"A COMPARATIVE EVALUATION OF AXIOSTAT WITH CONVENTIONAL DENTAL DRESSING METHODS FOR HEMOSTASIS AFTER EXTRACTION OF MOLARS – A RANDOMISED PROSPECTIVE STUDY."

Dissertation Submitted to

Maharashtra University of Health Sciences, Nashik

In the Partial Fulfillment of Regulations

for the Award of the Degree of

MDS

IN

ORAL AND MAXILLOFACIAL SURGERY

BRANCH III

2019

INDEX

LIST OF ABBREVIATIONS

Sr. No.	Abbreviations	Full form
1.	PEG	Polyethylene glycol
2.	SD	Standard Deviation
3.	ADD	Axiostat dental dressing
4.	Pvt.	Private
5.	Ltd.	Limited
6.	GRAS	Generally recognized as safe
7.	USFDA	American Food and Drug Administration
8	ISO	International Organization for Standardization
9..	FDCA	Federal Food, Drug and Cosmetic Act
10	mm	Millimeter
11.	%	Percentage
12.	Cm	Centimeter
13.	ml	Milliliter
14.	Cap.	Capsule
15..	Tab.	Tablet
16.	i.e.	That is
17.	g	Gram
18.	CD	Chitosan dressing
19	VAS	Visual analogue scales
20.	ANOVA	Analysis of variance
21.	e.g.	For example

Sr. No.	Abbreviations	Full form
22.	WBS	Wong-baker faces pain scale
23.	POD	Post operative day
24.	secs.	Seconds
25.	mins.	Minutes
26.	mg	Milligram
27.	HDD	HemCon dental dressing
28.	Hr	Hour
29.	OAT	Oral anticoagulation therapy
30.	No.	Number

LIST OF FIGURES

LIST OF TABLES

LIST OF GRAPHS

LIST OF COLOUR PLATES

Plate Number	Title
I	Armamentarium used for extraction in group- A.
	Armamentarium used for extraction in group- B.
II	Axiostat dental dressing
	Conventional dental pack
III	Axiostat dental dressing on extraction socket of mandibular first molar.
	Conventional dental dressing on extraction socket of mandibular first molar.
IV	Quicker Hemostasis achieved after application of axiostat dental dressing
	Hemostasis achieved after application of conventional dental dressing
V	Post extraction healing on 3^{rd},7^{th},15^{th} and 30^{th} Post operative day after application of axiostat dental dressing
	Post extraction healing on 3^{rd},7^{th},15^{th} and 30^{th} Post operative day after application of conventional dental dressing.

INTRODUCTION

Tooth removal or extraction is one of the most common and persistent oral surgical procedure carried out in regular dental practice and post extraction bleeding is one of the most predictable, repeatedly encountered difficulty seen after tooth removal in dental practice.[1]

Extraction of a tooth is carried out for numerous reasons, that include: severe periodontal disease, orthodontic purposes, severe caries, malaligned teeth, fractured teeth, preprosthetic purposes, impacted teeth, supernumerary teeth, ectopic eruptions, preceding radiation therapy, sometimes for teeth associated with pathologic lesions,

teeth in the line of jaw fractures in order to prevent infection, esthetics, and economics.[2]

Bleeding throughout oral surgical procedures can cause anxiety, distress and uneasiness to the patient. It also hampers the working quality as it makes the visualization poor leading to time consumption and displeasure to the oral surgeon.[1]

Post extraction bleeding is when there is persistence of bleeding even after pressure pack has been applied.[1] Post-extraction bleeding can be caused locally from soft tissue or bone bleeding. Soft tissue bleeding can be due to traumatic extraction, leading to laceration of blood vessels (arterial, venous or capillary). Bone or osseous bleeding can be from either the nutrient canals or from the central vessels. Inflammations at the site of extraction, the presence of infection, traumatic extraction and failure of the patient to follow post-extraction instructions have also been associated with post extraction bleeding. Systemic factors include platelet problems, coagulation disorders or excessive fibrinolysis, and inherited or acquired problems (medication induced).[3]

Management of post extraction bleeding in both healthy and medically compromised individuals can be achieved by various methods.[3] Local and systemic interventions are two kinds of interventions for managing post extraction bleeding.[4]

Different methods of local intervention are local hemostatic agents, moist pressure pack, sutures and acrylic surgical splints. Local hemostatic agents vary in effectiveness, cost and convenience. Ideal requirements for an oral surgery hemostatic agent is that it should be safe, well tolerated, bacteriostatic, sterile pack for single use and its application should be convenient for the operator.[5]

Local hemostatic agents can be classified as active and passive hemostatic agents. Passive topical hemostatic agents includes resorbable gelatin sponge, polysaccharide hemospheres, collagen sponge and oxidized cellulose while active topical hemostatic agents includes thrombin, floSeal (hemostatic matrix), chitin/chitosan based dressings, quikClot (inorganic haemostat), local hemostatic solutions such as tranexamic acid mouthwash, tannic acid, lysine analogs, Epsilon aminocaproic acid and hemocoagulase (botroclot), Bone hemostats are bone wax and ostene. Two other categories are flowable agents and sealants, which include fibrin sealants, polyethylene glycol (PEG) polymers, albumin and glutaraldehyde and cyanoacrylate. If these fail to provide hemostasis, systemic agents can be used.[6]

Hemostasis is a physiological process that stops bleeding from the site of injury while maintaining normal blood flow elsewhere in the circulation. It is the first step of wound healing. Blood loss is stopped by formation of hemostatic plug. Endothelium in the blood vessels acts as an anticoagulant surface which helps in maintaining blood in its fluid state, but if the blood vessel gets damaged, the components of the sub endothelial matrix are exposed to blood. Some of these components will activate two main processes of hemostasis to initiate formation of a blood clot which will be predominantly composed of platelets and fibrin. This process is activated within seconds of an injury and remains localized to the site of injury.[7]

