"A COMPARATIVE EVALUATION OF PHYSICS FORCEPS AND CONVENTIONAL EXTRACTION FORCEPS IN EXTRACTION OF MANDIBULAR FIRST AND/OR SECOND MOLAR"

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LIST OF ABBREVIATIONS

Sr. No.	Abbreviations	Full form
1.	PDL	Periodontal Ligament
2.	i.e.	That is
3.	VAS	Visual Analog Scale
4.	SD	Standard Deviation
5.	Secs.	Seconds
6.	POD	Post Operative Day
7.	mm	Millimetre
8.	ml	Millilitre
9.	Cap.	Capsule
10.	Tab.	Tablet
11.	mg	Milligrams

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INTRODUCTION

An ideal tooth extraction may be defined as the painless removal of the whole tooth or tooth roots with minimal trauma to the investing tissues, so that the wound heals uneventfully with no postoperative prosthetic problems.[1]

Exodontia is a practice that all dental surgeons are trained to perform in dental school and carried out by most general practitioners in their clinics.[2]

Extraction of a tooth is carried out for multiple reasons, that includes: severe periodontal disease, severe caries, orthodontic reasons, fractured teeth, malaligned teeth, preprosthetic reasons, impacted teeth, supernumerary teeth, ectopic eruptions, teeth associated with pathologic lesions, prior to radiation therapy, teeth in the line of jaw fractures, esthetics, and economics.[3]

Every maxillofacial surgeon should aspire to achieve an objective of performing an ideal tooth extraction. In order to accomplish this, he or she must adapt techniques in such a way that the difficulties and possible complications encountered while extraction of each individual tooth are dealt in the most acceptable manner.[1] A great deal of finesse and a definite degree of controlled force are the key factors which must be exercised by the dental surgeon while performing a simple tooth extraction.[2]

The process of a simple tooth extraction involves minor expansion of the alveolar bone, severance of the periodontal ligament (PDL), and finally delivery of the tooth with coronal forceps. Various factors on which successful tooth extractions relies are surgeon's detailed and thorough understanding of the tooth anatomy, the root form, curvature and angulations, attachment of the tooth to the periodontium, and the underneath bony structure.[4]

The traditional tooth extraction technique aims at complete removal of the tooth from its dentoalveolar casing. Occasionally this goal is achieved by fracturing or surgically removing the surrounding bone. Traumatic damage done to the dentoalveolar housing during the process of extraction, may result in significant alveolar ridge deficiencies or deformities postoperatively. In addition to compromised esthetics, such alveolar ridge deformities may hinder placement of dental implants or may result in food entrapment beneath the pontic in traditional fixed partial prosthesis.[5,6]

Atraumatic dental extraction techniques have gained importance and may become the standard technique for tooth removal in due course of time. Atraumatic extraction prevents damage to the bone and preserves periodontal architecture that allows for an

option of future or immediate dental implant placement. For minimally invasive tooth removal, various tools and techniques have been proposed, such as periotomes, powertome, proximators, benex extractor and physics forceps.[7]

Conventional extraction forceps are two first-class levers, interconnected with a hinge. The handles of the forceps acts as long side of the lever, beaks placed on the tooth acts as short side of the lever while the hinge acts as a fulcrum. The force applied on the handles by the operator magnifies to allow the forceps to take hold of the tooth with immense force. None of these forces are useful for the extraction of the tooth. Rather, greater forces may fracture or crush the tooth. The handles of the forceps let the operator to grasp the tooth, but do not aid in the mechanical advantage to extract it.[8]

Dr. Richard Golden designed physics forceps in the year 2004.[9] The biomechanical design of this instrument is such that, it preserves the buccal bone plate and decreases the incidence of root fracture, which are essential factors for the successful healing of an immediately placed dental implant. Physics forceps enables the removal of even the most grossly decayed tooth with minimal or no trauma to the surgical site. [10]

On the other hand, the biomechanical advantages of a first-class lever, stress distribution and creep are the basic principles on which physics forceps works, without the grasping, squeezing, twisting and pulling forces.[11]

Physics forceps have two handles, one is connected to a bumper which acts as a fulcrum during extraction and other continues to form a beak. Bumper is applied normally at the mucogingival junction on the buccal or labial aspect. The beak is

applied to the palatal or lingual aspect of the tooth and inserted into the gingival sulcus. This "beak and bumper" design facilitates uncomplicated extraction of tooth without the use of excessive forces.[8]

Physics forceps works on the principle of amalgamation of the biomechanical advantages of a first class lever with the biochemical reaction so that the removal of the tooth becomes easier with fewer complications. Tissue enzyme hyaluronidase is released when the periodontal apparatus is severed with forceps or elevators. This enables the tooth to be released from its attachment to the bony alveolus and thus can be extracted easily. The biomechanical action of physics forceps allows the release of greater amounts of hyaluronidase due to its property of delivering steady trauma to the periodontal ligament as compared to the conventional extraction forceps or elevator which exerts intermittent trauma.[7]

The physics forceps exerts a constant pressure with the help of only wrist movement. This technique necessitates minimal amount of strength that ultimately results in decreased incidence of buccal bone fracture. In addition the bumper, which is placed on the buccal alveolar ridge applies a compressive force over the buccal bone, thus results in supporting the bone and prevents its fracture.[7]

The physics forceps have a distinct learning curve as compared to conventional forceps, because the procedure of tooth extraction is distinctive. Unlike conventional forceps, which are frequently used for teaching and practice in dental school, the physics forceps is relatively novel, with its adoption happening gradually. Fewer dental professionals are therefore familiar with its design and technique. However,

once the dental surgeon is familiar with the working of physics forceps vis-a-vis wrist movement and direction of force application, the process of extraction becomes simple.[12]

This study was conducted to compare the efficiency of physics forceps and conventional extraction forceps in extraction of mandibular first and/or second molar.

AIM AND OBJECTIVES

AIM:

To compare the efficiency of physics forceps and conventional extraction forceps in extraction of mandibular first and/or second molar.

OBJECTIVES OF THE STUDY:

- To compare duration of operation i.e. time required for extraction with physics forceps to conventional extraction forceps in extraction of mandibular first and/or second molar.

- To compare the operative complications i.e. incidence of incomplete removal of root, fractured alveolus and soft tissue injuries (laceration) with physics forceps to conventional extraction forceps in extraction of mandibular first and/or second molar.
- To compare post-operative complications i.e. dry socket, delayed healing, post-operative infection, soft tissue injuries (ulceration) and pain with physics forceps to conventional extraction forceps in extraction of mandibular first and/or second molar.

REVIEW OF LITERATURE

The history of teeth extraction dates back to the period of **Aristotle (384 to 322 BC)**, where he had described the mechanics of tooth extraction forceps, including the advantages of "two levers working in contrary sense and having a single fulcrum.[11]

Various studies have been reported in the literature so far explaining various principles and procedures of exodontia. Newer techniques and instruments used in the field of exodontia had also been described in the recent years for the advancement of the procedure and benefit of the patients undergoing tooth extraction. These advancements aim at atraumatic tooth extraction procedure so that the bone for implant insertion is maintained.

Rounds FW in 1949 stated that, it is presumable that dentistry was a crude art among the earliest civilizations. There seems to be no specific date as to when the tooth extraction either by drawing or other forceful means of ejection was introduced. Although it is recorded that leaden forceps were found in the temple of **Apollo at Delphi,** which indicates that this edifice was used as an archive for such instrument. While termed forceps, it is likely that this instrument was more in the form of short jawed tongs.[13]

Abulkasim (1050-1122 A.D.) a famous Arabian surgeon, was an advocate of the actual cautery preceding forceps extraction and was the first writer to apply a lever under the tooth to force it from its bed. This indicates that the principle of the elevator or exolever is not a modern development.[13]

Modern extraction methods date from **1840** when **Tomes**, an English dentist, brought out his anatomical forceps, a set of instruments the working parts of which were adaptable to the various shapes of the individual teeth (Figure 1). The comparative ease with which teeth could be removed by their use, as contrasted to previous methods, was largely responsible for the promiscuous “tooth pulling” era as exemplified by barbers, blacksmiths, and other laymen as well as by physicians and dentists. Present forceps construction is based on Tome’s original models with beaks, handles and material, greatly changed but retaining the principle of the beaks fitting the neck of the tooth.[13]

Technical skill received a big impetus from 1840 to 1900 and many remarkable operators developed, but trauma during surgical intervention was an unconsidered factor.[13]

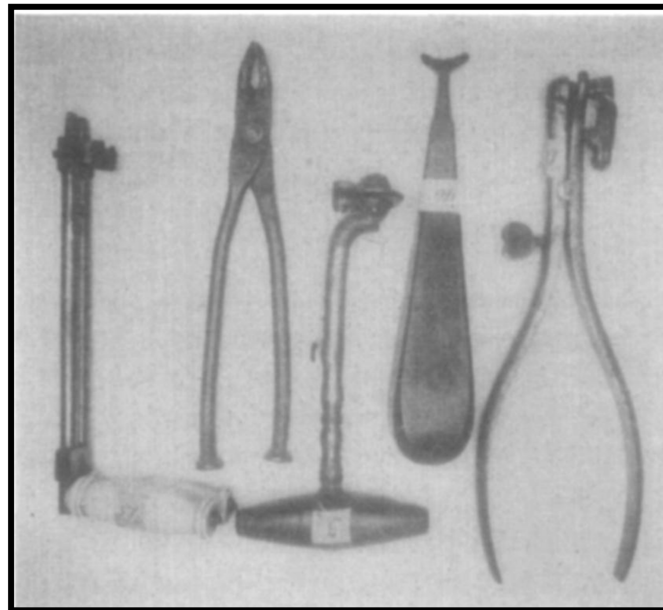

Figure 1: Mid-nineteenth century American extraction instruments.[13]

Amler MH et al in 1960 conducted a histological and histochemical study on undisturbed alveolar socket healing, utilizing post extraction biopsies from normal human tissues at two to three day intervals over a period of 50 days. Generally, the sequence in the healing of an alveolar socket after exodontia is as followed : (1) clot formation; (2) replacement of blood clot by granulation tissue (seventh day); (3) replacement of granulation tissue by connective tissue (twentieth day); (4) evidence of epithelization (fourth day) and definitely healed epithelium across the granulation tissue (twenty first day) and (5) appearance of osteoid at the base of the socket (seventh day) and filling of at least two thirds of socket fundus by trabeculae (thirty-eighth day).[14]

Howe GL in 1962 stated that every endeavor should be made to avoid fracturing teeth and roots in the first instance. The removal of the whole tooth or root is not the sole criterion of success in exodontia. Most extractions are followed by the prosthetic rehabilitation, and prosthetic difficulties should be eliminated at the time the teeth are extracted. Many dental prosthetic failures are created by lack of foresight on the part of the operator at the time of teeth removal.[1]

Pietrokovski J and Massler M in 1967 studied the amount of tissue resorption after tooth extraction in 149 plaster casts with single teeth missing through extraction by superimposing the edentulous region over its homotype ridge with teeth present on the opposite side. They concluded that the buccal plate in the mandible was resorbed more than the lingual plate. The center of the edentulous ridge, therefore shifts lingually, so that the arch length was also reduced in the edentulous mandible.[15]

MacGregor AJ in 1968 conducted a study on about 10,199 extractions and concluded that trauma, age, sex, site and number of teeth extracted, plays a significant part in the aetiology of dry socket. He observed that occurrence of dry sockets is site specific, the highest occurrence being in the lower molar region. Teeth which were fractured, showed a significantly higher level of occurrence of dry socket than those which did not fracture. Teeth which were considered difficult to extract had a significantly higher level of occurrence of dry socket. The occurrence of dry socket is sex specific and the male: female ratio is approximately 2:3. Recording the presence or absence of pulpitis or buccal bone loss at the time of tooth extraction is not likely to improve the powers of predicting dry sockets.[16]

Amler MH in 1969 in his study inferred that the first evidence of epithelization is seen at 4th day, the wound is covered with epithelium at around 20th day and complete fusion of epithelium occurs at around 24th to 35th post extraction day.[17]

Ojala T in 1980 conducted a study with the purpose of observing the rocking moments needed during the extraction of lower jaw teeth, by means of strain gauges attached to forceps handles. Great variation was found between the values for rocking moments and their acting times in different tooth groups. The mean value of the highest lingual rocking moments was recorded during the extraction of first and second molars, and the highest labial moments during the extraction of canines. The mean value of the total rocking moments was highest during the extraction of canines and lowest during the extraction of premolars. The mean value of total rocking moments for incisors and canines was significantly lower ($p < 0.01$) and for molars almost significantly lower ($p < 0.05$) for the group aged 40 and over when compared to corresponding values for the group under 40 years of age.[18]

Berge TI in 1988 conducted a study on visual analog scale (VAS) assessment of postoperative swelling. In his study, subsequent to removal of impacted lower third molars the interrelationship of four postoperative variables (swelling, pain, trismus, and dysphagia) was assessed. He concluded that registration of postoperative swelling by means of a VAS may be a sensitive and accurate method with obvious practical advantages.[19]

McCormack HM et al in 1988 in their review stated that VAS provide a simple technique for measuring subjective experience. They have been established as valid

and reliable in a range of clinical and research applications, although there is also evidence of increased error and decreased sensitivity when used with some subject groups. Decisions concerned with the choice of scoring interval, experimental design, and statistical analysis for VAS in some instances have been based on convention, assumption and convenience, highlighting the need for more comprehensive assessment of individual scales if this versatile and sensitive measurement technique is to be used to full advantage.[20]

Howe GL in 1990 in his book had described the technique for extraction of mandibular molars using conventional molar forceps. Lower molars are best extracted with molar forceps. Unless care is taken to force the blades well down the periodontal membrane so that the root mass can be gripped, the crown of the tooth will be crushed in the forceps. These teeth are often loosened by buccolingual pressure and are best delivered by secondary rotation.[21]

Malden NI in 2001 in his paper described two techniques involving the unconventional use of conventional dental extraction forceps with the aim of facilitating removal of the retained roots of certain teeth. The development of techniques for extracting teeth without resorting to surgery is a natural progression for operators performing extractions regularly. This paper presents the unconventional use of extraction forceps in an effort to avoid resorting to invasive procedure. The methods explained are safe and expedient ways of removing retained roots in certain situations. The term surgical forceps technique is put forward as an appropriate description of these procedures, in which dental forceps are used in such an unconventional manner.[22]

Williamson A and Hoggart B in 2005 stated in their review that pain rating scales have a fundamental place in clinical practice. The evidence suggests that patients are able to use them to communicate their pain experience and their response to treatment. The interpretation of pain scores is not straightforward. The key to successful pain management hinges upon the ability of the patient to use the tools made available and the careful interpretation of the scores by the health care professionals. They concluded that all three pain-rating scales (Visual analog scale, Verbal rating scale and Numerical/numeric rating scale) are valid, reliable and appropriate for use in clinical practice.[23]

Adeyemo WL et al in 2006 conducted a study on 311 patients to evaluate the clinical pattern of post-extraction wound healing with a view to identify the types, incidence, and pattern of healing complications following non-surgical tooth extraction. They found that healing was uneventful in 89%, while 11% developed healing complications. These complications were: localized osteitis 26 (8.2%); acutely infected alveolus 5 (1.6%); and an acutely inflamed alveolus 4 (1.2%). Females developed more complications than males. Most complications were found in molars (60%) and premolars (37.1%). They also demonstrated a painful alveolus is not necessarily a disturbance of post-extraction site wound healing. Therefore, a thorough clinical examination must be conducted to exclude any other complications.[24]

