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Alveolar Bone Biology in Extrusion Splint Technique

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Abstract: *Thermal, chemical or mechanical lesion that affects the dentition should be analyzed as a dental trauma and its effect, as a traumatic dental injury. Splinting is recommended as a treatment modality for traumatized teeth after avulsion or luxation. Replantation of teeth is the surgical method of positioning of teeth back in its original place in the sockets, which was altered by the consequences of trauma. Newer technique modification of replantation where there is induced extrusion and stabilized by splinting is called an extrusion splint. In this case we have treated the similar intruded teeth by u*
sing extrusion splint technique and evaluated for nine months, as a result good bone healing was obtained. Healing potential of bone is influenced by a variety of biochemical, cellular, hormonal, and pathological mechanisms. Healing of bone occurs by 3 phases namely reactive, reparative and remodeling. Bone remodelling is a highly coordinated process of bone resorption and formation. Bone remodelling is performed by clusters of bone resorbing osteoclasts and bone forming osteoblasts arranged within temporary anatomical structures known as "Basic Multicellular Unit" (BMUs). Splinting done in case of traumatized tooth has various advantages, it preserve tooth, periodontal healing and bone healing.

Keywords: *dental trauma, intrusion, extrusion splint, bone healing, bone remodeling, basic multicellular unit, RANKL and OPG*

I. Introduction:

The word trauma implies a reasonable severe, non-physiological lesion to any part of the body. Any thermal, chemical or mechanical lesion that affects the dentition should be analyzed as a dental trauma and its effect, as a traumatic dental injury[1]. Violence, road traffic accidents and sports activities have been identified as some of the major causes that contribute to dental trauma and pose a definite public health problem[2]. Injury can lead to displacement of permanent anterior teeth, rotation, intrusion and/or fracture[3]. Avulsion and luxation are complex injuries that affect multiple tissues[4, 5, 6], accounting for up to 16% of all traumatic injuries in the permanent dentition[7, 8] and 7–21% of injuries in the primary dentition[9]. Traumatic teeth can be treated in different ways, in the WHO system, eight groups were classified according to the anatomical structures involved, and treatment planning depends on the type of the injuries to the teeth and their supporting structures[10, 11]. Splinting, as a treatment modality for traumatized teeth after avulsion or luxation (with the exception of intrusive luxation), is recommended [12]. In a dental setting, splinting with flexible wire and dentin adhesive with composite resin is usually preferred. Replantation of teeth, exarticulated as a result of trauma, is now a routine and a well-established clinical procedure.

Replantation of teeth is the surgical method of positioning of teeth back in its original place in the sockets, which was altered by the consequences of trauma. This positioning of teeth is stabilized by various types of splints depending on its needs. One of the modifications in simple replantation is extrusion of tooth which was intruded due to trauma and splinted to stabilize in its relatively new position. This new position should be favorable functionally and esthetically. This newer technique modification of replantation where there is induced extrusion and stabilized by splinting is called an extrusion splint. In this paper we will be discussing this newer technique of extrusion splint and the favorable healing environment provided by the surrounding alveolar bone in adequate nine months follow up.

II. Description Of The Technique With A Case Report

Male patient aged twenty two years reported to emergency of BPKIHS (B.P.Koirala Institute of Health Sciences, Dharan, Nepal), due to Road Traffic Accident assaulted by motor-bike with the cut on upper lip, laceration of the check, lip and mobility of teeth. After the basic treatment such as extra oral suturing, tetanus (T.T) injection, antibiotic and analgesic patient is recalled to Dental Out Patient Department. Intra Oral examination revealed (fig 1) intrusion of upper central incisor of the left side with vertical fracture of cingulum area not extending to the root and Millers grade II mobility. Generalized stains and calculus are also present. There was cut on the upper labial