Some new generation haemostatic agents like Chitin/Chitosan-based products have shown to provide early hemostasis as well as improved postoperative healing.[5] Chitin is a naturally occurring polysaccharide found both in arthropod exoskeletons and as a fermentation product of algae, whereas chitosan is its deacylated form. These agents

bring out hemostasis by local vasoconstriction and by acting as a scaffold for erythrocyte agglutination. These topical dressings physically occlude the bleeding surgical site and possesses antimicrobial properties because of their acidic pH.[8]

Axiostat (Chitosan based) dental dressing is a milestone, which is being gradually used a lot by numerous dental surgeons.[9] Axiostat dental dressing (ADD) is made-up from Poly [-(1, 4)-2-amino-2-deoxy-D-glucosamine] which is a natural biomaterial, polysaccharide, isolated and purified from non-mammalian sources (Axio Biosolutions Pvt. Ltd., Ahmedabad, India). It comes under GRAS (Generally Recognized as Safe) category of USFDA and ISO accredited & FDCA approved material.[10]

Axiostat dental dressing is manufactured from chitin and obtained from shells of crustaceans.[11] Chitin is basically polysaccharide, polymer of glucosamine that is purified & partially deacetylated to form soluble chitosan aqueous gel, which is dried in moulds that turns into a sponge like material that is highly electropositive in nature.[5]

It has some unique characteristics such as it is polycationic and insoluble in nature, biodegradable, bioadhesive and non-toxic which is why it has been extensively used all around the world as an emergency hemostatic dressing for accidents, pre-hospital emergency care and to combat wounds to arrest bleeding. Due to its mucoadhesive property there is an interaction between positively charged dressing and negatively charged blood components which results in adaption and seal .[5]

Axiostat dental dressing being highly electropositive attracts red blood cells and platelets, having negative charge. Axiostat dental dressing while forming a strong seal at the mucosal wound site, allows the body to effectively activate its coagulation pathway. The platelets and red blood cells continue to be drawn towards axiostat and strengthen the initial seal. Axiostat dental dressings are designed to maintain this seal and serve as a scaffold for aggregation of platelets and red blood cells until hemostasis is achieved. It does not rely solely on the clotting cascade to stop bleeding. One advantage is its application on an actively bleeding surface, in contrast to the use of other local hemostatic agents which are preferably applied on dry surfaces.[5, 11]

Analgesic activity of chitosan (Axiostat dental dressing) acts by absorbing proton ions via chitosan which are released in the inflammatory area. The free fundamental −NH2 groups on chitosan protonate decrease the pH of effected area and cause effective analgesic impact in an acidic environment[12].The antibacterial property of chitosan (Axiostat) provides a barrier in opposition to a wide range of oral microbes along with early hemostasis which is beneficial to lessen the postoperative pain.[11]

Healing is the process which restores the integrity of injured tissues preventing organisms from deregulation of homeostasis. Chitosan biopolymer effectively depolymerizes to release N-acetyl-d-glucosamine, which initiates fibroblast proliferation during the process of wound healing. Chitosan monomer helps in ordered deposition of collagen and stimulates increased level of natural hyaluronic acid synthesis at the wound site. Chitosan based dressings (Axiostat) have a strong tissue adhesive property and provide an antibacterial barrier against a wide range of gram positive & gram negative organisms. Chitosan provides a cellulosic matrix for

the regeneration of skin tissues and promotes macrophages to cease abnormal growth activity, helping in quicker full thickness healing of the wound.[12]

The Aim of this prospective clinical study is to evaluate the effectiveness of axiostat haemostatic dental dressing in achieving early post extraction bleeding and to highlight the fact that early hemostasis and inherent virtues of axiostat have effect on post-operative pain and healing outcome following dental extractions as compared to the conventional dental dressing with a sterile piece of gauze.

AIM AND OBJECTIVES

AIM

To evaluate the efficiency of axiostat for hemostasis after extraction of molars.

OBJECTIVES

- To compare time required for hemostasis after extraction of molars with axiostat and conventional dental dressing.
- To compare post-operative healing after extraction of molars with axiostat dental dressing and conventional dental dressing.
- To compare post operative pain after extraction of molars with axiostat dental dressing and conventional dental dressing.

- To compare post-operative alveolar osteitis after extraction ofmolars with axiostat dental dressing and conventional dental dressing.

REVIEW OF LITERATURE

Various studies have been reported in the literature so far explaining various hemostatic agents to achieve quick hemostasis following the dental extraction. Newer hemostatic agents and techniques used in the field of exodontia to achieve faster hemostasis have also been described in the recent years for the advancement of the procedure and benefit of the patients undergoing tooth extraction. These advancements aim for early hemostasis and post extraction healing with lesser post operative complications after extraction of tooth.

Henri Braconnot in 1811 was the first to discover Chitosan. He was the director of the botanical garden in Nancy, France. Bracannot observed that sulfuric acid was unable to dissolve a certain substance (chitin) found in mushrooms.[13]

Over the closing 200 years, the exploration of chitosan has taken on many specific forms. Several different researchers continue to build on the original

discovering of Bracannot, discovering new uses for chitin as they find unique varieties of it in nature.

The name 'chitin' was introduced by Odier in **1823**. It was derived from 'chiton' , a Greek word meaning 'covering', 'tunic' or 'envelop'. In **1929 Albert Hofmann** was solved the structure of chitin.[14]

James L in 1953 stated that Post-extraction hemorrhage is always serious and potentially a great danger. The use of fibrin foam and thrombin under pressure fulfils the requirements for local control of post extraction bleeding. The effective use of these agents demands that they can be placed directly at the site of hemorrhage.[15]

Amler MH 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).[16]