Al-Khateeb TH and Alnahar A in 2008 conducted a study to assess pain experience after simple uncomplicated tooth extraction and to see if there is a need to prescribe analgesic drugs after such a procedure. Two hundred patients (100 females, 100 males) were selected randomly from patients undergoing simple (intra-alveolar) tooth

extraction followed by pain assessment during 4 telephonic interviews and 1 personal interview at the next appointment at the clinic. They found that patients experienced pain after simple uncomplicated tooth extraction. The pain intensity peaked at the evening of extraction and greater than 50% of patients used analgesic drugs after tooth extraction. Female gender predominance in pain reporting was statistically significant on 3rd and 5th post extraction day. The chronically inflamed teeth caused the highest mean pain intensity score. There was a significant correlation between mean pain intensity score and previous dental injection pain. They recommended that dental professionals should consider offering regular analgesic drugs during the first week after tooth extraction.[25]

Misch CE and Perez HM in 2008 stated that the principles of biomechanics are the basis for the development of the physics forceps, which is really a dental extractor rather than a forceps, and uses first-class lever mechanics. One handle of the device is connected to a "bumper," which acts as a fulcrum during the extraction. The beak of the extractor is positioned most often on the lingual or palatal root of the tooth and into the gingival sulcus. Implementation of a first-class lever, creep, and the type of force provides the mechanical advantages necessary to make this dental extraction device more efficient.[8]

Saker M et al in 2009 in their book described the technique for extraction of mandibular molars. Mandibular molars are often the most difficult teeth to remove owing to various factors, and they can have most complications because of anatomic considerations. They are best removed with #151 (universal) or #23 (cowhorn) forceps. Once the forceps is seated, heavy apical pressure is applied. If a cowhorn

forceps is being used, the tips of the beaks should be wedged into the furcation of the tooth by squeezing the handles of the instrument and gently rocking the beaks into position. Once the beaks are tightly seated around the crown, heavy luxation of the tooth occurs in a buccal and lingual direction (Figure 2). When the tooth is adequately mobile, a wiggling motion can be used to extract it from its socket. The figure-eight technique is also used at this point, and all the while, apical pressure is applied.[4]

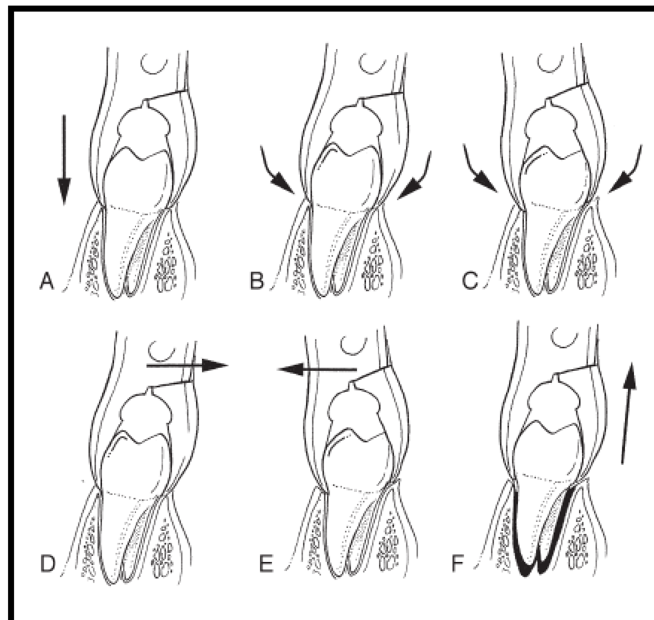

Figure 2: Conventional technique for extraction of mandibular molar teeth.[4]

White J et al in 2009 conducted a study on powertome assisted atraumatic tooth extraction, where seven cases were presented in which atraumatic extractions were performed with the powertome automated periotome. In all seven cases, dental extractions were performed flaplessly without damaging the dentoalveolar housing. Most cases were performed in a matter of minutes. The automated periotome described in this paper is an effective device for expedient atraumatic dental

extractions. By avoiding mucoperiosteal flap reflection and damage to adjacent bone, delicate gingival papillae are preserved and the opportunity for future or immediate dental implant treatment is maintained.[5]

Scull P in 2010 in her paper stated that conventional exodontia involves separating the periodontal attachment, using an elevator to rupture the periodontal ligament and expand the alveolar bone, and forceps to grasp and pull out the tooth. Two equal forces applied through the beaks of the forceps combined with a third force, movement of the operator's arm and wrist, cause further compression and expansion of the alveolar bone ultimately resulting in the release of the tooth from its socket. 'Snapped roots' and broken bone are the result of too much force being applied to often already compromised dental structures, exceeding the capacity of the bone and/or tooth to withstand it. This pulling technique also invites unnecessary trauma including broken roots and bone, inflammation and post operative pain, loss of tissue, and stress for the patient and dental team.[26]

On the other hand, physics forceps act like a simple first class lever. One force is applied with the beak on the lingual aspect of the tooth or root. The second force is applied via the 'bumper', which is placed on the alveolar ridge at the approximate location of the mucogingival junction. The handles of the physics forceps are not squeezed, just held, and gentle but steady rotational force applied through a small amount of wrist movement only. This limited amount of wrist movement is achieved by simply moving the wrist by about 3-4º, then maintaining this position to apply the steady gentle pressure. This application of a steady but moderate force builds up internal force or 'creep' which allows the bone to slowly expand and the periodontal

ligament to release. The operator will soon feel that the tooth disengages from the socket (or 'pop') and notice it rise occlusally from the socket by 1-2mm. The operator can then remove the physics forceps and lift out the tooth using either their fingers alone or another appropriate instrument.[26]

Perkins NJ et al in 2010 in their poster on the physics forceps described that the application of the physics forceps involves 6 stages: (1) separation of the gingival attachment from the tooth (e.g. using a periotome); (2) placement of the 'beak' onto a secure palatal/lingual application point (root surface); (3) placement of the 'bumper' (with single-use plastic sleeve attached) onto the buccal aspect of the alveolus at the level of mucogingival junction (this acts as a fulcrum; braces and protects the buccal plate); (4) application of a steady slow rotational force (facilitates creep in the periodontium) using only wrist movement; (5) occlusal elevation of the tooth a few millimetres from its socket; (6) delivery of the tooth using a haemostat/rongeurs/conventional forceps.[9]

As with any new technique, there is a learning curve for operators in making the transition from conventional forceps to physics forceps, especially the effective use of wrist movement. Physics forceps represent an important addition to the armamentarium for atraumatic exodontia.[9]

Fazio RC in 2010 stated that physics forceps is the revolutionary new concept in exodontia that materially changed the ease and predictability of extractions. The extractions using the physics forceps are more predictable in time commitment, faster procedures, and most assuredly, less traumatic physically and psychologically to the

patient. The constant, unrelenting pressure to the periodontal ligament by the physics forceps is substantially more efficient at "releasing" the tooth compared to the intermittent and alternating forces of conventional extraction technique. The simple first class lever multiplies the impact and speeds the process. This is what makes the physics forceps more efficient, faster and less traumatic to the alveolar bone.[27]

Feck A in 2010 in his paper affirmed that when the periodontal ligament is traumatized with forceps or elevators, hyaluronidase is released. This enzyme catalyzes the hydrolysis of hyaluronic acid, which comprises a substantial portion of the extracellular matrix of all human tissue, including the periodontal ligament. Once the chemical breakdown of the periodontal ligament by hyaluronidase is sufficient, the tooth is released from its attachment to the alveolus and can be easily removed. The more hyaluronidase released per unit time, the more efficient is the release of the tooth, and the less trauma there is to the alveolar bone. This explains why the physics forceps, with its steady, unrelenting pressure on the periodontal ligament, quantitatively creates a greater release of hyaluronidase in a shorter period of time than traditional forceps or elevator extractions, as the trauma from these techniques is intermittent.[28]

Choi YH and Bae JH in 2011 conducted a study with the purpose of clinical evaluation of a new extraction method for intentional replantation, where physics forceps was used as a new extraction method of atraumatic safe extraction for intentional replantation. Ninety-six patients who underwent intentional replantation were enrolled in this study. Preoperative orthodontic extrusive force was applied for 2-3 weeks to increase mobility and periodontal ligament volume. Physics forceps was

used for extraction and the success rate of atraumatic safe extraction was assessed. The extraction time was also measured in seconds from the moment the extraction force was applied until the tooth was completely removed from its socket. The complete success rate (no crown and root fracture) was 93% (n = 89); the limited success rates because of partial root tip fracture and partial osteotomy were 2% (n = 2) and 5% (n = 5), respectively. The clinical and overall success rates of atraumatic safe extractions were 95% and 100%, respectively; no failure was observed. The average extraction time was 4 minutes 8 seconds (range, 40 seconds-22 minutes 12 seconds). They concluded that atraumatic safe extraction can be regarded as a reproducible and predictable method of extraction for intentional replantation.[29]

Weiss A et al in 2011 in their article described various technological advances in extraction techniques and outpatient oral surgery. They stated that a variety of new instruments and techniques are revolutionizing the fields of oral and maxillofacial surgery and dentistry, of which physics forceps is one. The physics forceps uses first-class level mechanics to atraumatically extract a tooth from its socket. One handle of the device is connected to a "bumper," which acts as a fulcrum during the extraction. This "bumper" is usually placed on the facial aspect of the dental alveolus, typically at the mucogingival junction. The beak of the extractor is positioned most often on the lingual or palatal root of the tooth and into the gingival sulcus (Figure 3). Unlike conventional forceps, only one point of contact is made on the tooth being extracted. Together the "beak and bumper" design acts as a simple first-class lever. A squeezing motion should not used with these forceps. By contrast, the handles are actually rotated as one unit using a steady yet gentle rotational force with wrist movement

only. Once the tooth is loosened, it may be removed with traditional instruments such as a conventional forceps or rongeur.[30]

Golden R in 2011 in his paper has described the biomechanics and design of physics forceps. The physics forceps technique eliminates the need to firmly grasp, twist, rock, push and pull with your arm. When this technique is first attempted, a conscious effort must be made to retrain your hands to not squeeze the instruments and to not pull with your arm. This can be the largest barrier to break through and to be successful with this technique, but once this barrier is broken the advantages of the physics forceps are unlimited.[31]

Figure 3: Physics forceps beak placement on root (animation).[31]

Nazarian A in 2011 in his case report stated that, one set of instruments that are found to be more effective and efficient for extractions are the physics forceps. Once the instrument is properly placed, pressure is slowly applied using only wrist movement applying a steady and gentle pressure toward the buccal. Approximately within few seconds the internal force or "creep" will build up allowing the bone to

slowly expand and the periodontal ligament to release at which point the tooth will disengage from its socket (known as the "pop"). Once the tooth has disengaged from the socket, the instrument has completed its task and another instrument of choice (eg: rongeurs) or your fingers can be utilized to remove the tooth. If the tooth is severely broken down, the tooth may be relieved with a bur on the lingual aspect, so that the beak of the physics forceps may engage a solid portion of the tooth.[32]

Venkateshwar GP et al in 2011 conducted a retrospective study with the purpose of analyzing the incidence of various complications following routine exodontia performed using fixed protocols. A total of 22,330 extractions carried out in 14,975 patients, aged between 14 and 82 years and were evaluated for various complications. The most common complications encountered were tooth fracture, trismus, fracture of cortical plates and dry socket. This study showed a higher incidence of tooth fracture (20.4%), trismus (18%), fracture of cortical plates (16.2%) and dry socket (11.7%). Wound dehiscence, postoperative pain and hemorrhage were encountered less frequently. Luxation of adjacent teeth, fracture of maxillary tuberosity, and displacement of tooth into adjacent tissue spaces were rare complications. They concluded that the practice of exodontia inevitably results in complications from time to time. It is imperative for the clinician to recognize impending complications and manage them accordingly.[33]

Dym H and Weiss A in 2012 in their article reviewed and highlighted exodontia tips as well as new techniques to make simple and complex exodontia more predictable and efficient with improved patient outcomes. They stated that extraction of lower molars could be the most difficult extraction in the mouth because of the density of

the posterior mandible, the root form of lower molars, and proximity to vital anatomic structures. A lower universal forceps No. 151 is best used. A variety of cowhorn forceps are used to allow for the beaks to seat into the furcation with very gentle digital pressure. Once the cowhorn beaks are seated into the furcation, gentle approximation of handles of the forceps takes place. That process luxates the tooth coronally, and then simple delivery of the tooth follows. One must still pay great attention to prevent causing any damage to the soft tissue surrounding the extracted tooth.[2]

Unlike conventional forceps, in physics forceps only one point of contact is made on the tooth being extracted. Together the beak and bumper design acts as a simple first-class lever. A squeezing motion should not be used with these forceps. By contrast, the handles are actually rotated as one unit using a steady yet gentle rotational force with wrist movement only. Once the tooth is loosened, it may be removed with traditional instruments such as a conventional forceps or rongeur. With this technique, no prior elevator use is required before attempting the extraction and no mucosal flap need be used.[2]

Kosinski T in 2012 in his case series used physics forceps for extractions in preparation for dental implants. He concluded that the physics forceps can be utilized for atraumatic extractions where bone needs to be preserved and root fractures would only complicate a situation. Elevation of the tooth is no longer required as the instrument itself stretches and eventually breaks the periodontal ligament fibers, allowing easy removal of the tooth. The firm yet not excessive rotational forces applied to the periodontal ligaments are shear in nature. The lingual plate expands,

and the compressive forces placed on the facial aspect by the “bumper” prevent facial bone fracture.[10]

The constant pressure applied to the tooth by the design of this forceps leads to chemical changes in the periodontal ligament and the subsequent breakdown of the Sharpey’s fibers. When the PDL is traumatized, hyaluronidase is released. Once the chemical breakdown of the PDL by hyaluronic acid is sufficient, the tooth is released from its attachment to the alveolus and is removed.[10]

Patil SS et al in 2012 in their review have stated that the tooth extraction socket typically undergoes remodeling and resorption; the resulting ridge deformation may cause severe functional and esthetic problems. Several techniques are available to augment the ridge/socket following extraction; instead strategic extraction reduces the need for restoring such challenging ridge defects by providing an alternative in the form of a simple, minimally invasive socket-preservation procedure immediately following atraumatic tooth extraction. A number of tools and techniques have been proposed for minimally invasive tooth removal including the #15 scalpel blades and periotomes, which are routinely used during the atraumatic extraction procedure. Apart from these instruments, there are some advanced tools like physics forceps, powertomes, and some novel techniques like the ogram system, easy X-TRAC system, specially designed for atraumatic extraction procedures. The principle of biomechanics is the basis for the development of a different type of dental forceps called “Physics Forceps”. The physics forceps is a dental extractor that uses first class lever mechanics.[34]

Cicciù M et al in 2013 in their study analyzed all the applied movements while extracting healthy upper and lower jaw premolars for orthodontic purposes. The buccal and palatal rocking movements, plus the twisting movements were also measured in this in-vivo study during premolar extraction for orthodontic purposes. The physical strains or forces transferred onto the teeth during extraction are the following three movements: gripping, twisting, and traction. A strain measurement gauge was attached onto an ordinary dentistry plier. The strain measurement gauge was constituted with an extensimetric washer with three 45º grids. The system operation was correlated to the variation of electrical resistance. The variations of resistance (ΔR) and all the different forces applied to the teeth (ΔV) were recorded by a computerized system. The results underlined the stress distribution on the extracted teeth during gripping, twisting and flexion. The results of the study showed how the strength, needed for performing the first upper premolar extraction is 25 times higher than the lower jaw. This confirms that extraction of multi-rooted teeth will result in a very difficult surgical operation. Several factors, such as strange tooth anomalies, large root angles or strange root forms seem to be present when exodontia complications occur. However, bone structure and density do not influence the strength value.[35]

Kosinski T in 2013 in his article described the new molar series physics forceps, the GMX 400 molar series. The molar series has a new design and some new applications. The molar series has just 2 instruments (EZ1 and EZ2) that allow for bumper placement on the buccal or lingual side of the tooth as well as a smaller bumper that fits well in a shallow vestibule (Figure 4). In some instances, if the

lingual aspect of the tooth has severe decay, it can be difficult to engage the beak of the instrument. In these instances, the beak has the ability to engage on the buccal sulcus and rotation is done in a lingual direction. Additionally, as it is hard to place a larger bumper in the molar areas where a very shallow vestibule is present, the new design allows the bumper to sit nicely in the vestibule to achieve the proper leverage for this technique.[36]

