to connect to computer/laptop. The HD sensor's structural design consists of two layers of Mylar encasing a grid of resistive ink rows and columns printed between them. The sensors are manufactured in two sizes; large for broad Medio lateral and long anteroposterior dental arches and small for thin Medio lateral and short anteroposterior dental arches.

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T-scan features
The T-scan system features are as follows:
The sensors are manufactured in two sizes; large for broad Medio lateral and long anteroposterior dental arches and small for thin Medio lateral and short anteroposterior dental arches.
• Turbo recording: The T-scan III system allows a clinician to record incremental sensor scanning in a short time span of 0.003 s. • Force outliers: Force outliers are individual tooth contacts with high relative force at any given moment during a mandibular closure.
• Individual tooth timing: Tooth timing of selected tooth shows its individual force within a force versus time graph for comparison with other teeth.
• Integration of the T-scan III with an electromyography system: The T-scan III system can be linked through software integration with the electromyography system. Clinically, the T-scan 8 system is used to record different functional mandibular movements.
• Centric relation: This records centric relation prematurity.
• Multi-bite: This records two or more repeated self-closures made in patient's habitual intercuspation. This records the occlusion time (OT) and also captures the occlusal contact closure sequence from first contact to static intercuspation, and then past static intercuspation onto maximum intercuspation.
• Excursive functional movements – lateral and protrusive: This recording is used to assess the posterior disclusion time (DT) that occurs during mandibular excursions.
• Clenching and grinding: This records painful occlusal contacts during chewing and eating. The patient is instructed to first self-close firmly into their habitual intercuspation, and then grind back and forth across their teeth with the sensor interposed.
• Digital occlusal force distribution patterns: This records excess occlusal force concentrations in the arch for which the patient is instructed to bite firmly with maximum intercuspation on the recording sensor and then open to disarticulate their teeth.

III. PROTOCOLS AND NS2

AODV (Ad-hoc On-demand Distance Vector): WSN is an infrastructure-less wireless network that employs several sensors in an ad-hoc fashion to track the system, physical or environmental conditions. Considerable improvement can be achieved in the way the patients are monitored in an infirmary or a hospital by employing WSNs in healthcare systems. They collect, send and monitor patients' health parameters such as blood pressure, body temperature, pulse rate, wirelessly to remote monitoring systems. The ability to let hospitalized patients move around is vital to promote their quality of life and also enables them to seek immediate medical attention.
In the AODV routing protocol, the arbitrarily generated route implements a route determination process. Three control packets viz. RREQ, RREP, RERR. While a message needs to be sent from originator node to the destination node, RREQ control packet is broadcasted to its neighboring nodes during the absence of a predetermined route. Routing tables of these nodes are verified and updated after receiving the packet, followed by setting a backward pointer towards originator node along with a forward pointer to the destination node in their routing tables. An RREP message is sent back to the originator node on successful reception at the desired destination node, else RREQ message is rebroadcasted to the other corresponding nodes. A fresh enough route is selected by the node for determination of the route.
Advantages of AODV: Reliable for the wireless mesh networks. Loop free and does not require any cartelized system to handle routing process for wireless mesh networks.
Disadvantages: Shortest path may be lost due to traffic during the path discovery process. A large number of control packets generated in link failure. Consumes network bandwidth. Level of QoS decreases with an increasing network density.

DSR (Dynamic Source Routing): Dynamic Source Routing protocol (DSR) is a simple and efficient reactive routing protocol designed specifically for use in multi-hop wireless ad hoc networks of mobile nodes based on two main mechanisms: route discovery and route maintenance designed for a MANET of up to two hundred nodes with high mobility rates and is loop-free.

Advantages of DSR: Generally independent of the network size. Routes are maintained only between nodes that need to communicate. This reduces the overhead of route maintenance. A single route discovery may yield many routes to the destination, due to intermediate nodes replying from local caches.

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Disadvantages**:** Less secure due to the broadcast and multicast routing updates. Additional configuration settings such as passive interfaces and routing protocol authentication are required to increase security. Packet header size grows with route length due to source routing. Potential collisions between route requests propagated by neighboring nodes.

NETWORK SIMULATOR(NS2)

Network simulator (also popularly called NS- 2) is an open source separate event network simulator. The network simulator is discrete occasion packet level simulator covers a huge number of applications of various kinds of protocols of different types consisting of various network elements and traffic models. It is a bundle of tools that simulates behavior of networks such as creating network topologies, log event which happen under any load, analyze the events and understand the network. The principle point of first trial is to figure out the utilization of network simulator and to get familiarize with the simulated object and understand the function of network simulation and also it is needed to analyze the behavior of the simulation using network simulation.
Network simulator is a tool is needed for the simulation purpose. The simulation of the practical results needs to be a veritably important part for exploiting in world script. Simulation is the process of designing a model of a real system and conducting trials with this model for the purpose of understanding the geste of the system and assessing colorful strategies for the operation of the system. With the dynamic nature of computer networks, therefore actually deal with a dynamic model of a real dynamic system. Simulation is that the reproduction of some real thing and state of the process. The act of bluffing commodity generally entails representing certain crucial characteristics or behaviours of a named physical or abstract system.