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

Malette W G et al in 1983 conducted a study on Eleven dogs. A laparotomy was performed and the infrarenal aorta was dissected with its branches tied. Six centimeter lengths of knitted DeBakey Dacron grafts were soaked in the chitosan solution (2 mg per milliliter) or in saline as a control. Suitable lengths of the aorta were excised and the grafts were sewn into place. They randomly chose to remove the distal vascular clamp and waited for 4 minutes before removing the proximal vascular clamp to allow the reaction to occur; subsequent experiments have shown that 1 minute is sufficient. Blood loss following removal of the last clamp was measured for 5 minutes. Three dogs underwent reoperation , 24 hours later to determine if rebleeding has occurred. The grafts were examined grossly as well as by light and electron microscopy. And in this study they found that the 4 control animals suffered immediate exsanguinations and all of them died and The 7 animals that were treated with chitosan lost a mean of 43.57 ml of blood, most of which had come from the suture lines. These data were significant at a p value less than 0.001. They concluded that chitosan solution is used as a hemostatic agent, which prevents blood loss from porous vascular grafts. They also concluded that chitosan in some way allows the in growth of vascularized smooth supporting an endothelial luminal surface.[18]

Sindet-Pedersen S in 1987 carried out a study to investigate the content of tranexamic acid in plasma and in mixed, unstimulated whole saliva after oral administration and mouth rinsing. Ten healthy volunteers were given 1 g of tranexamic acid orally, whereas 20 healthy volunteers had to rinse their mouths with 10 mL of 5% aqueous tranexamic acid solution for two minutes.

Blood and saliva were collected at 30, 60, 120, 240, 360, and 480 minutes after tranexamic acid had been administered. Samples of saliva and blood were analyzed for tranexamic acid substance by electron capture gas chromatography. Following oral administration, the mean plasma concentration of tranexamic acid reached its highest after 120 minutes at about 7 micrograms/mL, whereas none of the saliva samples contained tranexamic acid at detectable levels. After mouth rinse, the plasma concentrations remained below 2 micrograms/mL, whereas the concentrations found in saliva was initially very high (after 30 minutes mean concentration above 200 micrograms/mL) and was maintained at a therapeutic level for more than two hours.

These findings indicate, that fibrinolysis can be inhibited only by local administration of tranexamic acid. These results may be of significance when the drug is used for avoidance and treatment of bleeding in the oral cavity in patients with coagulation defects.[19]

Wallerstein Jr RO in 1989 stated that most causes of abnormal bleeding can be determined from a complete blood count including platelet count and bleeding, prothrombin, activated partial thromboplastin, and thrombin times. Infrequently, additional assessment is required, for example tests of factor XIII function, vascular integrity and fibrinolysis. Possible diagnosis includes disseminated intravascular coagulation, thrombotic thrombocytopenic purpura, vitamin K deficiency, von Willebrand's disease, heparin-induced thrombocytopenia, acquired inhibitors of factor VIII, lupus anticoagulants, and coagulation disorders related to the acquired immunodeficiency syndrome.[20]

Koide SS in 1998 reported that Chitin and chitosan in vitro show antibacterial and anti-yeast activities. N-carboxybutyl chitosan, was tested against 298 cultures of various pathogenic microorganisms, and had shown bacteriostatic, bactericidal and candidacidal activities. The treated microorganisms had undergone marked morphological alterations compatible with bactericidal effect when examined by electron microscopy. Chitosans prepared from squid pen and crab crust had marked bactericidal activity against Streptococcus mutans and Streptococcus salivarius at a concentration of 0.0005%. Also in an in vivo study in a mice, chitin and chitosan administered intraperitoneally had a protective influence against infections with Candida albicans NIH A-207 strain. The bacteriostatic and bactericidal activities suggest that chitin-chitosans can prevent infections of wounds by direct application. [21]

Klokkevold PR et al in 1999 conducted a study to evaluate the effect of chitosan on lingual hemostasis in rabbits whose coagulation pathway had been impaired by administration of intravenous heparin. In ten white rabbits Bleeding times were evaluated for bilateral (15 mm X 2 mm) tongue incisions. Using a blinded and randomized experimental design, each animal's one incision was treated with chitosan, and the other which was control vehicle was treated without chitosan. Activated coagulation times and extraoral bleeding times each animal was measured before, during, and after heparinization. They concluded that Topical application of chitosan to lingual incisions effectively decreased intraoral bleeding time in a therapeutically anticoagulated (heparinized) rabbit model. Chitosan facilitated lingual hemostasis, possibly through interaction with erythrocytes, linking them together to establish a cellular clot or hemostatic plug.[22]

Matocha DL in 2000 concluded that the hemorrhagic risk related to dental extraction is a rare complication. The incidence of post extraction hemorrhagic complications, including other risk factors, does not exceed the average of 0.2 and 2.3%.[23]

Mi F L et al in 2001 carried out a study in which A novel asymmetric chitosan membrane was prepared by immersion-precipitation phase-inversion method and was evaluated as wound covering. This new type of chitosan wound dressing which consisted of skin surface on top-layer supported by a macroporous sponge-like sublayer was designed. The depth of the dense skin surface and porosity of sponge-like sublayer was controlled by the modification of phase-separation process using per-evaporation method. The asymmetric chitosan membrane showed controlled evaporative water loss, excellent oxygen permeability and promoted fluid drainage ability but inhibited exogenous microorganisms invasion due to the dense skin layer and inherent antimicrobial property of chitosan. Healing and hemostasis was took placed quickly as wound covered with the asymmetric chitosan membrane. Histological examination established that covering the wound with asymmetric chitosan membrane results in improved epithelialization rate and the deposition of collagen in the dermis was well prepared. The results in this study indicate that the asymmetric chitosan membrane thus prepared could be adequately employed in the future as a wound dressing.[24]

Vande Vord PJ et al in 2002 stated that the Biocompatibility is an essential characteristic for a hemostatic agent. Chitosan hydrogels are nontoxic when applied and are naturally degraded by lysosomal pathways in mammalian cells into naturally metabolized amino sugars. Cellular immune responses and antibody responses

measured using lymphocyte proliferation assays and immunoglobulin G assays, respectively, further demonstrated negligible Chitosan-specific binding reactions.[25]