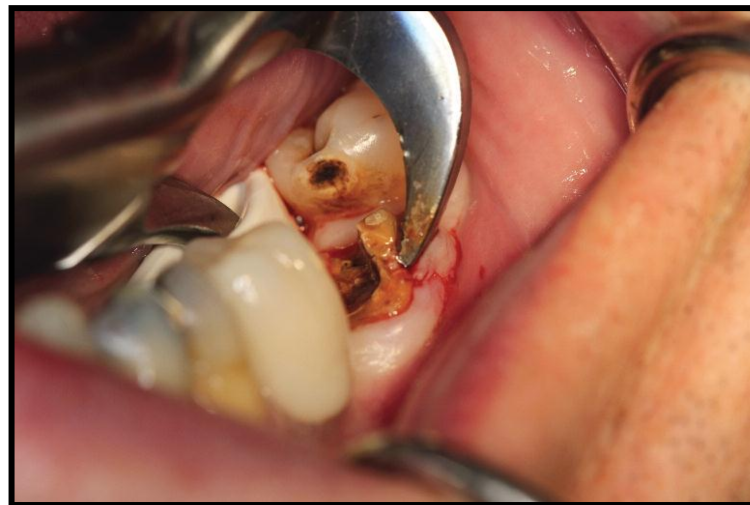

Figure 4: New Molar Series Physics Forceps: With the handles opened wide, the physics forceps bumper is placed as deep in the vestibule as possible on the lingual aspect of tooth, and the beak of the physics Forceps is placed approximately 3 mm subgingivally into the buccal sulcus, engaging the tooth's root surface.[36]

Hupp JR in 2014 in his chapter in book had described the mechanics of action of conventional forceps and technique for extraction of mandibular molars. Mandibular molars usually have two roots, with the roots of the first molar more widely divergent than those of the second molar. Additionally, the roots may converge at the apical one. The No. 17 forceps are usually used for extraction of mandibular molars; these forceps have small tip projections on both beaks to fit into the bifurcation of the tooth

roots. The forceps are adapted to the root of the tooth in the usual fashion, and strong apical pressure is applied to set the beaks of the forceps apically as far as possible. Strong buccolingual motion is then used to expand the tooth socket and allow the tooth to be delivered in the bucco-occlusal direction (Figure 5). Linguoalveolar bone around the second molar is thinner than the buccal plate, so the second molar can be removed more easily with stronger lingual pressure than buccal pressure.[37]

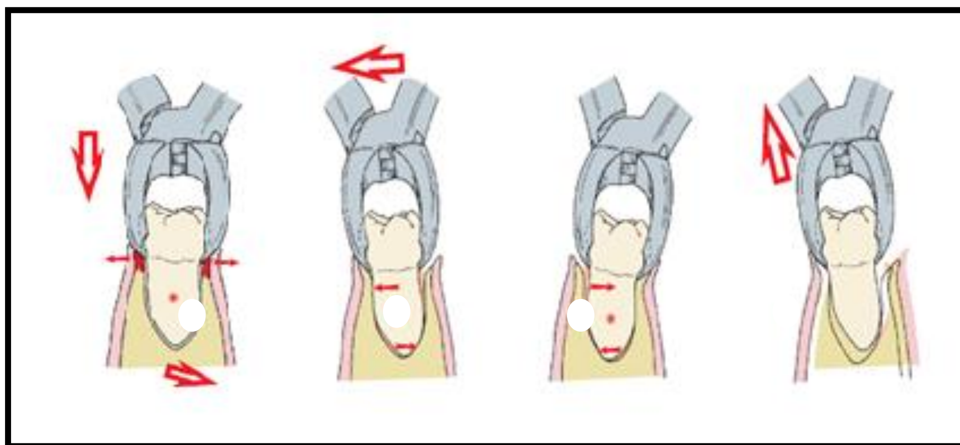

Figure 5: Technique for removal of mandibular molar teeth through conventional forceps.[37]

Hariharan S et al in 2014 in their study compared outcome variables (operative complications, inflammatory complications, and operating time) in patients being treated by orthodontic extraction of upper premolars with the physics forceps or the universal extraction forceps. They organized a single blind, split- mouth clinical trial to compare the outcomes of the 2 groups (n = 54 premolars). The physics forceps group had lower mean (SD) visual analog scores (VAS) for pain (0.59 (0.57)) on the first postoperative day than the other group (1.04 (0.85)) (p = 0.03). The mean (SD) operating time using physics forceps was 29.4 (27.3) seconds and with the universal extraction forceps 43.5(49.5) seconds. This difference was not significant (*t* (df) =52,

p=0.204). They concluded that there is a need for more prospective studies with larger sample size.[12]

Mandal S et al in 2015 conducted a study with the aim of evaluating efficacy of physics forceps in non-surgical mandibular multirooted tooth extractions. A prospective double blind, randomized controlled trial was conducted and 50 subjects were enrolled for the study consecutively who met inclusion and exclusion criteria. The mean time taken for extraction of multirooted tooth with physics forceps came to be 2.33 minute with a standard deviation of 1.588 minutes whereas with conventional forceps mean time came to be 3.94 minutes with a standard deviation of 2.145 minutes. Of the total 25 subjects in the test group, 3 subjects reported laceration in the test group as compared to 11 subjects of the total 25 subjects in the control group. A significant association was found between the physics forceps and conventional forcep (p=<0.05). In the test group in no subject cortical plate fracture was reported compared to 12 subjects reported with a cortical plate fracture in the control group. A significant association was found (P=<0.05).[11]

It was seen that of the total 25 subjects in the test group (physics forceps) 17 reported no hurt whereas 8 subjects from control group reported no hurt, on comparing test group with control group on basis on little bit hurt result came to be that out of 25 subjects 6 subjects reported little bit hurt but in control group there were more number of subjects with a complain of little bit hurt. A significant relation was seen (p =< 0.035). They concluded that the physics forceps can be used as a helpful aid in atraumatic extraction of mandibular tooth, it not only reduces patient's post-operative

discomfort but also maintain the socket integrity by not disturbing the soft tissue and hard tissue architecture and thus making future prosthesis replacement easier.[11]

Kosinski T and Golden R in 2015 in their article stated that the physics forceps design and associated technique eliminates not only the physical difficulty of removing teeth throughout the mouth; it also makes the process much easier and positive for the patient. The biomechanical design of the instrument reduces stresses placed on fragile root structure, helping maintain the facial plate of bone. When interseptal bone and the facial plate are maintained, the entire process of grafting and placing an immediate dental implant becomes more predictable.[38]

One of the biggest misconceptions of this innovative technique is that it is a "forceps" as the names implies, when it fact it is a lingual elevator. Our muscle memory wants us to use it like a traditional forceps, and thus, we tend to squeeze the handles and create undue stress on the root and facial bone. To use this instrument properly, we must remind ourselves not to treat the instrument like a conventional forceps to achieve success.[38]

Kumar MP in 2015 in his article reviewed and discussed new techniques to make simple and complex exodontias more predictable and efficient with improved patient outcomes. Which included physics forceps, powered periotome, piezosurgery, benex extractor, Sonic instruments for bone surgery and lasers.[39]

In dentistry, the physical change of expanding the dental alveolar bone (socket) along with the severing of the periodontal ligament is the basis of tooth extraction. Although this does happen, it is more important to understand what is occurring biochemically

with the tooth and its socket. When the periodontal ligament is traumatized with forces or elevators, hyaluronidase (hyluronate glycanohydrolase) is released. This is an enzyme that catalyzes the hydrolysis of the interstitial barrier, hyaluronan (hyaluronic acid). The tooth is released from its attachment to the alveolus and can be removed, once chemical breakdown of the periodontal ligament by hyaluronidase occurs. The physics forceps applies a steady rotational trauma to the periodontal ligament quantitatively creating a release of hyaluronidase in a shorter period of time than traditional forceps or elevator extractions because the trauma from these conventional techniques is intermittent. As a result, the physics forceps technique is more efficient, faster, and less traumatic to the alveolar bone than conventional methods.[39]

El-Kenawy MH and Ahmed WM in 2015 conducted a study to evaluate the efficacy of physics forceps versus conventional forceps in simple dental extraction. 200 adult patients seeking simple dental extraction were selected and were randomly allocated into two groups: group I: included 100 patients where extraction was done using physics forceps, and group II: included 100 patients and extraction were done using conventional forceps. In physics forceps group: crown fracture occurred in three cases (3 %), buccal bone fracture occurred in three cases (3 %), and root fracture occurred in 14 roots (8.5 %), while in conventional forceps group: crown fracture occurred in 10 cases (10 %), buccal bone fracture occurred in seven cases (7 %), and root fracture occurred in 27 roots (16.6 %).The difference between the two groups was statistically significant for crown fracture ($p = 0.04$) and root fracture ($p = 0.027$), while it was not significant for bone plate fractures ($p = 0.19$). They concluded that physics forceps are

innovative extraction instruments. By using them, it is possible to perform difficult extractions, with predictable results, and without need to reflect a flap. Using physics forceps decreases the incidence of crown, root, and buccal bone plate fractures, in comparison to the conventional forceps.[7]

Madathanapalli S et al in 2016 conducted a study and compared the physics forceps with the conventional forceps for the removal of maxillary first molars in 30 patients under the following parameters: time taken, postoperative pain on 3rd,5th and 7th day, incidence of crown/root/buccal plate fracture during extraction. There was a significatnt difference pertaining to the time taken (p=0.006) and pain on 3rd postoperative day (p=0.031). There were no other significant differences between the groups in any other variable studied. On comparing all of the aforementioned parameters, they have found that the utility of the instrument is better in comparison to the conventional forceps.[40]

Mandal S et al in 2016 conducted a study on physics forceps where they investigated and compared the prevalence of complication (laceration of soft tissue) and time taken for a simple tooth extraction with the help of a universal extraction forceps and physics forceps for mandibular single rooted tooth. They organized a randomized controlled trial to compare the outcomes of two groups (n= 50 mandibular single rooted teeth). The physics forceps had lower time coefficient (Mean:1.868 with SD 1.503), and when laceration was compared among two groups, the p value came to be 0.032. They concluded that physics forceps is more time efficient and decreases the incidence of laceration when compared to universal extraction forceps.[41]

Patel HS et al in 2016 in their study compared the efficacy of physics forceps with conventional forceps in terms of operating time, prevention of marginal bone loss & soft tissue loss, postoperative pain and postoperative complications following bilateral premolar extractions for orthodontic purpose. In this prospective split-mouth study, outcomes of the 2 groups (n = 42 premolars) requiring extraction of premolars for orthodontic treatment purpose using physics forceps and conventional forceps were compared. Clinical outcomes in form of time taken, loss of buccal soft tissue and buccal cortical plate based on extraction defect classification system, postoperative pain and other complication associated with extraction were recorded and compared. Statistically significant reduction in the operating time was noted in physics forceps group with p=0.019. Marginal bone loss and soft tissue loss was also significantly lesser with p=0.037 and p=0.035 respectively in physics forceps group when compared to conventional forceps group. However, there was no statistically significant difference in severity of postoperative pain between both groups. The results of the present study suggest that physics forceps was more efficient in reducing operating time and prevention of marginal bone loss & soft tissue loss when compared to conventional forceps in orthodontically indicated premolar extractions.[42]

Rajvanshi H et al in 2016 in their review had described a number of instruments and techniques being employed by clinicians for performing extraction of teeth. Physics forceps uses the “Beak and Bumper” design acting as a Class 1 lever. It functions by application of opposing forces. One force is applied with the beak of the forceps on the lingual aspect of the tooth/root. The second force, the bumper of the forceps is placed on the alveolar ridge below the mucogingival junction. The handles (once in

position) are rotated as one unit for a few degrees, and then the action is stopped for few seconds. During this period, deformation (creep) of the bone and periodontal ligament occurs. This allows socket expansion. Once creep has expanded and weakened the periodontal ligament and bone, the handle of the extraction device may be slowly rotated another few degrees for 10 to 30 seconds. This action contributes to the creep, rupture of the ligament and usually elevates the tooth a few millimeters from the socket. At this point the tooth is loose and ready to be removed from the socket using conventional forceps. It is claimed that as minimal force is placed on the beak, the tooth does not split, crush or fracture. Any tooth (except impacted) can be removed by this technique.[43]

Sonune AM et al in 2017 conducted a study with aim to evaluate the efficacy between the conventional extraction forceps and physics forceps in orthodontic extraction of maxillary premolars. They conducted the study on 50 healthy patients indicated for extraction of bilateral maxillary premolar for orthodontic reasons; split mouth design (control side, test side) in a randomized manner. The results of the study showed that the ease of technique, buccal cortical plate fracture, fracture of tooth or root, gingival laceration, soft tissue healing was not significant. While the extraction time and bleeding associated with extraction socket were significant. Pain on VAS score was not significant on post operative days 1-4 and on days 5-7 pain was 0.The results of present study suggested that, extraction using any forceps can produce predictable results and it totally depends on surgeon’s expertise in a particular technique.[44]

MATERIALS AND METHOD

SOURCE OF DATA:

A prospective, randomized, double-blind study was carried out on 100 patients reporting to the Department of Oral and Maxillofacial Surgery over the period of 18 months.

TIME PERIOD OF STUDY:

1st January 2016 to 30th June 2017.

SAMPLE SIZE:

100 patients visiting to the Department of Oral and Maxillofacial Surgery for tooth extraction procedure under inclusion criteria were included in the study.

INCLUSION CRITERIA:

- Patients in the age group of 18-60 years.
- Mandibular first and/or second molar tooth indicated for extraction under local anesthesia.
- Patient in good health.
- Subjects of both the gender.

EXCLUSION CRITERIA:

- Grossly decayed tooth/ root pieces.
- Periodontally compromised tooth (Grade II/III mobility).
- Existing moderate or severe infection.
- Medically compromised patients.
- Patient with known allergy to local anesthetic agent.
- Mentally challenged patients.
- Patient not willing to give informed consent.

SAMPLING TECHNIQUE:

100 patients visiting Oral and Maxillofacial Surgery department for tooth extraction procedure under the inclusion criteria were divided into two groups i.e. group A and group B. Randomization was done by lottery method. In group A patients, mandibular first and/or second molar was extracted using physics forceps while conventional extraction forceps was used in group B patients. All extractions were performed by the same operator.

PREOPERATIVE PROCEDURE:

A complete case history was recorded preoperatively using a standard case history proforma (Annexure I). Case history included a systematic documentation of patient's medical history and history of allergy (particularly in relation to local anesthesia).

Clinical examination was done and intraoral periapical radiographs of the tooth to be extracted were taken prior to the procedure to ensure that the tooth indicated for extraction was not periodontally compromised or having any periapical infection, if present then these patients were excluded from the study.

Routine investigations like recording of blood pressure, hematological assessments such as random blood sugar levels, bleeding time, clotting time etc. were carried out and in case if the values of these assessments were not within the normal range, subjects were excluded from the study.

The entire procedure, nature of study, benefits and pitfalls associated were explained to the patient in detail in the language understood by the patient. The patient was also explained about the visual analog scale and how to record pain scores on assessment form. (Annexure II).

Signatures/thumb impression of the patient, witness and investigator were taken thereafter on the consent forms (Annexure III).

MATERIALS USED:

1. Diagnostic instruments- Mouth mirror, straight probe, tweezer.

2. Luer lock (Unolok) - 2ml disposable syringes, needle size- 0.45 X 38 mm.

3. LOX 2%, lignocaine hydrochloride with 1:2,00,000 adrenaline available in 30ml vials, manufactured by Neon Laboratories Limited.