IV. Correction of TMJ Disorders using T-Scan System

Case1

A 19-year-old female visited the prosthodontic clinic with a chief complaint of trismus, sharp pain, and noise around her left TMJ. No specific medical history was noted. The patient received orthodontic treatment in she was 15 years old. The orthodontic treatment corrected her class II malocclusion with strategic extractions of all first premolars. the braces were removed and removable retainers were placed; however, she did not wear the retainers. She noticed noise around the left TMJ during jaw opening within half a year of the braces being removed and soon developed limited mouth opening. The patient visited an oral surgery clinic and received pharmaceutical therapy consisting of a muscle relaxant. However, no improvement was noted.

Initial examination

The midline of the mandible deflected to the right (Fig1). The maxillary central incisors were extruded with a deep bite. Overbite and overjet were approximately 4 and 2·5 mm, respectively. Advanced wear facets were noted on the incisal edge of the mandibular central incisors. The maxillary second premolars tilted mesially with extrusion. Open space was noted between the left canine and second premolar. Amalgam restorations were noted on the mandibular first molars and left second molar. The maxillary right first molar was restored with a full cast crown. The mandible deviated toward the left during jaw opening, and sharp pain was reported when the clicking noise occurred. Maximum mouth opening was approximately 40 mm. The palpation of TMJ revealed that clicking occurred during a first few jaw openings and no clicking was observed thereafter. Radiographic assessment revealed that the mandibular left condyle positioned posteriorly at the intercuspal position (ICP) and at rest (Fig 2). During jaw opening, the condyle did not travel far enough anteriorly the condyle was below the articular tubercle at the maximum opening.

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Figure 1. Baseline intraoral

Figure 2. Radiographic images of the mandibular left TMJ at ICP before treatment (top-left), at rest position (top-middle), and at opening position (top-right). The condyle appeared to be displaced posteriorly at ICP and not traveled enough anteriorly at the jaw opening position. No baseline radiographs of the right TMJ are available, due to development failures. Baseline MKG recordings of habitual mandibular movement are shown (bottom). Dyskinesia (arrows) was observed during jaw opening in Scan 1 (bottom-left). The mandible moved anteriorly during closing, arrived at the mid-lingual surface of the maxillary incisor, and slid into ICP. The velocity of jaw movements was recorded and shown in Scan 2 (bottom-right). Bradykinesia was observed when the jaw opened. The velocity of jaw closing movement was normal.

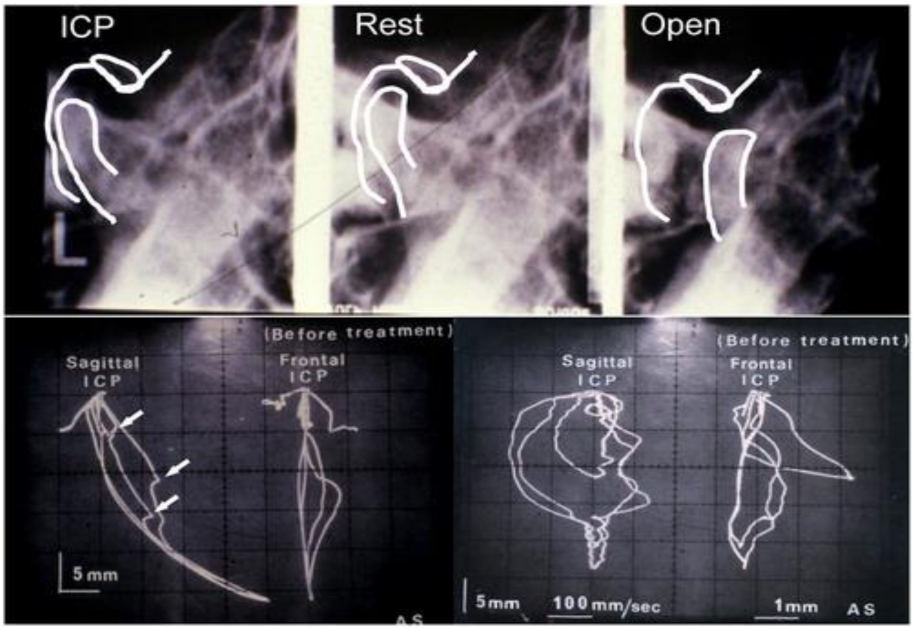

Figure 2. Radiographic images of the mandibular left TMJ at ICP before treatment (top-left), at rest position (top-middle), and at opening position (top-right).

Jaw movement assessment

Jaw movements were assessed using a mandibular kinesiograph, Dyskinesia was observed during jaw opening (arrows in Fig .2 bottom-left). During closing, the mandibular incisors first touched the mid-lingual surface of the maxillary

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incisors, and from there, the mandible slid posteriorly along the lingual surfaces of the maxillary incisors to ICP. Sagittal trajectories during rapid maximum jaw opening from ICP showed bradykinesia (slow movement) clearly in the opening phase and no deviation in the closing phase (Fig.2 bottom-right). Dyskinesia was also observed in frontal trajectories. No assessment of the muscle activity of the anterior temporalis and the middle masseters could be performed because a bilateral surface electromyography (EMG) recording device was not available in clinical dentistry. The patient received transcutaneous electrical nerve stimulation (TENS) using a Myomonitor J2 (Myotronics) to relax muscles. The Myo-centric position (MCP) was recorded as a reference jaw position. The intensity of electric stimuli by TENS was increased slightly to move the mandible approximately 1·5 mm above the rest position on a neuromuscular trajectory. This position was considered MCP. The discrepancy between MCP and ICP was approximately 1 mm sagittally, 3·5 mm vertically, and 2 mm laterally (Fig.3). After 60 minutes of muscle relaxation by TENS, the intensity of TENS was gradually increased until the mandibular incisor lightly touched the lingual surface of the maxillary incisor. This mandibular position was on the TENS-stimulated trajectory of mandibular movement and, therefore, defined as muscular tooth contact position (MTCP). Bite registration at MTCP was taken using low-resistance acrylic impression material The diagnostic models were mounted at MTCP using a Terminus Articulator (Myotronics) (Fig.4). Occlusal discrepancy of 2–3 mm was noted in molar regions.