Pusateri AE et al in 2003 studied the Effect of a Chitosan-Based Hemostatic Dressing on Survival, Blood Loss and fluid loss following Severe Venous Hemorrhage and Hepatic Injury in Swine. Swine received gauze sponges or chitosan dressings. Standardized, severe liver injuries were induced and dressings were applied after 30 seconds and resuscitation was initiated. Hemostasis, Blood loss, 60 minute survival and resuscitation volume were quantified. Observations in this study showed that reduced post treatment blood loss ($p < 0.01$) in the chitosan group (264 ml; 95% confidence interval [CI], 82–852 ml) in comparison to the gauze group (2,879 ml; 95% confidence interval (CI) , 788– 10,513 ml). Also, Fluid use (p 0.03) was reduced in the chitosan group (1,793 ml; 95% confidence interval (CI), 749–4,291) in comparison to the gauze group (6,614 ml; 95% confidence interval (CI), 2,519–17,363 ml). Hemostasis was improved in the chitosan group (p 0.03) also Survival was seven of eight in the chitosan and in gauze groups two of seven (p 0.04). They concluded that A chitosan dressing helped in decreasing blood loss and superior survival after severe liver injury in swine. Additional studies are necessary.[26]

Khor E and Limly in 2003 stated that Chitin is a co-polymers of N-acetylglucosamine and N-glucosamine units randomly or block distributed throughout the biopolymer chain depending on the processing method used to derive the biopolymer. The biopolymer is termed chitin when the number of N-acetyl-glucosamine units is higher than 50%. On the other hand when the number of N-glucosamine units is higher, the term chitosan is used. Chitosan has been the better

researched version of the biopolymer because of its ready solubility in dilute acids rendering chitosan more accessible for utilization and chemical reactions. Nowadays the chemistry, production and applications of chitin and chitosan are well known. Commercially chitin and chitosan are obtained from shellfish sources such as crabs and shrimps. In conclusion, this survey has demonstrated the utility of chitin and chitosan as potential materials for various implant applications and some of the challenges in demonstrating biocompatibility as well as sterility that must be addressed.[27]

Chou TC et al in 2003 tested chitosan (Molecular Weight = 50,000) for its enhancing platelet activity in rabbit platelet suspensions and the potential mechanisms involved were supplementary investigated. Observations in this study showed that after early (5 min) and long-standing (30 min) contact of platelets with chitosan, the platelet adhesion to chitosan-coated micro titer plates was dose-dependently improved compared to that of solvent control. Likewise, chitosan also dose-dependently increased the platelet aggregation and the intracellular free $Ca^{(2+)}$ rise of Fura-2-AM loaded platelets.

Furthermore, in the presence of FITC-labeled anti-CD41/CD61, chitosan considerably improved the appearance of platelet glycoprotein IIb/IIIa complex evaluated by a flow cytometer. It is inferred as for platelet adhesion and aggregation chitosan is an efficient inducer and the mechanisms of action of chitosan may be least likely associated, with the increasing $Ca^{(2+)}$ mobilization and improving expression of GPIIb/IIIa complex on platelet membrane surfaces.[28]

Connolly RJ in 2004 conducted a study in which an extremity wound involving skin, muscle, bone, and femoral arterial injury and a 1-cm vertical incision in the abdominal aorta in swine was studied to compare the Poly-N-Acetyl Glucosamine–Derived Rapid.

Deployment Hemostat Trauma Dressing Bandage, a fibrin sealant dressing and gauze to restore hemostasis. The total loss of blood was resoluted and the survival of animals was calculated. In the extremity injury model, the Poly-N-Acetyl Glucosamine–Derived Rapid Deployment Hemostat Trauma Dressing reduced blood loss by 63% compared with the gauze control. In the aorta arterial incision model, the Poly-N-Acetyl Glucosamine–Derived Rapid Deployment Hemostat Trauma Dressing required a significantly lower compression time to control bleeding compared with gauze and Tacho- Comb. The Poly-N-Acetyl Glucosamine–Derived Rapid Deployment Hemostat Trauma Dressing was able to stop bleeding from this injury in 100% of the tests.[29]

Kheirabadi BS et al in 2005 Evaluated the haemostatic efficacy of three products QuikClot powder (QC), chitosan dressing (CD), and fibrin sealant dressing (FSD); new haemostatic products touted to be more effective in controlling severe extremity bleeding than the current standard gauze dressing, in a model (swine) of severe extremity arterial hemorrhage that could not be stopped by standard gauze application and manual compression.

Each haemostatic agent was applied twice with three-minute compressions. All products were applied on vigorously bleeding wounds through a pool of blood. With

the first compression fluid recovery was started and titrated to a mean pressure of 65 mm Hg. Animals were kept under observations for 180 minutes or until death. Endpoints survival time, blood loss, resuscitation volume, wound temperatures and tissue histology.

They concluded that, fibrin sealant dressing (FSD) was superior to other currently utilized haemostatic products in controlling lethal arterial hemorrhage in this model of a fatal extremity wound. Chitosan dressing (CD) showed several haemostatic advantages. There was a gross and histological tissue change of unknown clinical significance due to the significant exothermic reaction of Quikclot powder (QC). Controlled human studies with capable products are required.[30]

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: 4 (1.2%) an acutely inflamed alveolus, 5 (1.6%) acutely infected alveolus and 26 (8.2%. localized osteitis. Males developed fewer complications than females. Most complications were found in molars (60%) and premolars (37.1%). They also established a tender 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.[31]

Wedmore I et al in 2006 stated Hemorrhage as a most important reason for death in both civilian and military trauma patients. For hemorrhage control HemCon chitosan-based is US Food and Drug Administration (FDA) approved haemostatic dressing. Animal data have shown the HemCon chitosan-based dressing to lessen hemorrhage and get better survival. The aim of this article was to report preliminary results of the haemostatic effectiveness of the HemCon chitosan-based dressing used in the pre hospital surroundings on combat casualties.

Total 68 uses of the HemCon chitosan-based dressing were documented and reviewed by two US Army physicians. In sixty eight cases four of which were determined duplicative resulting. In a total of 64 combat uses HemCon chitosan-based dressings were applied externally on extremities in 35 cases;on the chest, groin, buttock, and abdomen in 25 cases and on neck or facial wounds in 4 cases. In 66% of cases, dressings were applied following gauze failure and were 100% benificial. In 62 (97%) of the cases, the use of the HemCon chitosan-based dressing resulted in termination of bleeding and enhances haemostasis.