mucosa. Considering the unfavorable condition of the tooth, patient was informed that the prognosis was bad and that if treatment with flexible acrylic splint could not stabilize the tooth the next option would be extraction and prosthetic replacement of the particular tooth. Written informed consent was taken from the patient and treatment was carried out. We took the radiograph of the particular area. In fig.2 IOPAR (intra oral periapical radiograph) reveals Ellis & Deweys' Class III fracture of upper left central incisor and Class II fracture of upper right central incisor. Widening of periodontal ligament and periapical radiolucency of upper right and left central incisor is seen. After supra and subgingival scaling, infra-orbital and incisive nerve block on the both side was given to anesthetize the maxillary anterior area. Intentional extrusion of the upper left central incisor was done using maxillary anterior extraction forcep so that it is in the level to right central incisor (Fig.3) cut on the upper labial mucosa can also be seen. Extrusion sling suture is placed around upper left central incisor to stabilize near cervical area and to approximate the investing tissues for healing in primary intension (fig 4). After the stabilization of the tooth, etching was done with 37% phosphoric acid from upper right lateral incisor to upper left canine for 30 seconds. Then all teeth were dried and bonding agent was applied and light cured for 30 seconds on each tooth. Composite was placed and flexible acrylic fiber was placed on middle portion of the tooth and light cured for 60 seconds as seen in (fig.5). After the completion of entire clinical procedure post-operative radiograph was taken. In post-operative radiograph about 3mm of tooth has been extruded which can be seen in (fig.6). This radiograph was used as baseline radiograph for measuring the alveolar bone regeneration radiographically.

In second visit after a week patient was recalled for suture removal. Marked reduction in mobility was demonstrated on particular tooth. But oral hygiene became worse than previous visit due to limitations in oral hygiene performance (fig 7). After suture removal scaling was performed and referred the patient to department of endodontics for emergency access opening (fig 8). Patient was recalled for soft tissue evaluation and oral hygiene examination after a month, in his third visit there was still inflammed interdental and marginal gingival in relation to maxillary upper incisor. Patient was instructed to continue with the chlorhexidine and instructed to report after 15 days again for evaluation. In his 4th visit inflammation of the gingiva was reduced (fig.9) and mobility was almost nil. Radiograph showed initial trabecular pattern formation in the periapical area (fig.10). Patient was recalled after a month with completed root canal procedure to evaluate bone healing. Radiographic evaluation was done after a month which was a 3 month evaluation from the procedure it showed widening of PDL space and trabecular pattern was dense compared to the IOPAR taken 45 days back (fig 11). Similar IOPA was taken every 3 month interval to know the bone healing in 6th and 9th month (fig 12 and 13). Those radiographs showed marked increase in the bone density in the periapical area of the extruded tooth. PDL space was not violated nor there was widening. Root resorption was not appreciated.

Fig.1: Clinical View During 1st Visit

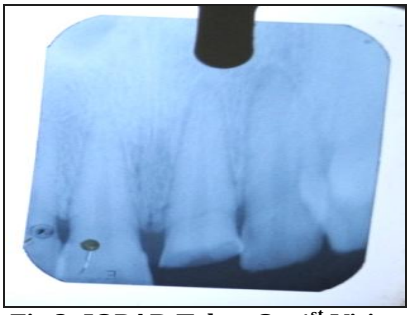

Fig.2: IOPAR Taken On 1st Visit -

Fig.3: After Surgical Extrusion Of Upper Left Central Incisor To The Level Of Right Central

Fig.4: Sling Sutures In Position.

Fig.5: Fiber Splint In Position From Upper Right Lateral Incisor To Upper Left Canine.

Fig.6: Radio Opacity Is Seen In The Root Apices

Fig.7: 1 Week After 1st Visit. Sling Suture Removed.

Fig 8: IOPAR Taken After Emergency Access Opening

Fig.9: Soft Tissue Inflammation Resolved.

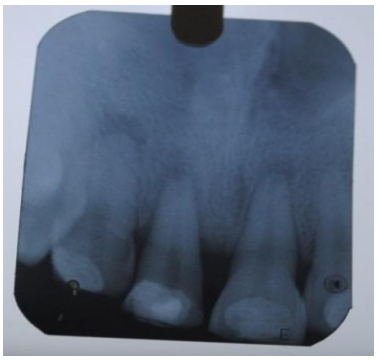

Fig.10: IOPAR Taken After 1 Month.