4. Physics forceps for mandibular molar extraction.

5. Standard exodontia armamentarium for mandibular molar extractions.

6. Stop watch

7. Gloves

8. Gauze pieces

9. Emergency drug kit.

10. Pre printed case history proforma and assessment form.

OPERATIVE PROCEDURE:

After explaining the procedure to the patient, the surgical site was painted with 5% povidone iodine solution and draped, the inferior alveolar nerve block was given using lignocaine 2% with adrenaline 1:200000 units (Neon Laboratories Limited) as local anesthetic solution. The stopwatch was set before application of forceps to the tooth.

In group A patients extraction was carried using the mandibular physics forceps following the complete onset of anesthesia. The beak of the forceps was placed over the lingual surface of mandibular molar in the lingual groove at the level of or below the cemento-enamel junction, while the bumper covered with rubber guard was placed buccally perpendicular to the tooth and at the level of mucogingival junction. A gentle

and steady rotational force was applied buccally through a small amount of wrist movement without squeezing the handles of the forceps until the tooth became loose. The tooth was grasped with hemostat or conventional forceps to deliver it out.

In group B patients extraction was done using conventional mandibular molar forceps. After the adequate anesthesia was achieved, the soft tissue surrounding the tooth was reflected using a moons probe. The beaks of the conventional molar forceps were opened wide and were placed in position over the buccal and lingual aspect. The beaks were placed at the level of or below the cemento-enamel junction. A firm grasp was taken and the alveolus was supported with fingers of the operator over the buccal and lingual aspect. A gentle and steady force was applied, first in the buccal direction and then in the lingual direction. The tooth was delivered out using the same forceps once it became loose in the socket.

The timer was stopped as the tooth was luxated completely out of the socket. In both the groups socket was left open without placement of sutures. After the procedure was carried out, the observer who was unaware of the forceps used for extraction assessed the tooth extracted and socket to evaluate the operative complications. The time required during extraction of tooth was also noted.

The entire procedure was done by a single operator under strict asepsis. After adequate hemostasis was achieved, all the patients were given standard postoperative instructions and were prescribed the following medications:

- Cap. Amoxicillin 500 mg (Cap. Almox 500, Alkem Laboratories Limited) thrice a day, for 5 days.

- Tab. Aceclofenac 100 mg and Parecetamol 325 mg combination (Tab. Zerodol-P, Ipca Laboratories Limited) twice a day, for 5 days.
- Tab. Ranitidine 150 mg (Tab. Rantac 150, J.B Chemicals and Pharmaceuticals Limited) twice a day, for 5 days.

The standard post extraction instructions were explained to the patient following the extraction.

POST-OPERATIVE FOLLOW UP:

The patients were recalled for post operative follow up on 1st, 3rd, 7th and 21st post extraction day and post operative pain and complications such as dry socket, delayed healing, post-operative infection, soft tissue injuries (ulceration) were assessed by the same observer, who evaluated the operative complications.

METHOD OF DATA ANALYSIS:

- 100 patients were assessed during extraction, immediately after extraction and on 1st, 3rd, 7th and 21st post extraction day following extraction of mandibular first or second molar. Parameters such as duration of operation, operative complications i.e. incidence of incomplete removal of root, fractured alveolus and soft tissue injuries (laceration), post-operative complications i.e. dry socket, delayed healing, post-operative infection, soft tissue injuries (ulceration) and pain were evaluated between physics forceps and conventional extraction forceps.

ASSESSMENT OF DURATION OF OPERATION:

The duration of operation was noted from the beginning of the extraction; after confirmation of onset of anesthesia and from the time of application of forceps to the completion of extraction and was measured in unit seconds using a stopwatch.

ASSESSMENT OF OPERATIVE COMPLICATIONS:

1: INCIDENCE OF INCOMPLETE REMOVAL OF ROOT:-

Incidence of incomplete removal of root was assessed clinically by the observer who was unaware of the forceps used for the extraction procedure. It was evaluated as present or absent and was rated as 1 or 0 respectively.

2: FRACTURED ALVEOLUS:-

The alveolus as well as the tooth roots were examined by the observer to evaluate the fracture of buccal cortex after tooth extraction as present or absent and was rated as 1 or 0 respectively.

3: SOFT TISSUE INJURIES (LACERATION):-

The soft tissue was assessed immediately after extraction of tooth. If soft tissue injury (laceration) was present it was rated as 1, if absent then 0.

ASSESSMENT OF POST OPERATIVE COMPLICATIONS:

1: DRY SOCKET:

Patient was examined on the 3rd post extraction day to assess the presence or absence of dry socket which was rated as 1 or 0 respectively.

2: DELAYED HEALING:

Healing was considered to be delayed if there was incomplete soft tissue coverage over the extraction socket within 21 days post operatively[14] and was rated as 1 if present and 0 if absent.

3: POST OPERATIVE INFECTION:

The presence of any redness, drainage of pus and swelling was considered as infection during post extraction follow up period and was rated as 1 if present and 0 if absent.

4: SOFT TISSUE INJURIES (ULCERATION):

Extraction site as well as attached gingiva and mucogingival junction over the buccal aspect were examined by the observer for the presence of any ulceration which was rated as 1 if present and 0 if absent.

ASSESSMENT OF POST OPERATIVE PAIN:

Pain perception was assessed with the help of a simplified visual analog scale (VAS)[19,20] which was explained to the patient pre extraction and post extraction The patient was asked to rate the intensity of pain by marking a X on a 10 point VAS. These measurements were done on 1st, 3rd and 7th post-extraction day. On VAS, 0 indicated no pain, 1-3 mild pain, 4-6 moderate pain, 7-9 severe pain whereas 10 indicated worst possible pain (Figure 6).

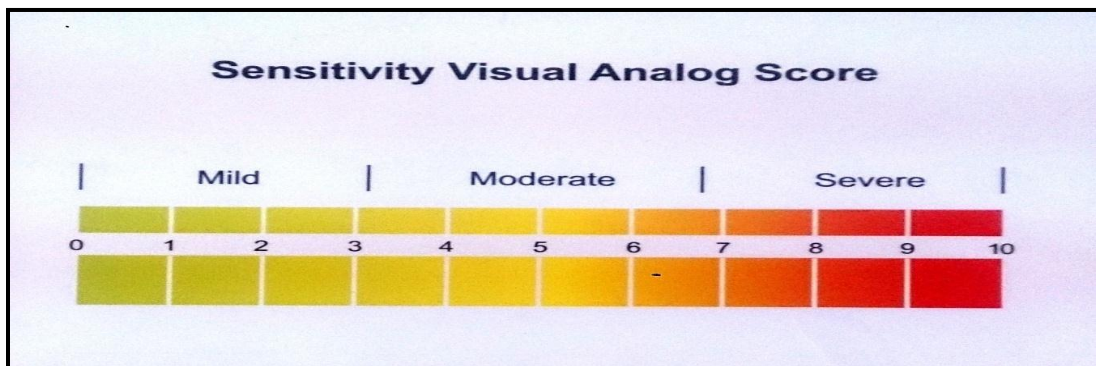

Figure 6: Visual Analog Scale

STATISTICAL ANALYSIS:

The demographic data obtained on patients in two groups was expressed in terms of numbers and percentage; and compared using Pearson's Chi-square test. The mean, SD and median of age of patients in two groups were also obtained. The distribution of extracted tooth in each group was obtained and compared using Pearson's Chi-square test. The mean, SD and median of time required for extraction of tooth were obtained for each group and compared using Wilcoxon rank sum test. Each operative complications i.e. incidence of incomplete removal of root, fractured alveolus and soft tissue injuries (laceration) in two groups was compared using Chi-square test. Further, post-operative complications i.e. dry socket, delayed healing, post-operative infection, soft tissue injuries (ulceration) were also compared between two groups using Chi-square test. The pain measured in terms of VAS score on 1st, 3rd and 7th post-operative day was compared between two groups using Wilcoxon rank sum test. Further, the pain across times in each group was compared using Friedman ANOVA.

All the analyses were performed using SPSS version 20.0 (IBM Corp) and statistical significance was tested as 5% level.

PLATE I

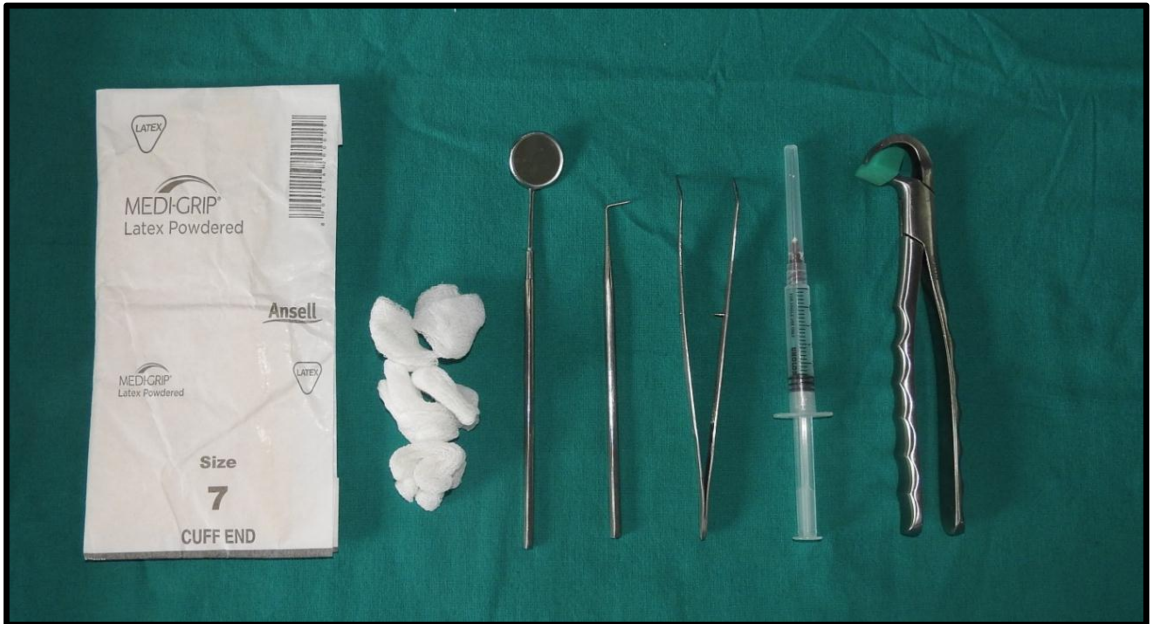

Figure 7: Armamentarium used for extraction in group- A

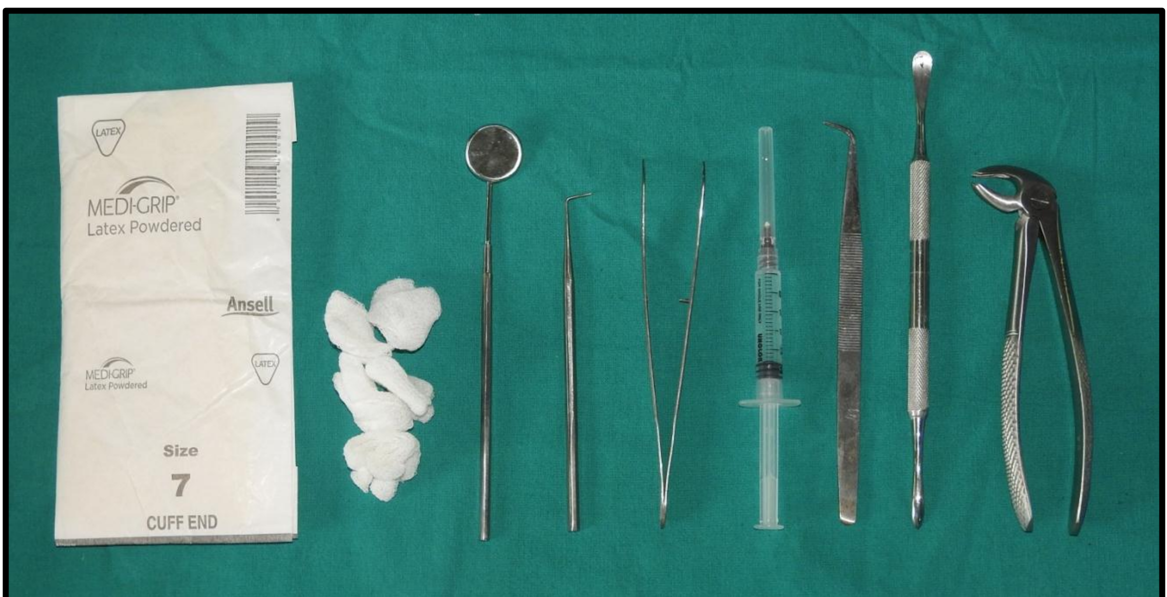

Figure 8: Armamentarium used for extraction in group- B

PLATE II

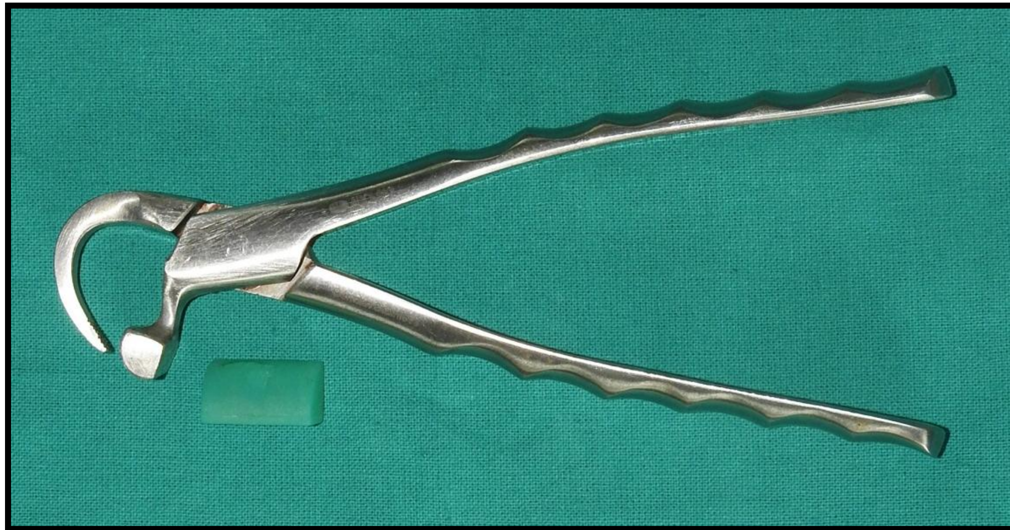

Figure 9: Mandibular physics forceps

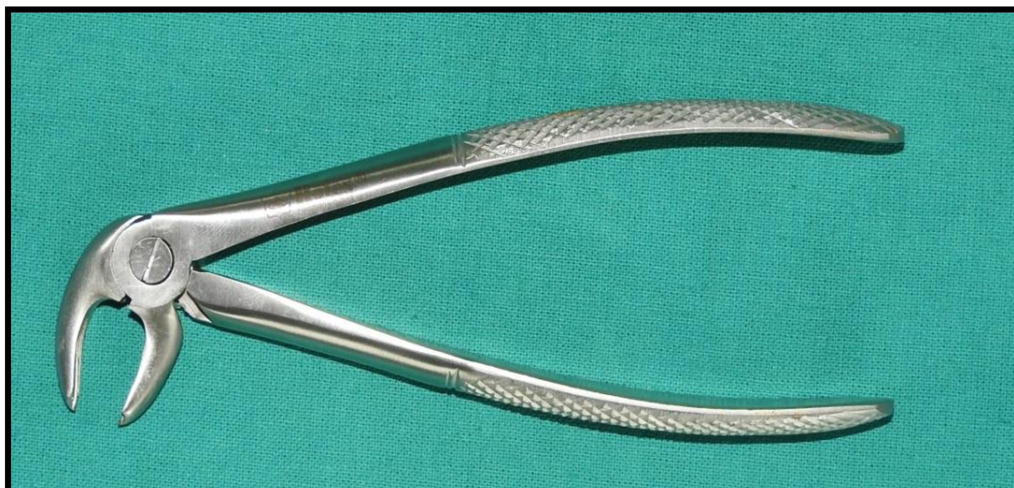

Figure 10: Conventional mandibular molar forceps

PLATE III

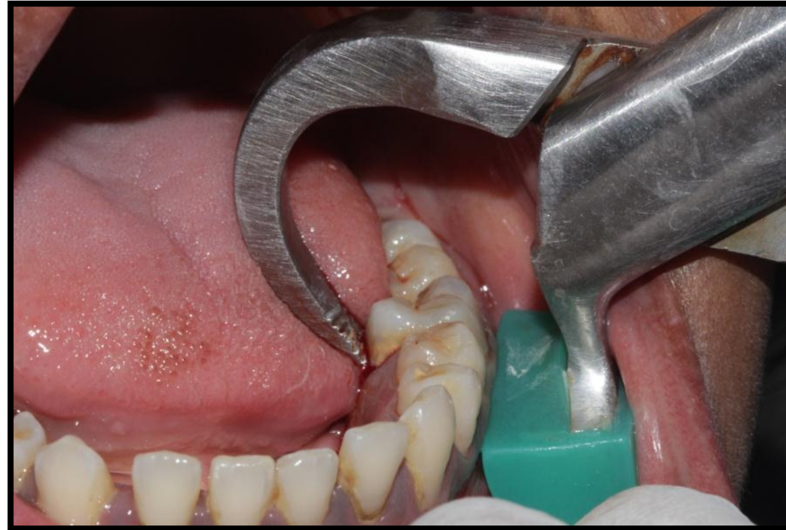

Figure 11: Application of physics forceps on mandibular first molar.