Two dressing failures were reported when bandages blindly were applied into large cavitational injuries. Dressings in areas where tourniquets could not be applied to control bleeding were reported to be most useful. The most difficult dressings that were reported were the ones used in in extremity injuries where they could not be placed easily into or onto the wounds. No reporting of complications or undesirable effects were seen.[32]

Burkatovskaya M et al in 2006 states that, HemCon chitosan-based bandage is an engineered chitosan acetate preparation used as a haemostatic control dressing and its chemical structure suggests that it should also be antimicrobial. It rapidly kills bacteria in vitro and in mouse models of infected wounds. Gram-negative species of Pseudomonas aeruginosa and Proteus mirabilis and the Gram-positive species of Staphylococcus aureus; had been stably transduced with the entire bacterial lux operon to allow in vivo bioluminescence imaging. An excisional wound in mice was inoculated with 50-250 million cells followed after 30 min by application of HemCon bandage, alginate sponge bandage, silver sulfadiazine cream or no treatment. HemCon was more adhesive as compared alginate to the wound and it conformed well to the injury.

Animal survival was followed and observed for bioluminescence emission and animal activity daily for 15 days. The mice were infected with P. aeruginosa and P. mirabilis and treated with chitosan acetate, all survived while those who receive alginate sponge bandage, silver sulfadiazine cream or who did not receive any treatment had demonstrated mortality for about 25-100%. Chitosan acetate was much more efficient than other treatments in quickly reducing bioluminescence in the wound constant with its quick bactericidal activity in vitro and its light-scattering properties. Even after temporaryafter temporary immunosuppression of the mice where S. aureus formed only non-lethal localized infections, HemCon was again more useful in reducing bioluminescence.

The data suggest that chitosan acetate is more superior as it rapidly kills bacteria in the wound before systemic invasion can take place as to alginate bandage and silver sulfadiazine that might support growth of bacteria.[33]

Shen E C et al in 2006 they discussed thrombin as a usually used agent for activating the platelets and releasing the growth factors on the application of platelet-rich plasma (PRP). They also state that chitosan can improve rabbit platelet aggregation. They conducted this study, in which the effects of chitosan on the following growth factors release after human platelets establishment were examined to assess the possibility of chitosan being used as a substitute for thrombin during PRP preparation.

The determination of Human platelet activation was by aggregation, adhesion and alpha-granule membrane glycoprotein expression. Turbid metric method was used for measuring platelet aggregation and the adhesion was examined directly on chitosan-coated glass plates under light microscope and scanning electron microscope (SEM) and the detection of the alpha-granule membrane glycoprotein was by fluorescent isothiocyanate (FITC)-conjugated anti-CD 61 antibody through flow cytometry. ELISA after mixing with chitosan was used for assaying subsequent epidermal growth factor (EGF), platelet-derived growth factor (PDGF)-AB and transforming growth factor (TGF)-beta1 released from platelets.

Observations were done for the enhancing effects on the platelet adhesion and the aggregation from chitosan. The adhesive platelets on the chitosan-coated plates were seen to have not only greater in number but also they were earlier in activation when compared to those on the control plates under both light microscope and scanning

electron microscope (SEM). Chitosan treatment increased glycoprotein IIIa expression in platelets was detected with flow cytometry. PRP after chitosan treatment had shown greater concentrations of growth factors than after the solvent treatment.

Because of the observations of growth factors releasing from activated human platelets after chitosan stimulation, they suggest that chitosan may be an appropriate substitute for thrombin in PRP preparation.[34]

Cunha-Reis C et al in 2007 discussed the state of the art approaches for tailoring the degradation of chitosan scaffolds based on altering the chemical structure of the polymer.

Changes in other properties of scaffolds such as the ability to promote cell adhesion may usually arise if there is alteration in chemical structure of the polymer. The main aim of this study was basically to investigate the influence of physical considerations such as porosity and fibre diameter on the degradation of chitosan fibre-mesh scaffolds, as a probable way of adapting the degradation of such scaffolds. The response to degradation and cell adhesion on four sets of scaffolds with distinct fibre diameter and porosity were produced and were studied accordingly.

5 weeks of degradation study was carried out at 37degrees C in a lysozyme solution. The level of degradation was expressed as percentage of weight loss of the dried scaffolds after lysozyme treatment. Confocal Microscopy was used for assessment of cell adhesion. The outcome showed that the scaffolds with higher porosity degrade faster while the scaffolds which were within the same range of porosity and the fibres

with smaller diameter degrade slightly faster. Furthermore, the morphological differences between the scaffolds did not affect the degree of cell adhesion, and the cells were observed throughout the thickness of all four types of scaffolds.[35]

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. Notable relationship between mean pain intensity score and previous dental injection pain was found. They recommended that dental professionals should consider offering regular analgesic drugs during the first week after tooth extraction.[36]

Burkatovskaya M et al in 2008 studied effects of chitosan dressing on healing of excisional wounds that were or were not infected with Staphylococcus aureus, in normal mice or mice previously pretreated with cyclophosphamide. In order to study the conflicting clamping and stimulating effects of chitosan acetate bandage on normal wounds, they removed the bandage from wounds at times after application ranging from 1 hour to 9 days. They found that there are two effects of chitosan

acetate bandage application on normal excisional wounds. Initially, there is a clamping effect that may be either advantageous or disadvantageous depending on whether the wound is likely to increase or not. In this study model relative benefit mainly depended on the time of application, with times from 32 hours to 5 days being beneficial and the maximum time of benefit was being 3 days. Secondly, there is a stimulation effect on the rate of wound healing when the bandage is finally removed. The slope of the healing curve was significantly steeper in all wounds that had chitosan acetate bandage applied, with the greatest effect for application times between 4 and 7 days.[37]

Yang J et al in 2008 Carried out Comparative studies among solid-state chitosan, chitosan acetic acid physiological saline solution, and carboxymethyl chitosan physiological saline solution to discover the haemostatic effect of molecular weight (M(w)) and deacetylation degree (DA) of chitosan.