Figure 3: Tscan records during the jaw movement from rest position before treatment (left) and post muscle relaxation. Shows irregular occlusal contacts and more on left side.

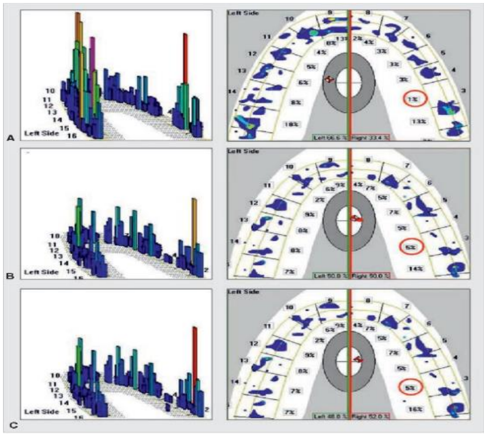

Figure 4: The three-dimensional jaw movement from rest position before treatment (left) and post muscle relaxation by TENS (middle). The mandible positioned approximately 0·6 mm anteriorly, 0·4 mm laterally, and 4·5 mm vertically from rest position after muscle relaxation. The position relationship between rest, MCP, and ICP after muscle relaxation by TENS is shown (right). ICP was located approximately 1 mm posterior to, 3·5 mm above, and 2 mm lateral to MCP.

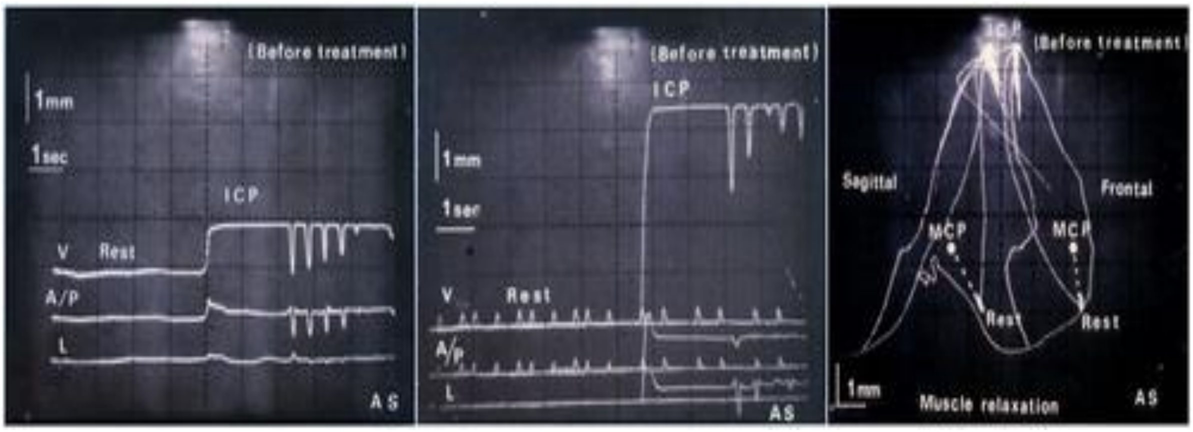

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Figure 5. Bite registration was taken at MTCP and mounted in Terminus Articulator. Posterior occlusal discrepancy of 2–3 mm is obvious at MTCP.

TMD diagnosis -Intermittent closed lock of the left TMJ.

Treatment

Since smooth jaw opening and closing were observed without pain when the patient took anterior position, MTCP was used as a therapeutic jaw position to alleviate TMD symptoms. A cranio-mandibular orthopedics (CMO) appliance was fabricated on the lower arch to stabilize the disc and condylar position at MTCP (Fig.5 top-left). Anatomical occlusal morphology was given to the appliance so that the CMO appliance could maintain the mandibular position relative to the cranium at the maximal intercuspal position, and so the patient could eat with the appliance in place. Occlusal adjustment was performed at MTCP using TENS-stimulated jaw closing. Small pieces of a thin (20 μm) articulating paper were prepared and placed on the occlusal surfaces of the mandibular teeth. TENS-stimulated jaw closing was performed to obtain occlusal contact for adjustment. After use of the CMO appliance for 1 month, smooth jaw movement was observed (Fig.5 bottom-left). However, ICP was not stable, as shown in the frontal view (Fig.5 bottom-right). The vertical and anteroposterior movements were approximately 1·5 and 1·0 mm, respectively, which fell in a normal range (Fig.5 top-right). However, the lateral shift was 0·25 mm, suggesting the requirement of further occlusal adjustment. Periodical occlusal adjustment continued until stable ICP was obtained. After use of the CMO appliance for 2 months, the patient reported neither TMJ pain nor clicking sound, indicating that the given occlusion was accepted by her physiological masticatory system. Hence, this occlusion was transferred to fixed restorations. Posterior onlays were fabricated using hard composite resin material (Isosit; Ivoclar Vivadent, Schaan, Liechtenstein) and seated with dental adhesive cement (Panavia EX; Kuraray, Osaka, Japan) (Fig.6 top). Occlusal adjustment was performed at MTCP using TENS-stimulated jaw closing as described above (Fig.6 top-right). Jaw movement was assessed 1 month later. The patient's jaw movement was smooth, and trajectory was reproducible with the newly established occlusion (Fig.6 bottom). The patient was placed on the maintenance program.