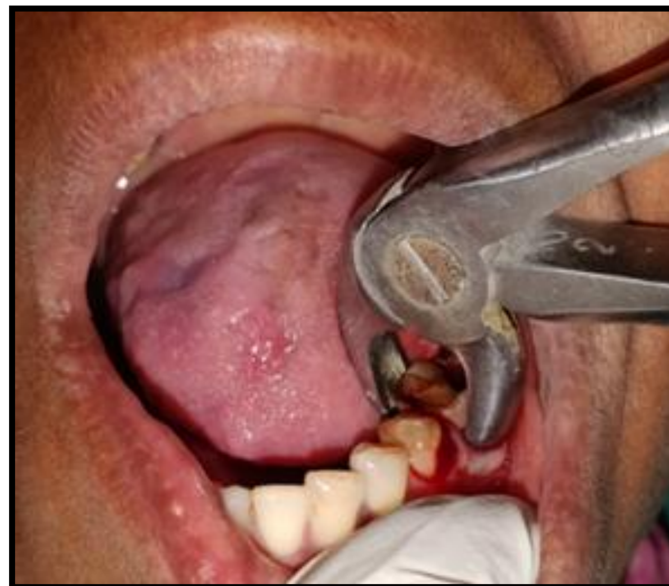

Figure 12: Application of conventional mandibular molar forceps on mandibular first molar.

PLATE IV

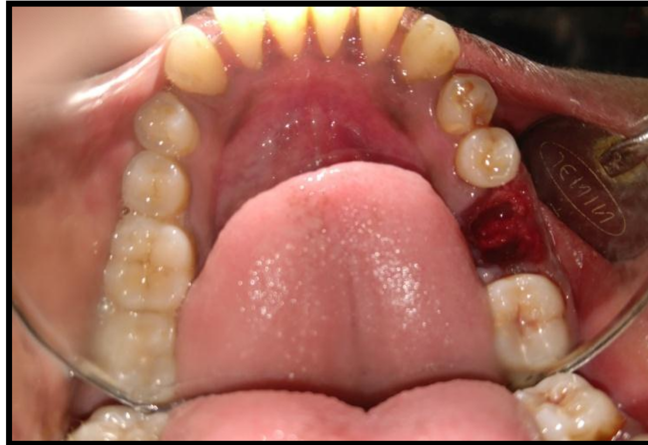

Figure 13: Intact extraction socket after tooth extraction with physics forceps.

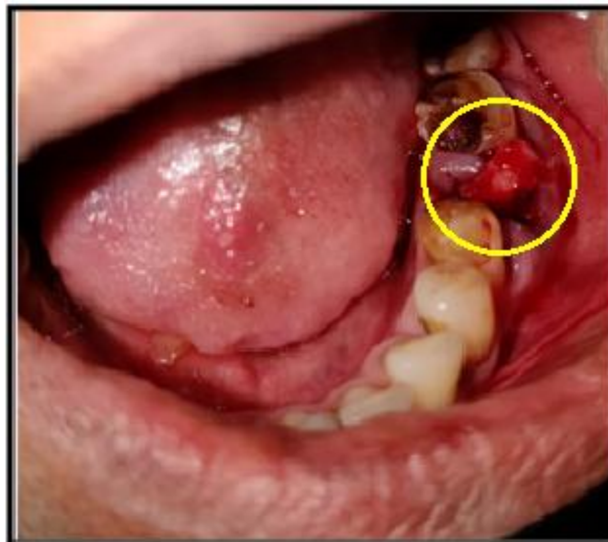

Figure 14: Fractured buccal cortical plate after extraction with conventional mandibular molar forceps.

RESULTS

This prospective, randomized, double-blind study was carried out on 100 patients reported to the Department of Oral and Maxillofacial Surgery for tooth extraction procedure under inclusion criteria, over the period of 18 months i.e. from 1st January 2016 to 30th June 2017. The patients were randomly divided into two groups of 50 patients each. In study group, mandibular first and/or second molar was extracted using physics forceps while conventional extraction forceps was used in control group. All extractions were performed by the same operator.

Table 1 provides the distribution of patients as per age in two treatment groups. The group in which physics forceps was used, the maximum i.e. 16 (32%) were in the age range of 31-40 years, followed by 15 (30%) in the range 41-50 years and 14 (28%) in the range 21-30 years. In the group operated with conventional forceps, there were 15

(30%) patients each in the age range of 21-30 years and 31-40 years, while 13 (26%) were in the age range of 41-50 years. The difference in the age distribution of patients in two groups was statistically insignificant as indicated by p-value of 0.95 using Pearson's Chi-square test. The mean age in physics forceps group was 36.38 ± 9.94 years, while in conventional forceps group was 36.42 ± 11.52 years. A graphical representation of the distribution is illustrated through column chart in Figure 16.

Table 2 provides the distribution of patients according to gender in two treatment groups. In physics forceps group, the distribution was symmetrical, while in conventional group, there were 22 (44%) males and 28 (56%) females. The distribution was insignificantly different in two groups as indicated by p-value of 0.688, obtained using Chi-square test. Figure 17 illustrates graphical representation of distribution of patients according to gender through column chart.

Table 3 gives the distribution of extracted tooth in two treatment groups. The difference in the distribution of extracted tooth between two groups was statistically insignificant as indicated by p-value of 0.8129 using Pearson's Chi-square test. A graphical visualization of the distribution is depicted in Figure 18.

Table 4 gives the descriptive statistics for time required for extraction using physics forceps and conventional forceps. The mean time required using physics forceps was 55.10 ± 16.42 seconds, while that of conventional forceps was 83.46 ± 27.31 seconds. The difference between the mean time required was compared using Wilcoxon rank sum test and was statistically highly significant with p-value < 0.0001. A graphical representation of the means is depicted through column chart in Figure 19.

Table 5 depicts the number of operative complications in two groups. It is evident from the table that the number of each type of operative complication i.e. incidence of incomplete removal of root, fractured alveolus and soft tissue laceration, are less in the group operated with physics forceps as compared to conventional forceps. However, the difference in the proportion of complications between two groups was found statistically insignificant as indicated by p-values more than 0.05 calculated using Chi-square test. Figure 20 provides the column chart representation giving number of complications in each group.

Table 6 provides the number of post-operative complications in two study groups. It is evident from the table, there were 3 (6%) cases of delayed healing in physics forceps group, while 4 (8%) in conventional forceps group. The difference in the proportions was statistically insignificant as indicated by p-value of 0.99. Similarly, there were 2 (4%) cases of post-operative infection in physics forceps group, while 3 (6%) in conventional forceps group, the difference was statistically insignificant with p-value of 0.99. As regards to soft tissue ulceration, there were 7 (14%) cases of soft tissue ulceration in physics forceps group, while 3 (6%) in conventional forceps group. The difference of proportions was statistically insignificant with p-value of 0.3173. Post operative complications between two groups were compared using Chi-square test. Figure 21 represents the post-operative complications through a column chart.

Table 7 is a depiction of the descriptive statistics for pain scores obtained at different time points after extraction for both physics forceps and conventional forceps groups. The analysis was performed at each day between groups. At 1st post-operative day, the difference in the VAS scores was statistically significant as indicated by p-value

of 0.0008 using Wilcoxon rank sum test. The mean for conventional forceps group was significantly higher than physics forceps group. However, at 3rd post-operative day, the difference in the VAS scores was statistically insignificant with p-value of 0.1356. On 7th post-operative day, none of the patients from both the group complained of pain.

Also the pain across times in each group was compared using Friedman ANOVA. In the group operated with physics forceps, the mean VAS score at 1st post-operative day was 1.94 with median of 2.0. The mean reduced to 0.22 at 3rd post-operative day. Further at 7th day, the mean score was 0. The change in the VAS score distribution with time was statistically highly significant as indicated by p-value < 0.0001 using Friedman ANOVA. Similarly, in conventional forceps group, the mean VAS score on 1st post-operative day was 2.7, with a median of 2.0. Subsequently, on 3rd day, the mean reduced to 0.42 and then on 7th day to 0. The change in the VAS score distribution with time was statistically highly significant as indicated by p-value < 0.0001 using Friedman ANOVA. A line plot showing the mean VAS scores with time in two groups is illustrated in Figure 22.

DISCUSSION

An ideal tooth extraction may be defined as the painless removal of the whole tooth or tooth root with minimal trauma to the investing tissues, so that the wound heals uneventfully and no post-operative prosthetic problem is created.[1]

Exodontia is a basic procedure taught to all trainees in dental school and most commonly practiced by general clinicians. Due to high success rate and more predictability of implant dentistry, teeth with questionable prognosis are now extracted for implant placement instead of salvaging them through intense endodontic or periodontic procedures. Therefore good skill in basic and complex exodontia is necessary for well-trained dentists to be clinically involved in this aspect of practice.[2]

PRINCIPLE OF SIMPLE EXTRACTION:

A great deal of finesse and controlled force are requisite for a simple tooth extraction. If in a situation surgeons have to apply a significant degree of force to deliver a certain tooth, they must stop and reassessment is required before resuming.[4]

The process of a simple tooth extraction involves minor expansion of the alveolar bone, severance of the periodontal ligament (PDL), and finally delivery of the tooth with coronal forceps. Various factors on which successful tooth extractions relies are surgeon's detailed and thorough understanding of the tooth anatomy, the root form, curvature and angulations, attachment of the tooth to the periodontium, and the underneath bony structure.[4]

Surgeon's tactile sense enhances with experience and will be able to appreciate the force applied over the tooth's roots and its effects on the alveolar bone. This leads to prevention of any excessive forces that would result into root and alveolar bone fractures.[2]

Positioning of the patient in the dental chair is very important to allow for the operator's optimal accessibility and visibility. The patient's mandible should be positioned parallel with the floor while extractions in the lower arch are being performed. Then the height of the patient should be adjusted such that to allow the mandible to be positioned at the operator's resting elbow level so that when the extraction is being performed, the operator's forearm remains parallel with the floor. Use of appropriate instrumentation facilitates the procedure and makes it more predictable. The operator starts the tooth extraction by separating the superior part of the periodontal ligament and then luxating the tooth with an elevator. Selection of

appropriate forceps is essential for grasping the cervical portion of the tooth and positioning it as apically as possible in order to move the center of rotation towards the root. This placement of the forceps allows for the most efficient alveolar bone expansion and prevention of the fracture of crown or roots at the same moment. Sharp instruments i.e. forceps and elevators are always more advantageous to use since they engage the tooth in a more firm manner, delivers efficient forces and prevents slippage of instrument.[2]

Due to the density of bone in the posterior mandible, root form of lower molars and proximity to vital anatomic structures, extraction of lower molars could be the most demanding procedure in the mouth. Among conventional forceps, a number 151 lower universal forceps is best suited. Cowhorn forceps number 23 are also used for mandibular molar extraction where the beaks are allowed to seat into the furcation with very gentle digital pressure. Once the beaks are seated into the furcation, handles of the forceps are approximated. This process leads to coronal luxation of the tooth followed by simple delivery. Great attention must be given by the operator to prevent any damage to the soft tissue adjacent to the extracted tooth. Bone resorption after tooth extraction is a well-documented phenomenon which further increases if tooth is not replaced. So any traumatic extraction should be avoided in order to prevent further bone remodeling and eventually more bone resorption. In situations, the surgeon expect a traumatic extraction along with excessive bone removal, then the need for socket preservation and augmentation procedures by the various grafting techniques should be explained to the patient.[2]

In recent years the importance of atraumatic removal of teeth has increased, especially in view of placement of immediate dental implants and may become the standard technique for teeth removal in due course of time.[9]

Atraumatic extraction prevents damage to the bone and preserves periodontal architecture that allows for an option of future or immediate dental implant placement. For minimally invasive tooth removal, various tools and techniques have been proposed, such as periotomes, powertome, proximators, benex extractor and physics forceps.[7]

The most recent innovation in dental extraction expertise is the physics Forceps. They provide an effective means for atraumatic dental extraction procedure. Physics forceps was invented by Dr. Richard Golden in year 2004, and have further evolved into their current ‘beak and bumper’ design.[9]

PRINCIPLE OF PHYSICS FORCEPS:

The physics forceps have an innovative design of combination of beak and bumper which allows for atraumatic extractions in a more effective manner using wrist movement acting on class I lever principle. This technique eliminates the requirement of the forceps, such as to firmly grasp, rock, push, pull and twist with your arm. When physics forceps is used initially, a conscious endeavor must be made to retrain your hands to avoid squeezing and pulling of the instrument with the arm. This can be a major obstacle in being successful with this technique, but once it is overcome, there are unlimited advantages of the physics forceps.[31]

The physics forceps acts on the principle of class I lever, where single force is applied on the lingual aspect of the tooth or tooth root with the beak. Once the beak is positioned, the bumper is placed over the alveolar ridge in the region of the mucogingival junction to balance the beak. The beak grasps the tooth over lingual aspect, while the bumper acts as the fulcrum and provides stability and leverage to the beak.[31]

Once the instrument is appropriately positioned, maximum leverage must be obtained by placing the operator's hands (or fingers) loosely towards the end of the handles. This can be achieved by simply placing two fingers or any other similar position where the operator feels comfortable while holding the instrument, as long as operator is not squeezing the handles. After the proper placement of the instrument, slow pressure is applied using only wrist movement.[31]

A steady and gentle pressure is applied over the buccal aspect using only wrist movement. During this period (approximately 30 seconds) the internal force or "creep" will build up which allows the bone to expand slowly and the periodontal ligament liberates and at this point the tooth will disengage from the socket (known as the "pop"). The buccal rotation of the tooth is successful only by rotating the wrist.[31]

It is generally understood that the physical change of expansion of the dental alveolar bone along with the severance of the periodontal ligament is the basis of tooth extraction. Although this happens, but it is more essential to understand what occurs biochemically with the tooth and its socket. Trauma to the periodontal ligament with forceps or elevators, leads to release of hyaluronidase (hyluronate glycanohydrolase).