It was found that solid-state chitosan and chitosan acetic acid physiological saline solution performed different haemostatic mechanisms. The erythrocytes has aggregated and were deformed As blood mixed with chitosan acetic acid physiological saline solution. The deacetylation degree, particularly a low deacetylation degree in the chitosan acetic acid physiological saline solution, An important effect was seen in the dstrange aggregation and deformation of erythrocytes, compared with the effect of M_w in a range between 10^5 and 10^6. Though, in solid-state chitosan this phenomenon was not observed. chitosan in solid-state with a low deacetylation degree absorbed additional platelets and were more haemostatic.

Carboxymethyl chitosan physiological saline solution had nothing to do with the aggregation and deformation of erythrocytes but caused local roulex. The values of thrombin time (TT), prothrombin time (PT), activated partial thromboplastin time (APTT), and fibrinogen concentration (FIB) were calculated after the blood was mixed with chitosan acetic acid physiological saline solution, solid-state chitosan and carboxymethyl chitosan physiological saline solution, individually. The findings confirmed that coagulation factors might not be activated by them.[38]

Jay P. Malmquist et al in 2008 In their study on patients aged between 18-90 years all patients on oral anti-coagulant therapy having 2 or more extraction sites were included in the study; except those allergic to sea-food. Post-operative bleeding was controlled using HemCon chitosan-based Dental Dressings/ Pressure dressings (sterile gauze under biting pressure). The authors concluded that HemCon chitosan-based dental dressing treated sites, achieved haemostasis in <1 min & control wounds in 9.53 mins (P< .001). Moreover 32% of HemCon chitosan-based treated sites had better healing (P<.001) than control sites.[5]

Dai T et al in 2009 studied whether the chitosan acetate bandage could act as a topical antimicrobial dressing when it was applied to third-degree burns in mice contaminated with fatal doses of two of these invasive bacterial species *(*P. aeruginosa *and* P. mirabilis*).* They demonstrated that the chitosan acetate bandage performs better than the clinically approved nanocrystalline silver bandage when it is topically applied to third-degree burns heavily contaminated with an aggressive and invasive strain of *P. aeruginosa*. In the case of the virulent but less invasive organism *P. mirabilis*, the effectiveness of the two dressings was equal. During the

care of combat casualties, heavy bacterial contamination of serious burns is a distinct possibility.[39]

Muzzarelli RA in 2010 discussed about the fact that some folks are allergic to crustaceans, the alleged relationship between allergy and the presence of chitin in crustaceans has been explored in literature. In vivo, chitin is part of complex structures with other organic and inorganic compounds: in arthropods chitin is covalently linked to proteins and tanned by quinones, in bacteria chitin is diversely combined according to Gram(+/-) classification, and in fungi it is covalently linked to glucans. On contrary, purified isolated chitin is a plain polysaccharide that, at the nano level, presents itself as a highly associated structure, recently refined in terms of regularity, nature of bonds, crystallinity degree and unusual colloidal behaviour. Chitins and modified chitins have many advantageous actions, i.e., (i) they interact with receptors on the macrophage surface that mediate the internalization of chitin particles by stimulating macrophages which in turn get degraded by lysozyme and N-acetyl-beta-glucosaminidase (such as Nod-like, Toll-like, lectin, Dectin-1, leukotriene 134 and mannose receptors); (ii) the macrophages induce non-specific host resistance against bacterial and viral infections, and anti-tumor activity by generating cytokines and other compounds that; (iii) chitin is a powerful Th1 adjuvant in which immunity is iduced by heat-killed mycobacterium bovis and upregulated by chitin, while down-regulating Th2 immunity induced by mycobacterial protein; (iv) direct intranasal application of chitin microparticles into the lung was also able to considerably down-regulate allergic response to Dermatophagoids pteronyssinus and Aspergillus fumigatus in a murine model of allergy; (v) chitin microparticles had a positive effect

in avoiding and treating histopathologic changes in the airways of asthmatic mice; (vi) authors braced the fact that chitin depresses the development of adaptive type 2 allergic responses. Since the expression of chitinases, chitrotriosidase and chitinase-like proteins is increased during many infections and diseases, the common feature of chitinase-like proteins and chitinase activity in all organisms become visible to be the biochemical defence of the host. Unfortunately, intangible and procedural inaccuracy are present in certain recent articles dealing with chitin and allergy, i.e., (1) mislaid consideration of mammalian chitinase and/or chitotriosidase secretion, accompanied by inactive chitinase-like proteins, as an ancestral protective means against invasion, capable to prevent the revolution of allergy; (2) omitted consideration of the fact that the mammalian organism recognizes without delay the secreted water soluble chitinase created by a pathogen, rather than the unsolvable and greatly protected chitin within the pathogen; (3) superficial and unfinished reports and investigations on chitin as an allergen, lacking revealation of the potent allergen tropomyosine from crustacean flesh; (4) inadequate awareness of the importance of the chemical/biochemical characteristics of the isolated chitin or chitosan for the replication of experiments and to optimize the results; and (5) inadequacy of interdisciplinary actions. There is huge data of research today on the use of chitosans as biomaterials, and in particular as drug carriers for a variety of applications: the routes of delivery is same as those approved for the immunological studies. Said articles, that give over attention to the safety and biocompatibility aspects, by no means reported intolerance or allergy in individuals and animals, even when the quantities of chitosan used in single experiments were huge. Therefore, in conclusion that crab, shrimp, prawn and lobster chitins, as well as chitosans of all grades, once

purified, should not be considered as "crustacean derivatives", because the segregation procedures have removed proteins, fats and other contaminants to such an extent as to allow them to be classified as chemicals despite of their source.[40]

Mao S et al in 2010 stated that among non-viral vectors, chitosan and chitosan derivatives have been developed in vitro and in vivo for DNA and si RNA delivery systems, due to their cationic charge, biocompatibility and biodegradability, in addition to their mucoadhesive and permeability enhancing properties. The transfection efficiency of chitosan-based delivery systems can be adjusted by changing formulation related parameters.[41]