Figure 5. Fabricated CMO appliance on the mandible cast model had anatomical occlusal morphology (top-left). Jaw movements were recorded using MKG K5 after use of the CMO appliance for 1 month. Jaw open–close movements were smooth (bottom-left), and velocity of the movements was significantly improved (bottom-right). However, ICP appeared not yet stable (bottom-right). The recording of three-dimensional jaw movement from rest position shows that the mandible travels approximately 1·5 mm vertically, 1 mm anteriorly, and 0·2 mm laterally at the incisal position.

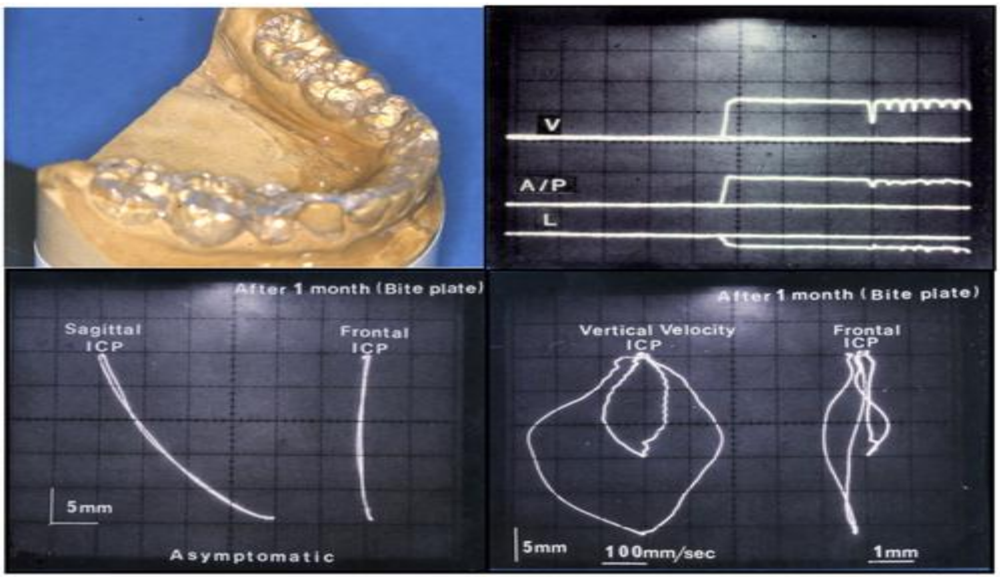


Fig5. Tscan record after the treatment shows equal occlusal contacts and relatively equal force distribution.

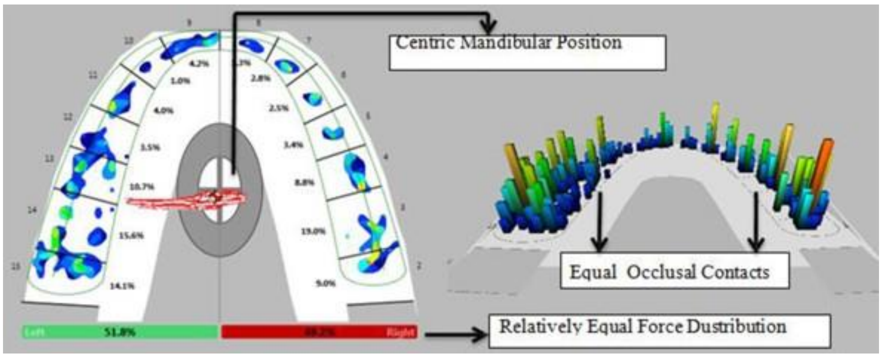
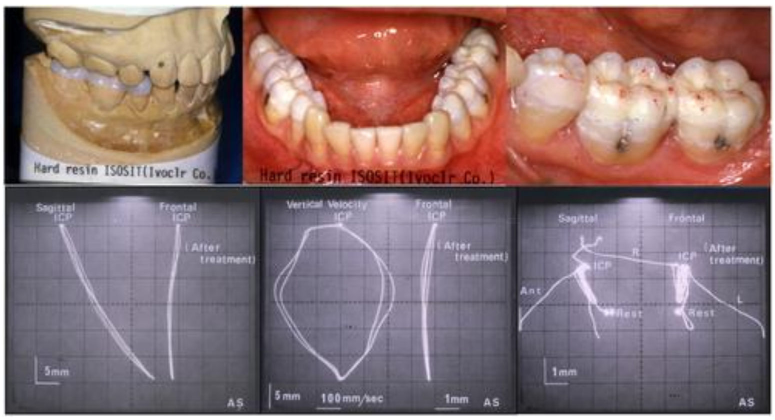


Figure 6. Posterior onlays were fabricated and seated using Panavia EX (top). Jaw movements were recorded using MKG K5 (bottom). Smooth movement to ICP with undisrupted velocity was observed.