Hyaluronidase is an enzyme that catalyzes the chemical breakdown of the interstitial barrier hyaluronan (hyaluronic acid), which is a cement substance (extracellular matrix) of all human tissues. Once the hydrolysis of the periodontal ligament by hyaluronidase occurs, tooth is released from its attachment to the bony alveolus and can be extracted.[31]

Once the tooth has been disengaged from the alveolar socket, another instrument of choice (eg, rongeurs, haemostat) or fingers can be utilized to remove the tooth.[31]

The biomechanical advantage created by the physics forceps makes them a very efficient set of instruments.[31]

Figures 15: Two suggested hand positions- lower physics forceps.[31]

Physics Forceps utilizes the biomechanical principles of a first class lever, favorable stress distribution and creep. The application of the physics forceps involves 6 steps: (1) separation of the attachment of marginal gingiva from the tooth; (2) positioning of the 'beak' onto a secure palatal/lingual application point (root surface); (3) positioning of the 'bumper' (with rubber sleeve attached) onto the buccal aspect of the alveolus at the level of the mucogingival junction (this acts as a fulcrum; support and protects the buccal plate); (4) application of a steady slow rotational force using only

wrist movement (facilitates creep in the periodontium); (5) elevation of the tooth a few millimetres occlusally from its socket; (6) delivery of the tooth using a conventional forceps /haemostat/rongeurs.[9]

In our study we aimed to compare the efficiency of physics forceps and conventional extraction forceps in extraction of mandibular first and/or second molar. A prospective, randomized, double-blind study was carried out on 100 patients reported to the Department of Oral and Maxillofacial Surgery for tooth extraction procedure under inclusion criteria, over the period of 18 months. The patients were randomly divided into two groups of 50 patients each. In study group patients, mandibular first and/or second molar was extracted using physics forceps while conventional extraction forceps was used in control group patients.

The demographic data obtained on patients in two treatment groups was expressed in terms of numbers and percentage. Also the mean, SD and median of age of patients in two groups were obtained. The difference in the age distribution of patients in two groups was statistically insignificant as indicated by p-value of 0.95 using Pearson's Chi-square test. The mean age in physics forceps group was 36.38 ± 9.94 years, while in conventional forceps group was 36.42 ± 11.52 years, as given in Table 1. A graphical representation of the distribution is illustrated through column chart in Figure 16.

The distribution of patients according to gender in two treatment groups is provided in Table 2. In physics forceps group, the distribution was symmetrical, while in conventional group, there were 22 (44%) males and 28 (56%) females. The

distribution was insignificantly different in two groups as indicated by p-value of 0.688 was obtained using Chi-square test. Figure 17 illustrates graphical representation of distribution of patients according to gender.

The difference in the distribution of extracted tooth between two groups was statistically insignificant as indicated by p-value of 0.8129 using Pearson's Chi-square test, given in Table 3. A graphical visualization of the distribution is depicted in Figure 18.

In our study the mean time required using physics forceps was 55.10 ± 16.42 seconds, while that of conventional forceps was 83.46 ± 27.31 seconds. The difference between the mean times required was compared using Wilcoxon rank sum test and was statistically highly significant with p-value < 0.0001 (Table 4). A graphical representation of the means is depicted through column chart in Figure 19.

Similar results were found in study conducted by **Patel HS et al[42] (2016)**, where they conducted study on orthodontic extractions of premolars and concluded that the mean time taken for extraction using physics forceps was 58.8 (±48.13) seconds while that with conventional forceps were 88.33 (±37.59) seconds and the difference was found statistically significant with $p < 0.05$.

Also a study conducted by **Madathanapalli S et al[40] (2016)** had shown a significant difference between mean times taken for extraction using physics forceps and conventional forceps.

Studies conducted by **Hariharan S et al[12] (2014), Mandal S et al[11] (2015)** and **Mandal S et al[41] (2016)** had concluded that time taken by physics forceps is lesser as

compared to conventional forceps but the difference was not statistically significant. While on contrary, study conducted by **Sonune AM et al**[44] **(2017)** concluded that mean time taken for extraction by conventional forceps was 19.42 seconds which was found to be significantly lesser as compared to physics forceps (33.64 seconds).

Various operative complication i.e. incidence of incomplete removal of root, fractured alveolus and soft tissue laceration were assessed in our study, given in Table 5. It is evident from the table that the number of each type of operative complication are less in the group operated with physics forceps as compared to conventional forceps. However, the difference in the proportion of complications between two groups was found statistically insignificant as indicated by p-values more than 0.05 calculated using Chi-square test.

Usually the root fracture occurs in cases where roots may be dilacerated or unfavorable in form. In our study 4 (8%) cases of root fracture occurred with the use of physics forceps and 6 (12%) with application of conventional forceps. However, the difference between two groups was found statistically insignificant.

Similar inferences were found in studies conducted by **Hariharan S et al**[12] **(2014), Patel HS et al**[42] **(2016)** and **Madathanapalli S et al**[40] **(2016),** where they concluded that number of cases of root fracture were lesser in physics forceps group as compared to conventional forceps group, but the difference was not statistically significant.

El-Kenawy MH, Ahmed WM[7] **(2015)**, in their study concluded that there was significant difference (p = 0.027) between the two groups since roots fracture

occurred in 41 cases of which 14 (8.5 %) occurred in physics forceps group while 27 (16.6 %) in conventional forceps group.

Conversely, results of the study conducted by **Sonune AM et al[44] (2017)** shows higher number of root fracture cases with physics forceps as compared to conventional forceps, but the difference was not statistically significant.

The cortical plates along with alveolus form a casing which holds the tooth. In the mandible there are buccal/labial as well as lingual cortical plates. For an atraumatic dental extraction, it is desirable that both the cortical plates should be intact. Studies conducted by **El-Kenawy MH, Ahmed WM[7] (2015) and Madathanapalli S et al[40] (2016)** concluded that cases of fractured alveolus were lesser in physics forceps group in comparison with conventional forceps group but the difference was statistically insignificant.

In our study we found 3 (6%) cases of fractured alveolus in physics forceps group and 7 (14%) in conventional forceps group. However, the difference between two groups was found statistically insignificant. The reason of lesser number of cases of fractured alveolus found in physics forceps group is the biomechanics and design of the forceps. The force applied in the region of mucogingival junction and over the bone by the bumper is a compressive force and is applied over a greater surface area thus braces the buccal bone. This mechanism permits the lingual plate to expand and protects the buccal plate from fracture.

A significant difference was noted between two groups in study conducted by **Mandal S et al**[11] **(2015)** where 12 subjects reported with a cortical plate fracture in conventional forceps group while no cases were found in physics forceps group.

On the contrary, in the study conducted by **Patel HS et al**[42] **(2016)**, 2 cases of fractured alveolus were found in physics forceps group and no case was noted in conventional forceps group. The difference was statistically insignificant.

For an effective tooth extraction, marginal gingiva surrounding the tooth has to be separated from the tooth and the alveolar bone for the application of beaks of the forceps. Laceration of the gingiva can result while reflection, placement of beaks or during movement of forceps. In our study we found that only 3 (6%) cases were noted with soft tissue laceration in physics forceps group while 6 (12%) in conventional forceps group. The difference between the groups was statistically insignificant.

A study done by **Mandal S et al**[11] **(2015)** concluded that lesser number of subjects i.e. 3 cases reported laceration with the use of physics forceps as compared to 11 subjects in the conventional forceps group while extraction of mandibular multi-rooted teeth. A significant association was found between the groups. Similarly a significant difference was found in the other study conducted by **Mandal S et al**[41] **(2016)** over mandibular single-rooted teeth.

Higher number of cases of soft tissue laceration was noted in conventional forceps group. During tooth extraction, the beaks of the conventional forceps are placed in the gingival sulcus after separating the marginal gingiva, which results in soft tissue

damage. On the other hand the bumper of physics forceps is applied at the mucogingival junction, which prevents the marginal gingiva from laceration.

Figure 20 provides the column chart representation of each operative complication i.e. incidence of incomplete removal of root, fractured alveolus and soft tissue laceration in both the groups.

Post operative complications such as dry socket, delayed healing, post operative infection and soft tissue ulceration were also recorded in our study. Table 6 provides the number of post-operative complications in two study groups. There was no difference between the groups on the basis of dry socket as none of the patients from both the groups reported with dry socket. Similar results were found in the studies conducted by **Hariharan S et al**[12] **(2014)** and **Sonune AM et al**[44] **(2017)** as no case of dry socket was noted.

Amler MH et al[14] **in (1960)** conducted a histochemical and histological study on undisturbed alveolar socket healing, using post extraction biopsies from normal human tissues at 2-3 day intervals over a period of 50 days. They stated that replacement of blood clot by granulation tissue occurs at seventh day and evidence of epithelium definitely healed across the granulation tissue is seen at twenty-first day.[14]

Healing is influenced by various local and systemic factors. If there was incomplete soft tissue coverage within 21 days postoperatively, healing was considered to be delayed. In our study it is evident from the table 6, there were 3 (6%) cases of delayed healing in physics forceps group, while 4 (8%) in conventional forceps group. The

difference in the proportions was statistically insignificant as indicated by p-value of 0.99.

Our study was in consonance with the studies done by **Hariharan S et al[12] (2014)** and **Sonune AM et al[44] (2017)**, where the results were not significant when delayed healing was compared between both the groups.

The presence of any redness, drainage of pus and swelling was considered as infection during post extraction follow up period.

In our study there were total 5 cases of post-operative infection which was manifested as redness and mild swelling, in both the groups. 2 (4%) cases were in physics forceps group, while 3 (6%) in conventional forceps group, the difference was statistically insignificant with p-value of 0.99. As all the aseptic measures were followed and the patients of both the groups were under antibiotic coverage, no patient reported with pus discharge.

In a study conducted by **Hariharan S et al[12] (2014)** no case of post-operative infection was noted while **Sonune AM et al[44] (2017)** inferred insignificant difference between both the groups.

Mechanism of action and designing of physics forceps is such that the bumper applies the forces over the buccal gingiva, which can result into soft tissue injury. Extraction site as well as attached gingiva and mucogingival junction over the buccal aspect were examined for the presence of any ulceration.

In our study there were 7 (14%) cases of soft tissue ulceration in physics forceps group, while 3 (6%) in conventional forceps group. The difference of proportions was statistically insignificant with p-value of 0.3173. No previous studies have evaluated soft tissue ulceration between both the groups.

There were higher numbers of cases of soft tissue ulceration in physics forceps group because during extraction, the bumper is placed over the region of mucogingival junction on the buccal aspect. This acts as a fulcrum for class I lever principle. The pressure applied by the bumper over the soft tissue results in post operative ulceration.

Figure 21 represents the post-operative complications: dry socket, delayed healing, post operative infection and soft tissue ulceration through a column chart.

Pain is defined as an unpleasant emotional experience usually initiated by a noxious stimulus and transmitted over a specialized neural network to the central nervous system where it is interpreted as such.[45]

In the present study pain perception was assessed with the help of VAS which was explained to the patient pre extraction and post extraction The patients were asked to rate the intensity of pain by marking a X on a 10 point VAS. These measurements were done on 1st, 3rd and 7th post-extraction day.

Table 7 is a depiction of the descriptive statistics for pain scores obtained at different time points after extraction for both physics forceps and conventional forceps groups. The analysis was performed at each day between groups. At 1st post-operative day, the mean VAS score in physics forceps group was 1.94, while in conventional forceps group it was 2.7. The difference in the VAS scores was statistically significant as

indicated by p-value of 0.0008 using Wilcoxon rank sum test. However, at 3rd day, the difference in the VAS scores was statistically insignificant with p-value of 0.1356. On 7th day, none of the patients from both the group complained of pain.

Also the pain across times in each group was compared using Friedman ANOVA. In the group operated with physics forceps, the mean VAS score at 1st post-operative day was 1.94 which reduced to 0.22 at 3rd post-operative day. Further at 7th day, the mean score was 0. The change in the VAS score distribution with time was statistically highly significant as indicated by p-value < 0.0001 using Friedman ANOVA. Similarly, in conventional forceps group, the mean VAS score on 1st post-operative day was 2.7, on 3rd day the mean reduced to 0.42 and then on 7th day to 0. The change in the VAS score distribution with time was statistically highly significant as indicated by p-value < 0.0001 using Friedman ANOVA. A line plot showing the mean VAS scores with time in two groups is illustrated in Figure 22.

Our results were in consonance with the results of the study conducted by **Hariharan S et al[12] (2014)** where the mean VAS score was less in physics forceps group. The difference between the groups on the basis of VAS was found to be significant on 1st postoperative day and insignificant on 3rd and 7th post operative days.

Study conducted by **Madathanapalli S et al[40] (2016)** concluded that the difference between the groups on the basis of VAS was found to be significant on 3rd postoperative day and insignificant on 7th post operative day. While in the studies conducted by **Sonune AM et al[44] (2017)** and **Patel HS et al[42] (2016)** the difference

between the groups on the basis of VAS was found to be insignificant on 1st and 3rd post operative days.

Advantages of physics Forceps includes:[26]

- Achieving atraumatic extractions quickly and easily.
- Applicable to almost all teeth.
- Possible elimination of the need for surgical flaps and the resultant bone loss.
- Preserves the buccal bone and cortical plate.
- Helps facilitate immediate placement of implants.
- Virtually eliminates root tip fractures.

Disadvantages of physics Forceps:[12,28]

- Definite learning curve.
- Occasional ulceration at the point of placement of bumper.
- Needs additional instrumentation in the form of burs for creation of purchase point on the lingual/buccal aspect in grossly decayed teeth.

SUMMARY AND CONCLUSION

Every dental surgeon should aspire to achieve an objective of performing an ideal tooth extraction.[1] A great deal of finesse and a definite degree of controlled force are the key factors which must be exercised by the dental surgeon while performing a simple tooth extraction.[2] Atraumatic dental extraction techniques have gained importance and may become the standard technique for teeth removal in due course of time. Atraumatic extraction prevents damage to the bone and preserves periodontal architecture that allows for an option of future or immediate dental implant placement.[7]

A prospective, randomized, double-blind study was carried out on 100 patients reported to the Department of Oral and Maxillofacial Surgery for tooth extraction procedure under inclusion criteria, over the period of 18 months where patients were

randomly divided into two groups of 50 patients each. In study group patients, mandibular first and/or second molar was extracted using physics forceps while conventional extraction forceps was used in control group patients.

The result of our study showed that the mean time required for extraction using physics forceps was significantly less as compared to that of conventional forceps. Operative complications i.e. incidence of incomplete removal of root, fractured alveolus and soft tissue laceration, were observed to be fewer in the group operated with physics forceps as compared to conventional forceps. However, the differences in the proportion of complications between two groups were found statistically insignificant. The post-operative complications i.e. dry socket, delayed healing, post-operative infection were found less in the group operated with physics forceps as compared to conventional forceps, but higher number of cases of soft tissue ulceration were noted in physics forceps group, however the difference of proportions was statistically insignificant. Pain on 1st post operative day was significantly less in physics forceps group as compared to conventional group while it was insignificant on 3rd and 7th post operative day.

One of the limitation of the study was restricted sample size. Hence, further trials and multicentre studies with a larger number of patients and correlation among these studies are recommended.

So, it can be concluded that physics forceps is better than conventional extraction forceps as it requires less time during extraction of mandibular first or second molar. Also the post operative pain, operative complications and post operative

complications are lesser when extraction is done by physics forceps. On the other hand, use of physics forceps is technique sensitive and has a definite learning curve, which could act as a barrier. If overcome, physics forceps could serve as a boon in alleviating pain and also result in faster action. It could play an important role in areas of routine extraction procedure and also in cases that allows for an option of future or immediate dental implant placement.