Fig. 11: 3rd Month Radiograph

Fig. 12: 6th Month Radiograph

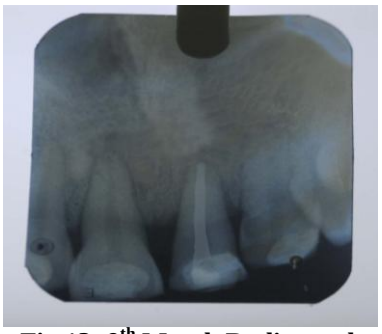

Fig 13: 9th Month Radiograph

III. Discussion

The large number of motor vehicle accident injuries with multi-organ trauma, the necessity for life saving, and the lack of dental instruments in the emergency and operating rooms, may lead the general medical practitioner or surgeon to ignore the dental trauma or postpone dental treatment to a later stage. The emergency management of intruded tooth due to any reason like trauma is to bring back to its original position and fixated as soon as possible. In the above case we have treated the similar intruded teeth by using extrusion splint technique and evaluated for nine months, as a result good bone healing was obtained. When the tooth was initially extruded and splinted there was no periapical bone support, but within a month time bone healing has been started and noticed radiographically. There was a constant improvement in the periodontal ligament space and periapical bone in interval of 3 and 6 months. Periapical bone was prominent with regular trabecular pattern compared with the initial radiograph by the end of nine months. There was no signs of ankylosis and on vertical and horizontal percussion there was dull sound which can be attributed to dehydration of tooth as a result of avascular and nonvitality. After an injury which causes

tooth mobility at the socket or total avulsion, there is damage to the tooth support system, including the periodontal ligament, cementum layer, and blood vessels that supply blood to the tooth pulp. The support system may not heal properly when extensive damage affects over 20% of the root surface[13]. If the tooth is out of socket prompt tooth re-implantation and fixation are most important to prevent future complications[14]. The longer the tooth remains out of the mouth, beyond the recommended time limit, even when restored in a storage medium, the greater the risk for ankylosis[15]. Avulsed teeth should be maintained in a storage medium[16], such as milk, Viaspan, Hanks balanced salt solution (HBSS), saliva, and saline. The preferred storage medium recommended by The American Association of Endodontists is HBSS, because of its ability to preserve the vitality of periodontal ligament (PDL) cells for a longer duration[17, 18]. HBSS preserves the vitality of fibroblast cells for 72 hours[19], but is not commonly found in the emergency room. As an alternative, saline can be used, but it has only 2 hrs. preservation time[20].