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Case 2:

Optimal dental care is based on making an accurate diagnosis, followed by patient counselling regarding their problems and possible solutions, prior to designing an individualized and appropriate treatment plan. The occlusal analysis plays an important role in the comprehensive dental examination. The etiology of temporomandibular disorder (TMD) is multifactorial. Although occlusion is considered to play a pivotal role in initiation of disorder, this is not being conclusively demonstrated. Temporomandibular dysfunction is mostly due to functional malocclusion rather than morphological malocclusion. TMDs arise due to occlusal instability by causing excessive load on the masticatory system. T-scan system (Tekscan Inc.) accurately identifies the location of premature occlusal contacts that are not always visualized by direct clinical observation, or with ink ribbon markings. The T-scan system enables the clinician to quantitatively evaluate the occlusal contacts during continuous mandibular movement and can also provide functional occlusion information such as OT and DT. The T-scan I could measure occlusal contact timing sequences in 0.01 s increments, a new occlusal functional movement parameter, known as posterior DT, was isolated that measured prolonged excursive movement durations. The OT (A–B) is the elapsed time in seconds, measured from the first tooth contact until the last tooth contacts, as a patient closes all their teeth together from completely open (no tooth contact) to the beginning of static intercuspation (the A–B increment). Static intercuspation always occurs before the patient achieves maximum intercuspation (MIC) force levels. The OT describes the degree of bilateral time simultaneity present in a patient's occlusion. It has been deemed ideal when the OT is ≤0.2 s in duration. The DT (C–D) is the elapsed time in seconds, measured from the beginning of an excursive movement made in one direction (right, left, or forward) with all teeth in complete intercuspation through until only canines and/or incisors are in contact. The DT can be measured in all three different mandibular excursive movements. The DT describes the quality of the anterior guidance mechanism present in a patient's occlusion. It has been deemed ideal when it is ≤0.5 s in duration and is deemed to be prolonged when it is >0.5 s. [Demonstrating immediate posterior disclusion is considered a desirable component of occlusal health and advocated to be a requirement for an optimum occlusal design. Studies have shown that prolonged DT can be an instigator of excursive muscle hyperactivity and muscular TMD symptoms. It was in 2004 that T-scan III/BioEMG synchronization was introduced which represented a major advancement in the study of occlusal function as the dynamic occlusal contact information and its corresponding muscle activity response could be recorded simultaneously.

The BioEMG electromyography system records electrical (biopotential) activity from eight muscles simultaneously. Bilaterally, the anterior temporalis, masseter, digastric, and sternocleidomastoid muscles can be measured. Kerstein and Radke conducted a study to investigate the correlation between activity of masseter and anterior temporalis muscles and the DT. In their study, 45 subjects (29 female and 16 male) with TMD were selected and their right and left DTs were recorded with T-scan III. Simultaneously, the electromyographic activity of bilateral masseter and anterior temporalis muscle was also recorded with BioEMG III (n = 180 muscles). They concluded that there was significant activity reduction in all four muscles after reduction in the pretreatment prolonged DT to less than 0.4 s. Hyperactivity in muscle causes lactic acid accumulation, muscular ischemia, and chronic TMD symptoms.[19] In 2012, Wang and Yin performed an analysis of occlusal risk factors associated with TMDs in 31 patients with complete natural dentition and angle class I occlusion who exhibited TMD and compared them with 31 healthy non-TMD control subjects. The occlusal recordings were performed using the T-scan II system. Among the various parameters recorded and compared with the control subjects, the TMD subjects had a significantly higher frequency of premature contacts (16/32, 50.0%) and greater bilateral asymmetry in the occlusal force. Furthermore, prolonged OT and DT were also observed in the TMD subjects. All these data suggest that there was a significant association between occlusal stability and TMD in young adults.[20]

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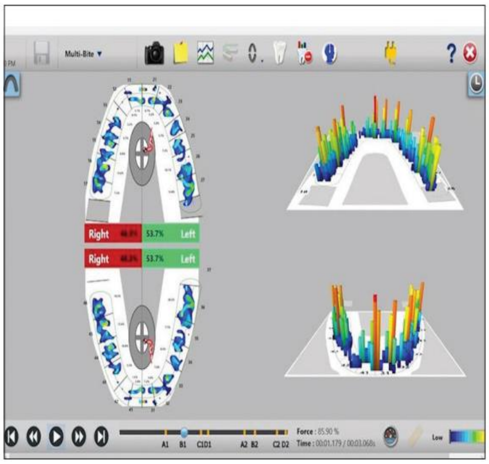

Fig.1

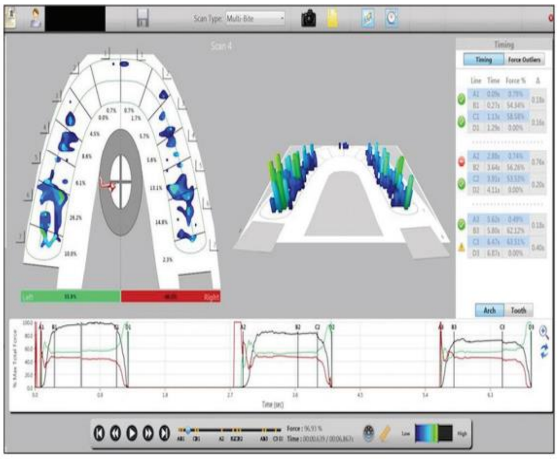

Fig.2

Fig.1 The three-dimensional view of the occlusal analysis shown as differing height columns ranging from low force, small blue columns; moderate force, green columns; and the high force, tall red columns.Fig.2 The occlusion time (OT; A–B) and disclusion time (DT; C–D) in the bottom graph Case 2.