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Table 1

Distribution of patients as per age in two treatment groups

Age (Years)	Physics forceps (n=50)		Conventional forceps (n=50)		p-value*
	No	%	No	%	
< 20	2	4	2	4	0.9501 (NS)
21 – 30	14	28	15	30	
31 – 40	16	32	15	30	
41 – 50	15	30	13	26	
>= 51	3	6	5	10	
Mean	36.38		36.42		
SD	9.94		11.52		
Median	36		36		

**Calculated using Chi-square test; NS: Not Significant*

Table 2

Distribution of patients as per gender in two treatment groups

Gender	Physics forceps (n=50)	Conventional forceps (n=50)	p-value*
Male	25 (50%)	22 (44%)	0.688 (NS)
Female	25 (50%)	28 (56%)	
Total	50	50	

**Calculated using Chi-square test; NS: Not Significant*

Table 3

Distribution of extracted tooth in two treatment groups

Tooth Extracted	Physics forceps (n=50)	Conventional forceps (n=50)	p – value*
36	15 (30%)	16 (32%)	0.8129 (NS)
37	8 (16%)	9 (18%)	
46	14 (28%)	16 (32%)	
47	13 (26%)	9 (18%)	

**Calculated using Chi-square test; NS: Not Significant*

Table 4

Descriptive statistics for time required for extraction of tooth in each group

Time Required (Seconds)	Physics forceps (n=50)	Conventional forceps (n=50)	p – value*
Mean	55.1	83.46	< 0.0001 (HS)
SD	16.42	27.31	
Median	53	78	

** Calculated using Wilcoxon rank sum test; HS: Highly Significant*

Table 5

Different operative complications in patients treated in two groups

Operative Complications	Physics forceps (n=50)	Conventional forceps (n=50)	p – value*
Incidence of incomplete removal of root	4 (8%)	6 (12%)	0.7389 (NS)
Fractured alveolus	3 (6%)	7 (14%)	0.3173 (NS)
Soft tissue injuries: Laceration	3 (6%)	6 (12%)	0.4846 (NS)

* *Calculated using Chi-square; NS: Not Significant*

Table 6

Different post-operative complications in patients treated in two groups

Post-operative Complications	Physics forceps (n=50)	Conventional forceps (n=50)	p – value*
Dry socket	0	0	-
Delayed healing	3 (6%)	4 (8%)	0.99 (NS)
Post-operative infection	2 (4%)	3 (6%)	0.99 (NS)
Soft Tissue injuries: Ulceration	7 (14%)	3 (6%)	0.3173 (NS)

* *Calculated using Chi-square test; NS: Not Significant*

Table 7

Descriptive statistics for VAS score in two treatment groups

Pain-VAS Score	Physics forceps (n=50)				Conventional forceps (n=50)				p – value*
	Mean	Median	Min	Max	Mean	Median	Min	Max	
1ST POD	1.94	2	1	5	2.7	2	1	7	0.0008 (S)
3RD POD	0.22	0	0	3	0.42	0	0	3	0.1356 (NS)
7TH POD	0	0	0	0	0	0	0	0	NA
P – value**	< 0.0001 (HS)				< 0.0001 (HS)				

** Calculated using Wilcoxon rank sum test; HS: Highly Significant, S: Significant; NS: Not Significant; **Calculated using Friedman ANOVA*

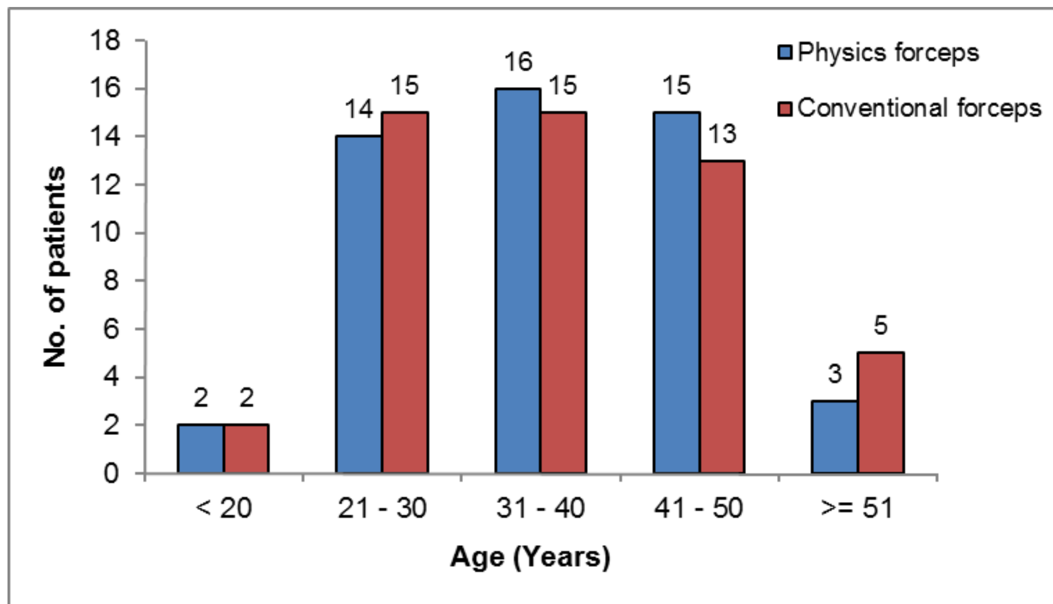


Figure 16: Column chart showing number of patients as per age in two treatment groups

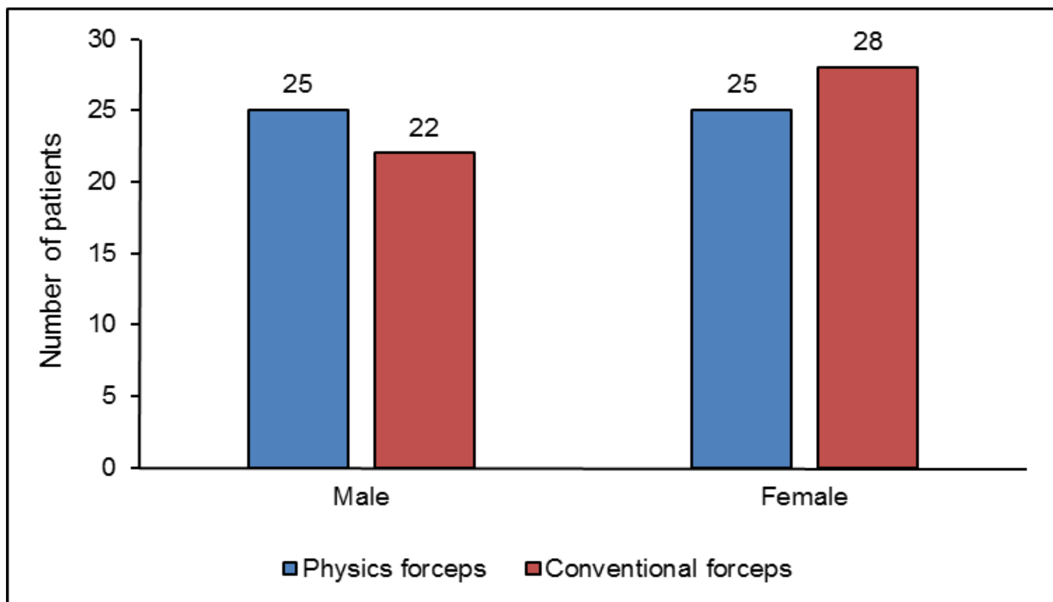


Figure 17: Column chart showing distribution of patients according to gender in two treatment groups

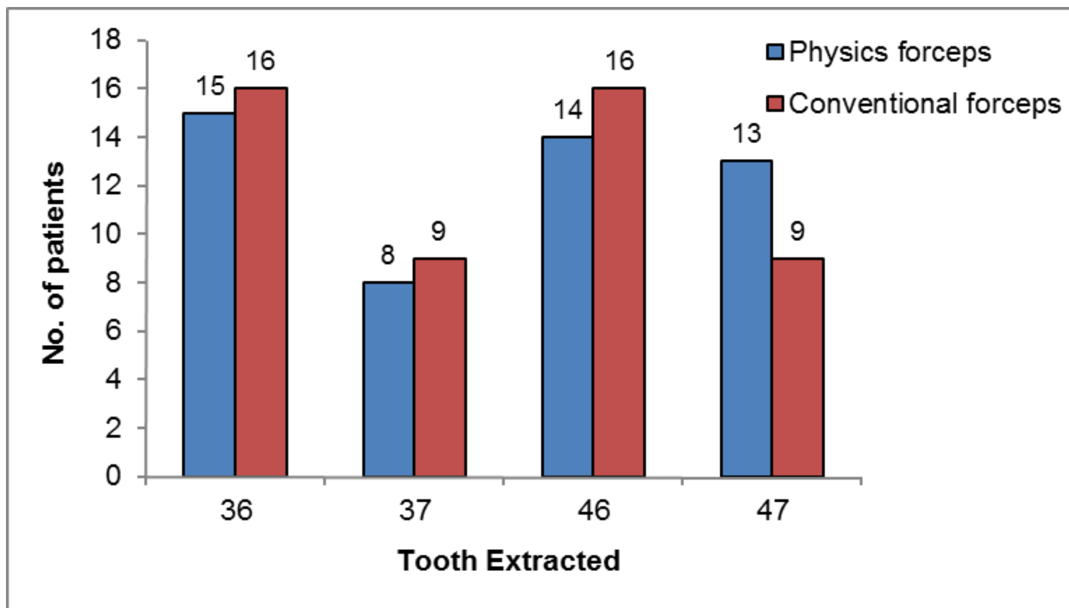


Figure 18: Column chart showing distribution of extracted tooth in two treatment groups

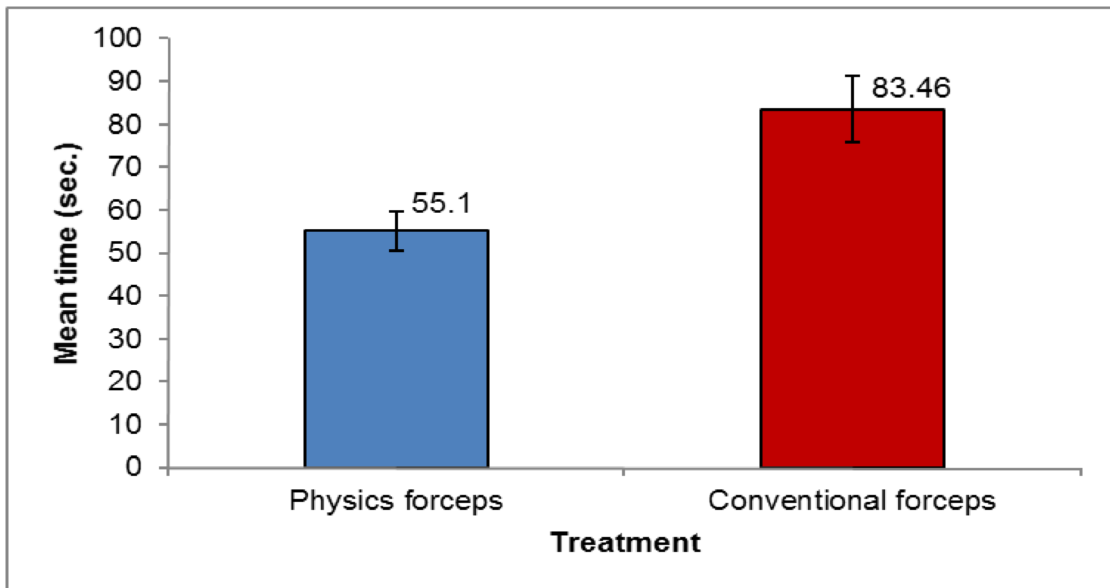


Figure 19: Column chart showing time required for extraction of tooth in each group

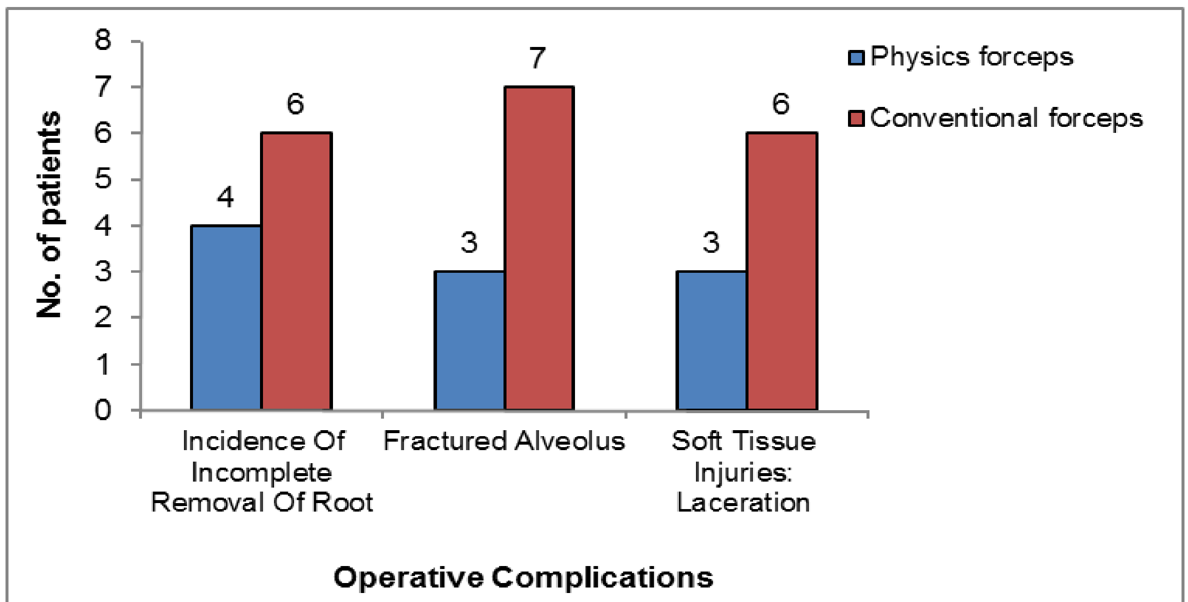


Figure 20: Column chart showing different operative complications in patients treated in two groups

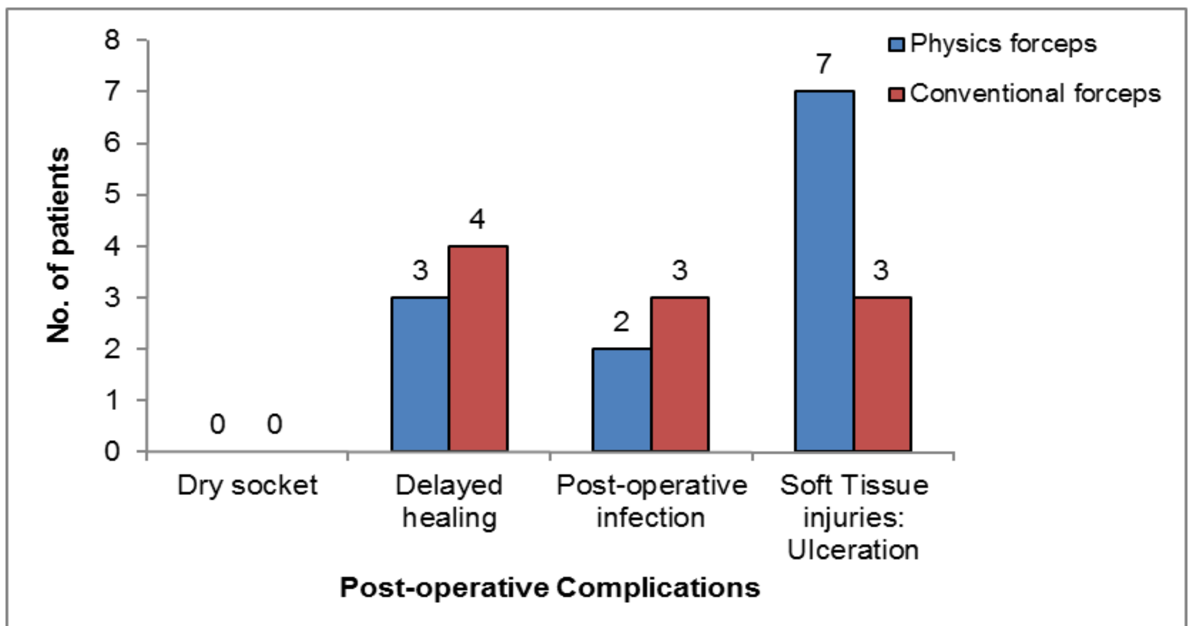


Figure 21: Column chart showing different post-operative complications in patients treated in two groups