Garra G et al in 2010 for justification of the Wong-Baker FACES Pain Rating Scale conducted a observational, prospective study of children ages 8–17 years with pain presenting to a suburban, academic pediatric ED. Pain severity amongst the Children was rated on a Wong-Baker FACES Pain Rating Scale (six-item ordinal faces scale) from none to worst and on a 100 mm Visual Analogue Scales (VAS) from least to most. Analysis of variance (ANOVA) was used to compare mean WBS scores across the VAS. They concluded that the Visual Analogue Scales (VAS) was found to have an outstanding association in older children with acute pain in the ED and had a consistently rising relationship with Wong-Baker FACES Pain Rating Scale. Wong-Baker FACES pain rating scale Is used as an evaluation tool to find out implications for research on pain management.[42]

Kong M et al in 2010 in their review article stated that an ideal wound dressing material must be capable of absorbing the exuded liquid from the wounded area and

must allow water evaporation at a certain rate with no microbial transport. Polysaccharides, e.g. chitosan, owning hydrogel-forming properties have been considered to be advantageous in their application as a wound dressing materials. The photo cross linkable chitosan hydrogel directly acted as antibacterial biomaterial on a Dacron graft and at least chitosan hydrogel was effective to inhibit the local infection.[43]

P. V. Mohanan et al in 2011 in their research article evaluated the haemostatic potential of Chitosan based haemostatic dressing material on albino rabbits. The result indicated that the material has local biological activity in the form of haemostatic action and together with its ability to activate macrophages, resulted in wound healing applications. And in this study they concluded that the haemostatic dressing material is non-toxic, non-skin irritant, and has better haemostatic potential than a commercially available material with enhanced haemostatic capabilities for various wound dressing.[10]

Kale TP et al in 2012 conducted the study to evaluate the efficiency of the HemCon chitosan based Dental Dressing in controlling post extraction bleeding and to determine its role in healing of extraction wounds, as compared to conventional dental dressing . The 40 patients in the study were all receiving oral antiplatelet therapy in which 80 extractions were conducted without altering the patients' drug therapy. The extraction sites were divided into 2 groups: one group received a HemCon chitosan based Dental Dressing while in the control group for achieving haemostasis the conventional method of pressure pack was given. Suturing was used with sterile gauze under biting pressure for achieving haemostasis. Haemostasis was found to be

achieved quicker (mean = 53 seconds) than the control sites (mean = 918 seconds) which was statistically significant (P <0.001) with all HemCon chitosan based placed sites. Postoperative pain in the HemCon chitosan based Dental Dressing group (1.74) was also significantly lower than in the control group (5.26) (P <0.001). Approximately 72.5% of HemCon chitosan based Dental Dressing treated sites showed significantly better postoperative healing when compared to the control site (P<0.001).

They concluded that HemCon chitosan based Dental Dressing proved to be an excellent haemostatic agent that significantly shortened the bleeding time following dental extraction in patients on OAT. Additionally, HemCon chitosan based Dental Dressing offered significantly improved post-operative healing of the extraction socket and less postoperative pain.[44]

Sanandam M et al in 2013 conducted a study on Two healthy male rats (M1 and M 2) were taken for test, the animals were anesthetized and Metal rod was heated used and burn wounds were created. (All experimentations were done as per INSA rules for vanimal experimentation). Then, bandages (containing crude and standard chitosan) were placed onback. Wound healing was checked in M1 &M2 rats together when kept in examination for 7 days.

Comparative study on different properties of Chitosan extracted from Prawn Shell and Standard Chitosan indicated that chitosan takes two fold less time to clot the blood than that taken by the natural blood clotting process. Moreover the chitosan extracted from prawn shell shows wound healing properties. On application of bandages dipped

into both standard & crude chitosan It has shown major healing effect on cut made on back, on application of bandages dipped into both standard & crude chitosan respectively. It can be used effectively used in medical treatment to decrease blood loss and induce faster wound healing in case of heavy blood loss resulting from injury.[45]

Chang HH in 2014 was conducted a study to evaluate if C-PGA could promote new bone formation in the alveolar socket following tooth extraction. An animal model was planned by means of radiography and histomorphology at the similar time to analyze the symmetrical sections of Wistar rats. The maxillary incisors of Wistar rats were extracted and the extraction sockets were unsystematically treated with neat chitosan, gelatin sponge, C-PGA or received no treatment. The extraction sockets were evaluated at one, two, four, or six weak post extraction of selected rats from each group.

The results of radiography and histopathology indicated that the extraction sockets treated with C-PGA exhibited lamellar bone formation (6.5%) as early as 2 week after the extraction was performed. Moreover, the degree of new bone formation was significantly higher ($P < 0.05$) in the extraction sockets treated with C-PGA at 6 wk post-extraction than that in the other study groups. In this study, they demonstrated that the proposed animal model involving symmetrical sections and simultaneous radiography and histomorphology evaluation is feasible. They also conclude that the novel C-PGA has great potential for new bone formation in the alveolar socket following tooth extraction.[46]

Ashraf S in 2015 was assessed post extraction healing Healing using the standardised index by Landry,Turnbull and Howley scores.These healing score index starts from 1 to 5. Scores,1 indicated very poor healing, 2 indicated poor healing,3 indicated good healing,4 indicated very good healing and 5 indicated excellent healing.[47]

Vezeau PJ et al in 2016 stated that Chitin/chitosan dressings are believed to promote hemostasis by local vasoconstriction and by acting as a scaffold for erythrocyte agglutination. These topical dressings also physically occlude the bleeding surgical site and possess antimicrobial properties due to having an acidic pH. These materials stimulate fibroblast activation and collagen deposition. A topical form for emergency field trauma is supplied as a flat bandage with chitosan on one side (to be applied to the wound) and a non-stick side facing away from the wound to allow topical pressure to be applied. Chitosan dressings are currently used in both military field medical and civilian emergency medical service settings and show promise as possible guided tissue scaffolds.[8]