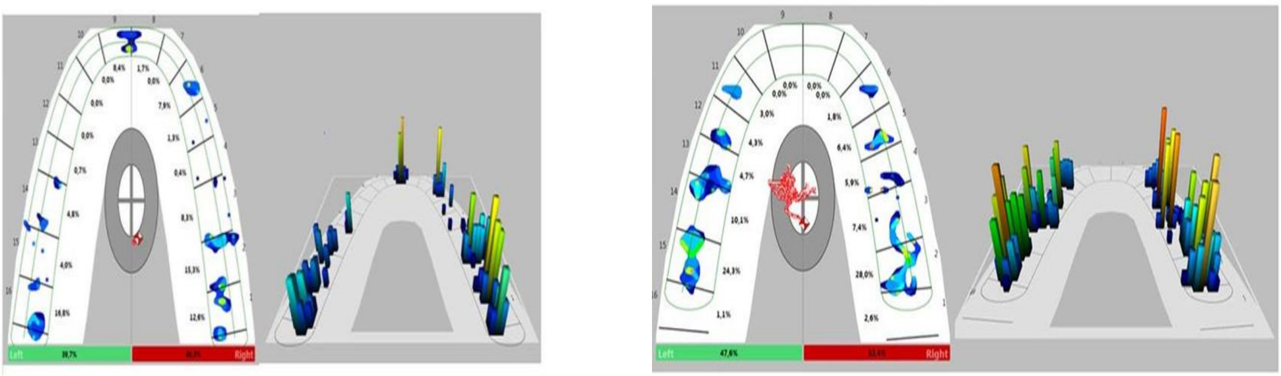

Figure3 : Occlusal force distribution before and after surgery using T-Scan

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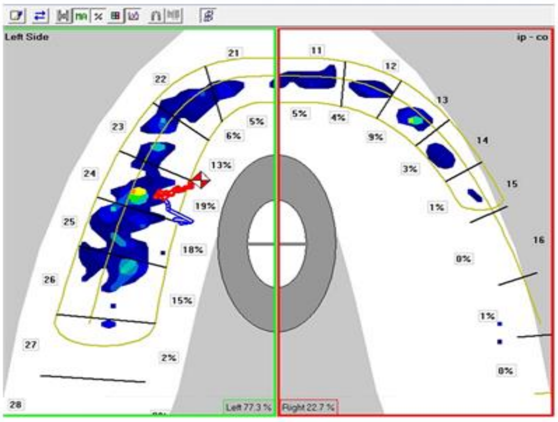
CASE 3 :



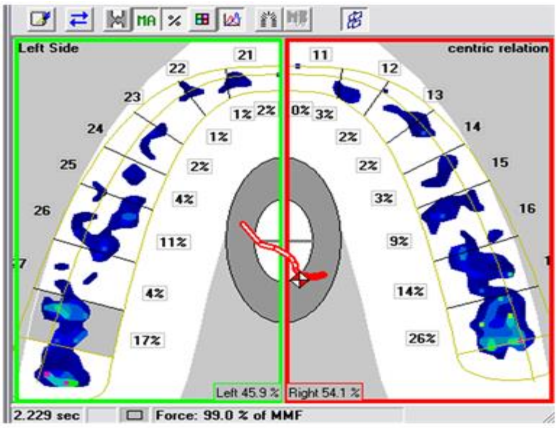


Fig.1: The screen of the T-Scan centric relation bite recording before occlusal adjustment.

Fig.2: The screen of the T-Scan centric relation bite recording after occlusal adjustment.

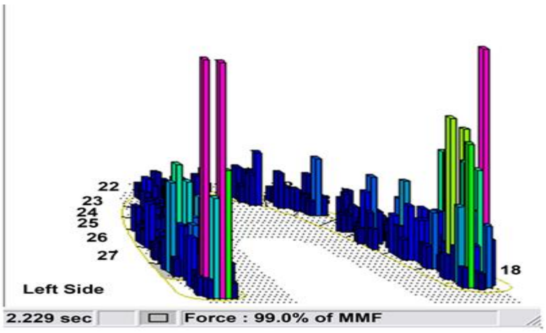
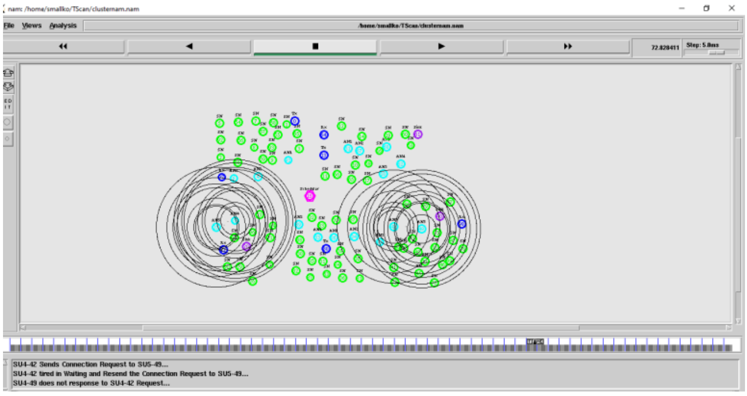


Fig 3: The color and height of each bar indicate the intensity of force per contact.