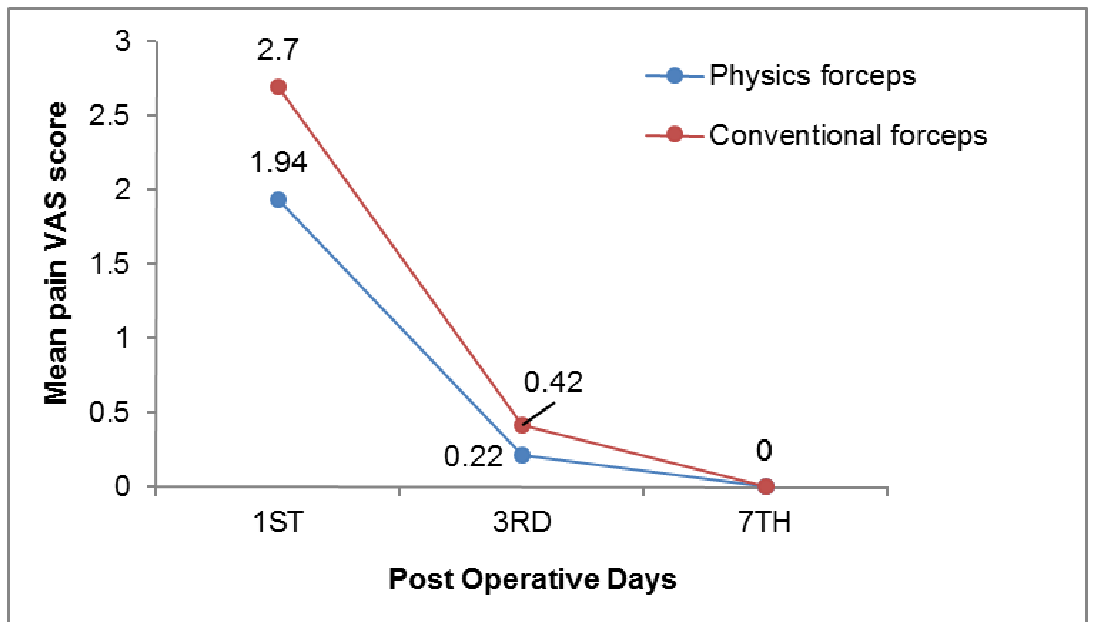


Figure 22: Line plot showing VAS score in two treatment groups

ANNEXURE-I

DEPARTMENT OF ORAL & MAXILLOFACIAL SURGERY

CASE HISTORY PROFORMA

Case number-

Date-

Name-

Age/Sex-

Registration No-

Address-

Education-

Occupation-

Chief Complaint-

History of present illness –

Cause of tooth extraction-

Past Medical History-

Past Dental History-

Drug Allergy History-

Family History-

Personal History-

- Diet
- Habits

Examination-

Extraoral examination:

- Facial Symmetry
- TMJ
- Lymph nodes

Intraoral Examination**:**

- Teeth present
- Missing teeth
- Root piece
- Occlusion
- Caries/attrition/abrasion/erosion/abfraction
- Mobility
- Others

Diagnosis-

Radiographic investigations: IOPA-

OPG-

Other investigations-

Advice-

ANNEXURE - II

ASSESSMENT FORM

1. DURATION OF OPERATION

Time (in Seconds)-

2. Operative complications- Present-1, Absent- 0

a. Incidence of incomplete removal of root-

b. Fractured alveolus-

c. Soft tissue injuries (Laceration)-

3. Post-operative complications- Present-1, Absent- 0

a. Dry socket-

b. Delayed healing-

c. Post operative infection-

d. Soft tissue injuries (ulceration)-

4. Post operative pain- VAS Score

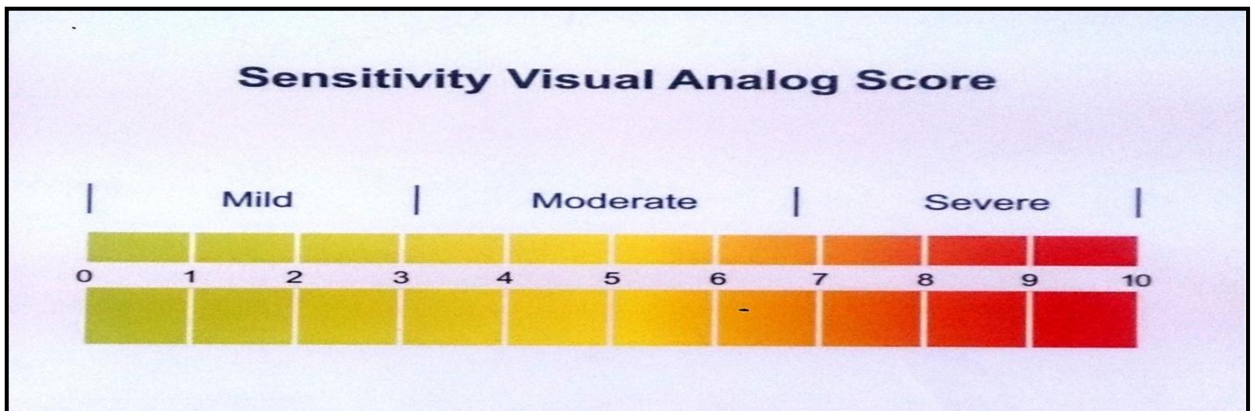
a. 1st post op day-

b. 3rd post op day-

c. 7th post op day-

VISUAL ANALOG SCALE (for pain)

	0	1	2	3	4	5	6	7	8	9	10
1st POD											
3rd POD											
7th POD											



ANNEXURE-III

DEPARTMENT OF ORAL & MAXILLOFACIAL SURGERY

INFORMED CONSENT FORM

(Confidential)

"A Comparative evaluation of Physics forceps and conventional extraction forceps in extraction of mandibular first and/or second molar."

I ____, resident of ____; aged____ years. Exercising my free will, without any pressure/lure of incentive in any form, hereby give my consent to be included as subject in the said clinical study.

The doctor has informed me about this research project suitably and sufficiently to my satisfaction. I agree to allow my photographs to be drawn as required. I agree to take part in this project and will not mix any other projects during the period of this trial. I shall report to the dental hospital or other place where called on given appointment dates and time. I shall inform the doctor on any adverse effect or unusual symptom noticed by me. I shall co-operate with the doctors in all respects. I permit publishing the results of my participation in this study. I shall not be given any reimbursement or compensation. I have been informed about my right to withdraw from the research project at any given time.

I hereby record my consent for participation in the said trial.

1. ___________________ ________________ _________ _________
   Patient's name Signature Date Time

2. ___________________ ________________ _________ _________
   Witness name Signature Date Time

3. ___________________ ________________ _________ _________
   Investigator's name Signature Date Time

ANNEXURE –IV

KEY TO MASTER CHART

Serial Number- I

Age (Years) - II

Gender- III

- Male- M
- Female- F

Tooth Extracted- IV

- 36- Mandibular left first molar
- 37- Mandibular left second molar
- 46- Mandibular right first molar
- 47- Mandibular right second molar

Duration of operation in seconds- V

OPERATIVE COMPLICATIONS: Present-1, Absent-0

- Incidence of incomplete removal of root- VI
- Fractured alveolus- VII
- Soft tissue injuries: Laceration- VIII

POST OPERATIVE COMPLICATIONS: Present-1, Absent-0

- Dry socket- IX
- Delayed healing- X
- Post operative infection- XI
- Soft tissue injuries: Ulceration- XII

PAIN-VAS SCORE

- 1ST POD- XIII
- 3RD POD- XIV
- 7TH POD- XV

MASTER CHART- GROUP A- PHYSICS FORCEPS

I	II	III	IV	V	OPERATIVE COMPLICATIONS: PRESENT-1, ABSENT-0			POST OPERATIVE COMPLICATIONS: PRESENT-1, ABSENT-0				PAIN-VAS SCORE		
					VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV
1	38	F	46	45	0	0	0	0	0	0	0	1	0	0
2	26	F	36	34	0	0	0	0	0	0	0	3	0	0
3	41	F	36	48	0	0	0	0	0	0	0	1	0	0
4	36	M	46	56	0	0	0	0	0	0	0	2	0	0
5	24	M	46	28	0	0	0	0	0	0	0	2	0	0
6	32	F	47	38	0	0	0	0	0	0	0	2	0	0
7	50	F	46	76	0	0	0	0	0	0	1	4	2	0
8	26	F	46	30	0	0	0	0	0	0	0	1	0	0
9	29	M	36	46	0	0	0	0	0	0	0	2	0	0
10	40	F	47	48	0	0	0	0	0	0	0	2	0	0
11	29	F	47	38	0	0	0	0	0	0	0	1	0	0
12	44	F	46	67	0	0	0	0	0	0	0	3	0	0
13	37	M	37	46	0	0	0	0	0	0	0	2	0	0
14	23	F	37	56	0	0	0	0	0	0	0	1	0	0
15	35	M	47	43	0	0	0	0	0	0	0	2	0	0
16	45	F	37	78	0	1	1	0	1	1	1	5	3	0
17	50	M	36	84	1	0	0	0	0	0	0	3	0	0
18	28	M	36	53	0	0	0	0	0	0	0	2	0	0
19	41	M	36	66	0	0	0	0	0	0	0	2	0	0
20	22	M	36	75	0	0	0	0	0	0	1	2	0	0
21	31	F	36	54	0	0	0	0	0	0	0	2	0	0
22	56	M	47	87	1	1	1	0	1	0	1	5	1	0
23	18	F	46	33	0	0	0	0	0	0	0	1	0	0

I	II	III	IV	V	OPERATIVE COMPLICATIONS: PRESENT-1, ABSENT-0			POST OPERATIVE COMPLICATIONS: PRESENT-1, ABSENT-0				PAIN-VAS SCORE		
					VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV
24	60	M	36	84	0	0	0	0	0	0	1	4	1	0
25	42	M	47	65	0	0	0	0	0	0	0	2	0	0
26	35	M	46	46	0	0	0	0	0	0	0	2	0	0
27	27	F	36	77	0	0	0	0	0	0	0	1	0	0
28	43	M	47	79	0	1	1	0	1	1	0	5	2	0
29	51	M	37	69	0	0	0	0	0	0	0	2	0	0
30	50	M	46	58	0	0	0	0	0	0	0	1	0	0
31	33	F	46	65	0	0	0	0	0	0	0	2	0	0
32	43	F	36	64	0	0	0	0	0	0	0	1	0	0
33	20	M	47	35	0	0	0	0	0	0	0	1	0	0
34	30	F	36	38	0	0	0	0	0	0	0	1	0	0
35	45	M	46	78	1	0	0	0	0	0	1	3	1	0
36	45	F	47	46	0	0	0	0	0	0	0	1	0	0
37	40	F	46	54	0	0	0	0	0	0	0	1	0	0
38	22	F	47	33	0	0	0	0	0	0	0	2	0	0
39	35	F	36	45	0	0	0	0	0	0	0	1	0	0
40	39	M	37	69	1	0	0	0	0	0	0	1	0	0
41	44	M	46	44	0	0	0	0	0	0	0	1	0	0
42	23	F	47	41	0	0	0	0	0	0	0	1	0	0
43	26	M	36	49	0	0	0	0	0	0	0	2	0	0
44	35	M	37	36	0	0	0	0	0	0	0	2	0	0
45	28	F	36	46	0	0	0	0	0	0	0	1	0	0
46	38	F	47	67	0	0	0	0	0	0	1	3	1	0
47	47	M	47	83	0	0	0	0	0	0	0	1	0	0
48	32	M	46	55	0	0	0	0	0	0	0	2	0	0
49	36	M	37	53	0	0	0	0	0	0	0	1	0	0
50	49	F	37	47	0	0	0	0	0	0	0	1	0	0

MASTER CHART- GROUP B- CONVENTIONAL FORCEPS

I	II	III	IV	V	OPERATIVE COMPLICATIONS: PRESENT-1, ABSENT-0			POST OPERATIVE COMPLICATIONS: PRESENT-1, ABSENT-0				PAIN-VAS SCORE		
					VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV
1	23	F	37	46	0	0	0	0	0	0	0	4	1	0
2	45	M	47	78	0	0	0	0	0	0	0	3	0	0
3	32	F	37	65	0	0	0	0	0	0	0	3	0	0
4	30	F	37	80	0	0	0	0	0	0	0	3	0	0
5	51	M	46	75	0	0	0	0	0	0	0	4	1	0
6	22	F	36	56	0	0	0	0	0	0	0	3	0	0
7	30	M	36	88	0	1	1	0	1	0	1	5	3	0
8	36	M	36	74	0	0	0	0	0	0	0	3	0	0
9	21	F	47	110	0	0	0	0	0	0	0	2	0	0
10	29	F	36	124	0	0	0	0	0	0	0	2	0	0
11	22	M	36	86	0	0	0	0	0	1	0	5	2	0
12	47	F	46	90	0	1	0	0	0	0	0	3	0	0
13	60	M	46	120	0	0	0	0	0	0	0	1	0	0
14	60	M	36	182	1	1	1	0	1	0	1	7	3	0
15	19	F	36	76	0	0	0	0	0	0	0	2	0	0
16	41	M	37	65	0	0	0	0	0	0	0	2	0	0
17	36	M	46	80	0	0	0	0	0	0	0	4	1	0
18	55	M	37	94	0	0	0	0	0	0	0	3	0	0
19	22	F	46	64	0	0	0	0	0	0	0	2	0	0
20	40	F	37	88	1	0	0	0	0	0	0	4	1	0
21	35	F	36	75	0	0	0	0	0	0	0	2	0	0
22	23	F	36	59	0	0	0	0	0	0	0	3	0	0
23	60	F	47	165	1	1	0	0	0	0	0	3	1	0
24	42	M	46	125	0	0	1	0	0	0	0	3	0	0
25	40	F	46	94	0	0	0	0	0	0	0	2	0	0

I	II	III	IV	V	OPERATIVE COMPLICATIONS: PRESENT-1, ABSENT-0			POST OPERATIVE COMPLICATIONS: PRESENT-1, ABSENT-0				PAIN-VAS SCORE		
					VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV
26	46	M	36	108	1	0	0	0	0	0	0	3	0	0
27	32	M	47	86	0	0	0	0	0	0	0	2	0	0
28	19	F	37	54	0	0	0	0	0	0	0	2	0	0
29	21	F	46	60	0	0	0	0	0	0	0	2	0	0
30	23	M	46	72	0	0	0	0	0	0	0	2	0	0
31	50	F	36	95	0	1	1	0	1	1	1	6	2	0
32	32	M	47	82	0	0	0	0	0	0	0	2	0	0
33	45	F	36	78	0	0	0	0	0	0	0	4	1	0
34	45	F	46	128	1	0	0	0	0	0	0	2	0	0
35	40	F	47	116	0	1	1	0	1	0	0	5	2	0
36	45	F	46	84	0	0	0	0	0	0	0	1	0	0
37	22	F	46	64	0	0	0	0	0	0	0	1	0	0
38	45	M	36	90	1	0	1	0	0	1	0	4	2	0
39	34	M	36	72	0	0	0	0	0	0	0	2	0	0
40	38	F	46	64	0	0	0	0	0	0	0	1	0	0
41	48	F	47	56	0	0	0	0	0	0	0	2	0	0
42	29	F	36	62	0	0	0	0	0	0	0	1	0	0
43	38	M	37	70	0	0	0	0	0	0	0	2	0	0
44	22	M	46	62	0	0	0	0	0	0	0	1	0	0
45	47	F	46	84	0	1	0	0	0	0	0	3	1	0
46	25	F	47	54	0	0	0	0	0	0	0	2	0	0
47	39	M	37	76	0	0	0	0	0	0	0	2	0	0
48	33	M	47	55	0	0	0	0	0	0	0	2	0	0
49	35	M	46	78	0	0	0	0	0	0	0	1	0	0
50	47	F	36	64	0	0	0	0	0	0	0	2	0	0