In a case of dentoalveolar trauma, there will be damage to the entire tooth supporting structures. Most importantly alveolar bone is prime important because at most it will help in tooth ankylosis. The impact of trauma will cause microfracture in the socket wall, radiographically complete or partial loss of lamina dura is noticed. Healing and regeneration of bone in the closed cavity is a complicated and interesting unless the mobile segment - the tooth, is stabilized. The healing potential of bone, whether in a fracture or fusion model, is influenced by a variety of biochemical, cellular, hormonal and pathological mechanisms. A continuously occurring state of bone deposition, resorption, and remodeling facilitates the healing process. Fracture ultimately heals through physiological processes. The healing process is mainly determined by the periosteum and endosteum which serves as a source of precursor cells which develop into chondroblast, osteoblast, small blood vessels and fibroblast. Healing of bone elsewhere in the body occurs in three phase, Reactive Phase in which inflammatory reaction and granulation tissue forms, Reparative Phase involves cartilage callus formation and lamellar bone deposition, the last phase is Remodeling phase where the bone is remodeled to original contour. In the inflammatory phase, a hematoma develops within the fracture site within the socket during the first few hours and days. Inflammatory cells (macrophages, monocytes, lymphocytes, and polymorphonuclear cells) and fibroblasts infiltrate the bone under prostaglandin mediation. This results in the formation of granulation tissue, ingrowth of vascular tissue, and migration of mesenchymal cells. The primary nutrient and oxygen supply of this early process is provided by the exposed cancellous bone and muscles. The use of antiinflammatory or cytotoxic medication during this 1st week may alter the inflammatory response and inhibit bone healing. During the repair stage, fibroblasts begin to lay down a stroma that helps support vascular ingrowth. As vascular ingrowth progresses, a collagen matrix is laid down while osteoid is secreted and subsequently mineralized, which leads to the formation of a soft callus around the repair site. In terms of resistance to movement, this callus is very weak in the first 4 to 6 weeks of the healing process and requires adequate protection in the form of bracing or internal fixation. Eventually, the callus ossifies, forming a bridge of woven bone between the fracture fragments. Alternatively, if proper immobilization or splinting of teeth is not done, ossification of the callus may not occur resulting in unfavourable healing of socket. Bone remodelling is a highly coordinated process of bone resorption and formation and is necessary to repair damaged bone and maintains mineral homeostasis. Osteoclasts, osteoblasts and osteocytes, that are necessary for bone remodelling, several immune cells have also been implicated in bone reformation. Bone remodelling occurs over several weeks and is performed by clusters of bone resorbing osteoclasts and bone forming osteoblasts arranged within temporary anatomical structures known as "Basic Multicellular Unit" (BMUs). Megakaryoctes enhance osteoblast proliferation and differentiation, express RANKL and OPG and secrete an unknown soluble anti-osteoclastic factor. Osteoblasts occupy the tail portion of the BMU and secrete and deposit unmineralised bone matrix known as osteoid and direct its formation and mineralization into mature lamellar bone. Osteoid is the unmineralized organic matrix, composed of 90% type I collagen and 10% ground substance, which consists of noncollagenous proteins, glycoproteins, proteoglycans, peptides, carbohydrates, and lipids[21, 22]. The mineralization of osteoid by inorganic mineral salts provides bone with its strength and rigidity.

Although the physiological stages of bone repair in the tooth extruded socket are similar to those that occur in long bone fractures, there are some differences. Unlike long bone fractures, pluripotent cells of residual periodontal ligament fibers are used in tooth extruded socket. During the socket healing process, pluripotent and totipotent cells of periodontium are incorporated by an integrated process in which old necrotic bone is slowly resorbed and simultaneously replaced with new viable bone. This incorporation process is termed "creeping substitution[23]."

The most affected teeth during trauma to dentoalveolar structure were the permanent maxillary central incisors, accounting for 53.2% of cases, which exhibited higher occurrence of coronal fracture, concussion/ subluxation, and avulsion[24]. Immediate care is required in cases of dento-alveolar trauma. This type of emergency situation often requires several sessions for treatment, continuity for investigation and even treatment of possible

sequelae[25-30]. Splinting done in case of traumatized tooth has various advantages, it preserve tooth, periodontal healing and bone healing can be seen. It prevents tooth loss so esthetic consideration is also maintained. But, in course of time extruded tooth can have bone loss and undergo ankylosis if immediate root canal treatment is not performed. Some of the precautions should be taken during this extrusion splint procedure such that teeth should not be ankylosed, its supporting structures should be preserved. The most common consequence of trauma is avulsion of tooth, during this there are more chances of tooth getting contaminated. In that case conditioning of tooth is mandatory. In conditioning the tooth parallel to regular root canal treatment it is immersed in 2.4% sodium fluoride solution (pH 6.5) for 20 minutes. The root surface is then rinsed with saline. After invitro obturation of root canal with gutta-percha the teeth were then left overnight in 3g Amoxycillin made up to 50ml[31].Vitality of the tooth can be compromised rather than compromising its surrounding structures. Series of cases with extrusion splint technique can be done in large samples and vitality of periodontium should be assessed in each. It is widely recommended for surgical reentry in the periapical area to evaluate the quality of bone formed after extrusion splint with adequate time for bone healing. Further histological and clinical studies are required in this technique and quality of periodontium is appraised so that this proficiency can be used in regular basis and avoiding the least preferred ankylosis.

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