V. SIMULATIONS AND RESULTS



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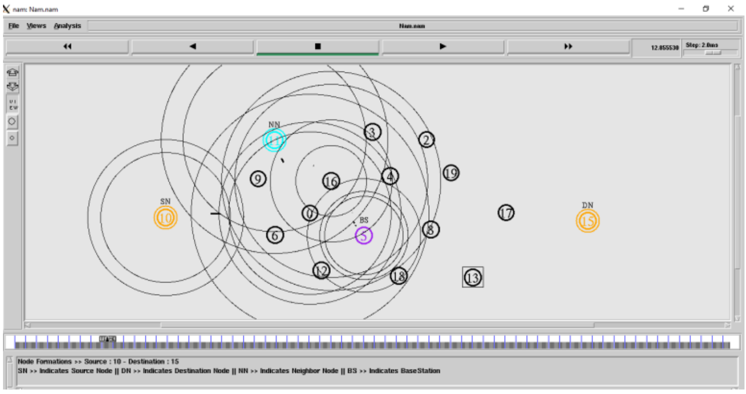

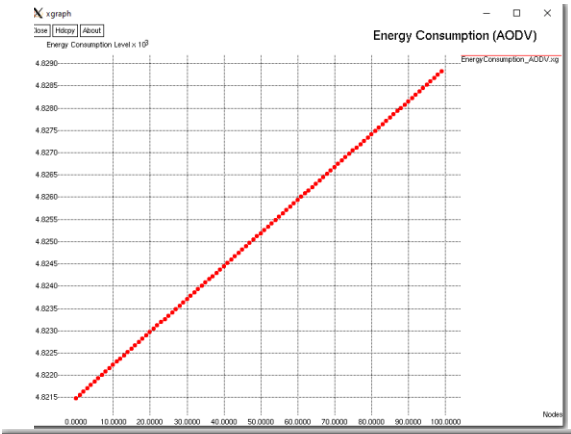

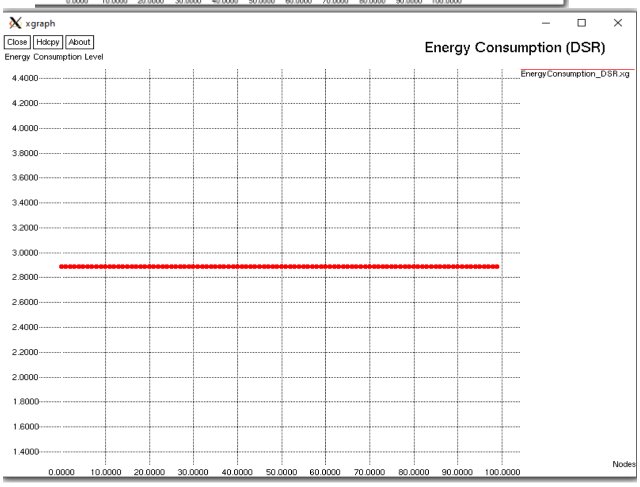

Conclusion:

Dental occlusion fascinates various field of dentistry. T scan is effective in diagnostic and management part of occlusion. It is important evidences-based tool in modern research of occlusion and TMJ. The combination of contact order, contact duration, contact location, and contact force content, all determine the degree of contact simultaneity, and the force balance that is present or absent in a particular occlusal scheme. T scan is also useful in various discipline like Implantology, Prosthodontics, Periodontics, Oral surgery, Endodontics. They can see the static and dynamic quality of inter-arch contacts in real time in a form that can be preserved in a record for comparison at any future date. The T-scan precision, which can be quantified in milliseconds and square millimeters, has won recognition as a reliable.

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REFERENCES

[1]Asha S R, Dr.Narendrakumar G 2022, ‘ Real Time Tscan Pattern of Occlusion Monitoring and Correction For Dentistry’ Approach of IJARSET ,Volume9 ,Issue 6 ,June 2022.

[2] Maness WL, Benjamin M, Podoloff R, Bobick A, Golden RF. Computerized occlusal analysis: a new technology. Quintessence Int 1987; 18:287-92.

[3] Kerstein R, Lowe M, Harty M, Radke J. A force reproduction analysis of two recording sensors of a computerized occlusal analysis system. J Craniomandib Pract. 2006; 24:1-10.

[4] Krestein RB. Current applications of computerized occlusal analysis in dental medicine. Gen dent.2001;32:7-18.

[5] Gazit E, Fitzigs S, Lieberman MA. Reproducibility of occlusal marking technique. J Prosthet Dent.1986;55:505-9.

[6] Millistein PL. An evaluation of occlusal contacts marking indicators: a descriptive, qualitative method. Quintessence Int.Dent Dig 1983; 14:813-36.

76] Reza Moini M, Neff PA. Reproducibility of occlusal contacts utilizing a computerized instrument. Quintessence Int 1991; 22:357-60.

[8] Harvey WL, Osborne JW, Hatch RA. A preliminary test of the replicability of a computerized occlusal analysis system. J Prosthet Dent 1992;67: 697-700.

[9] Hsu M, Palla S, Gallo LM. Sensitivity and reliability of the T-scan system for occlusal analysis. J Craniomandib Disord 1992;6:17-23.

[10] Mizui M, Nabeshima F, Tosa J, Tanaka M, Kawazoe T. Quantitative analysis of occlusal balance in intercuspal position using the T-Scan system. Int J Prosthodont. 1994 Jan-Feb;7(1):62-71.

[11] A study on display and accuracy of occlusal contacts by means of T-Scan System Kanagawa Shigaku. 1990 Sep;25(2):236-41.

[12] Hirano S, Okuma K, Hayakawa I. In vitro study on accuracy and repeatability of the T Scan II system Kokubyo Gakkai Zasshi. 2002 Sep;69(3):194-201.

[13] Koos B, Godt A, Schille C, Goz G. Precision of an instrumentation-based method of analyzing occlusion and its resulting distribution of forces in the dental arch; J Orafac Orthop 2010; 71:403-10.

[14] Throckmorton G.S.;Rasmussen J; Caloss R. Calibration of T-Scan sensors for recording bite forces in denture patients. Journal of Oral Rehabilitation 2009 36;636- 643.

[15] Jain R, Jabbal R, Bindra S, Aggarwal S, T- Scan a digital pathway to occlusal perfection: a review, Annals of Prosthodontics and Restorative Dentistry, 1(1), 2015, 32-35.

[16] Kerstein RB, Articulating paper misconception and computerized occlusal analysis technology, Dental Implantology, 19 (6), 2008, 41-46.

[17] Koc D, Dogan A, and Bek B, Bite Force and Influential Factors on Bite Force Measurements, Eur. J. Dent., 4 (2), 2010, 223-232.

[18] Masanori M, Fumikazu N, Junichi T, Masahiro T, Takayoshi K, Quantitative analysis of Occlusal Balance in Intercuspal Position Using T- Scan System, International Journal of Prosthodontics, 7 (1), 1994, 62-71.

[19] Ming-Lun Hsu, Sandro P, Gallo Luigi M, Sensitivity and Reliability of the T- Scan System for Occlusal Analysis, Journal of Carniomandibular Disorders, 6 (1), 1992, 17-23.

[20] An evaluation of occlusal contact marking indicators -A descriptive quantitative method. PHILIP MILLSTEIN, D.M.D., M.S.; ALVARO MAYA,D.M.D., M.S.D. Journal of American Dental Association, Vol. 132, September 2001.

[21] Millstein PL. A method to determine occlusal contact and noncontact areas: preliminary report. J Prosthet Dent 1984;52(1):106-10.

[22] Zuccari AG, Oshida Y, Okamura M, Paez CY, Moore BK. Bulge ductility of several occlusal contact measuring paper-based and plasticbased sheets. Biomed Mater Eng 1997;7:265-70.

[23] Millstein PL, Alibrandi S. Occlusal contact marking indicators for improved dentist-technician communication. Quintessence Dent Technol 1984;8(4):247-8.

[24] O’Brien WJ, Ryge G. An outline of dental materials and their selection. Philadelphia: Saunders; 1978:395.

[25] Leinfelder KF. Porcelain esthetics for the 21st century. JADA 2000;131:1186-7.

[26] Richard A Reinhardt, Amy C Killeen (2015) Do Mobility and Occlusal Trauma Impact Periodontal Longevity? Dent Clin North Am 59(4): 873-883.

[27] Newman MG, Carranza FA, Takei HH, Klokkevold PR (2006) Clinical Periodontology. 10th edn. Missouri. Saunders pp.467.

[28] Profitt WR (1986) on the aetiology of malocclusion. British Journal of Orthodontics 13: 1-11.

[29] Weinberg LA (1983) The role of stress, occlusion, and condyle position in TMJ dysfunction-pain. Journal of Prosthetic Dentistry 49(4): 532-545.

[30] Schelb E, Kaiser DA, Bruki CE (1985) Thickness and marking characteristics of occlusal registration strips. Journal of Prosthetic Dentistry 54(1): 122-126.

[31] Halperin GC, Halperin AR, Noting BK (1982) Thickness strength and plastic deformation of occlusal registration strips. Journal of Prosthetic Dentistry 48(5): 575-578.

[32] Millstein PL (1984) A method to determne occlusal contact and non-contact areas: Preliminary report. Journal of Prosthetic Dentistry 52(1): 106-110.

[33] Arcan M, Zandman F (1984) A method for in vivo quantitative occlusal strain and stress analysis. Journal of Biomechanics 17(2): 67-79.

[34] Kerstein RB (2004) Combining technologies: a computerized occlusal analysis system synchronized with a computerized electromyography system. Journal of Craniomandibular Practice 22(2): 96-109.

[35] Liu CW, Chang YM, Shen UF, Hong HH (2014) Using the T-scan III system to analyze occlusal function in mandibular reconstruction patients: A pilot study. Biomedical Journal 38(1):52-57

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