MP SK in 2016 stated that Chitosan enhances hemostasis by interacting with cellular components forming a cellular lattice that entraps cells to form an artificial clot. The creation of a clot occurs independently of the extrinsic or intrinsic clotting pathways. Chitosan based is a new generation hemostatic agent which achieves early hemostasis and improves post-operative healing. They do not cause any adverse reactions in shell-fish sensitive patients.[6]

Sirintawat N et al in 2017 Regardless of whether it is acute or chronic, the assessment of pain should be simple and practical. There are many scales to assess

pain as the intensity of pain is thought to be one of the primary factors that determine its effect on a human's overall function and sense,. The aim of this article was to review pain intensity scales that are frequently used in oral and maxillofacial surgery (OMFS) and in dental practice. Earlier studies established that multidimensional scales, for example unidimensional pain scales, like the Verbal descriptor scale, Visual Analogue Scales (VAS), Numerical rating Scale, Verbal rating scale, Faces Pain Scale, Full Cup Test and Wong-Baker Faces Pain Rating Scale (WBS), were used to assess acute pain. While the McGill Pain Questionnaire, Short form of the McGill Pain Questionnaire, and Wisconsin Brief Pain Questionnaire were appropriate for assessing chronic pain, in children and elderly the WBS is generally used to assess pain as other scales are often difficult to understand, which could as a result lead to an over rate of the pain intensity. In OMFS or in dental research, the VAS is more commonly used as it is more valid, sensitive, reliable and appropriate. Though, some researchers use NRS to assess OMFS pain in adults for the reason that this scale is easier to use than VAS and yields comparatively similar pain scores. This review only assessed pain scales used for post-operative OMFS or dental pain.[48]

Pippi R et al in 2017 conducted a study to evaluate the effectiveness of an extra-alveolar hemostatic agent, the Chitosan-Derived Hemostatic Agent (HemCon Dental Dressing) in controlling postsurgical bleeding in which atraumatic tooth extractions were performed in a single session under local anesthesia without a vasoconstrictor and without interruption of antiplatelet therapy.

Tooth Extraction sites were divided into two groups: Study Group (I) received the Chitosan-Derived Hemostatic Agent (HemCon Dental Dressing) and control group

(II) received a common hemostatic sponge (CollaPlug, Zimmer Dental) was placed and secured in situ with a suture. All patients underwent extraction of two teeth in the same sitting, with each in a different dental hemi arch and the hemostatic method to be used was randomly chosen.

The mean application time was considerably shorter in the test (Chitosan-Derived Hemostatic Agent) group than in the control group; the mean bleeding time in the control group was considerably shorter than in the test (Chitosan-Derived Hemostatic Agent) group; pain values were lower in the test (Chitosan-Derived Hemostatic Agent) group than in the control group, especially at suture removal; and postextraction socket healing was better in the test (Chitosan-Derived Hemostatic Agent) group than in the control group.[49]

S Sharma et al in 2017 conducted a study to evaluate the efficacy of (Axiostat chitosan) Hemostatic Dental dressing in achieving early post extraction hemostasis and determining its effect on healing and pain of the extraction wound, as compared with conventional Dental dressing method of after extraction in patients on oral antiplatelet therapy. In the study 40 patients (80 extractions sites i.e. split mouth study design) on oral antiplatelet drugs were included without altering patient's drug regime. Tooth Extraction sites were divided into two groups: Study Group (I) received Axiostat Hemostatic Dental Dressing and control group (II) received conventional method; pressure pack with sterile gauze under biting pressure followed by suturing if necessary was used to achieve hemostasis.

They concluded that Axiostat established to be an efficient hemostatic agent that significantly lessens the bleeding time, minimum post operative pain and superior healing of the extraction wound in patients on oral antiplatelet drugs post extraction. On comparing the results of this study with their study in **2012** on HemCon Dental Dressing, Axiostat Dental Dressing (ADD) is found to be as the mean time taken to achieve hemostasis is significantly lower when ADD (73 seconds) or HDD (53 seconds) was used compared with conventional method.[11]

Ijaz Bano et al in 2017 discussed the vital properties of chitosan important for ideal wound dressings. So, exploiting chitosan properties and modifying into various forms can be fearlessly used as dressing material for wounds. The dressing materials based on chitosan and its derivatives have the properties of high durability, good biocompatibility, non-toxicity, good water uptake capacit. Also, chitosan and its derivatives in combination with natural or synthetic polymers would lead to accelerate wound healing. So, chitosan-based material may be considered as an outstanding dressing for wound management due to their antimicrobial nature, ability to accelerate wound contraction and healing, haemostatic and analgesic.[12]

Nishant Sinha in 2018 conducted a study on 50 cardiac patients undergone single tooth extraction without stopping or altering the antiplatelet therapy and axiostat (chitosan based dental dressing) was positioned in the extracted socket for Hemostasis. Patients were evaluated for the efficiency of axiostat as a hemostatic measure in the study. All patients who underwent extraction under the protocol that they followed showed the average hemostatic time in all the patients was 1.5 minutes.

They conducted that axiostat (Chitosan based dental dressing) is quite efficient as the haemostatic agent and is of outstanding aid in cardiac patients undergoing tooth extraction; as the use of axiostat (Chitosan based dental dressing) significantly reduces the danger of thromboembolism by allowing the continuation of antiplatelet therapy. Supplementary the antimicrobial property of the axiostat (Chitosan based dental dressing) and superior post extraction healing can be used in other surgical tooth extraction also in other minor oral surgery. The understanding and cost factor of the product between dental surgeons are necessary.[9]

MATERIALS AND METHOD

SOURCE OF DATA:

Randomized split mouth study, prospective and comparative in nature was carried out in 40 patients (80 Extraction sites) who reported to the Department of Oral and Maxillofacial Surgery over the period of 18 months.

TIME PERIOD OF STUDY:

1st January 2017 to 30th June 2018.

SAMPLE SIZE:

40 patients (80 Extraction sites) who reported to the Department of Oral and Maxillofacial Surgery for tooth extraction procedure under inclusion criteria were included in this study.

INCLUSION CRITERIA:

- Patients in the age group of 18-40 years.
- Molars indicated for extraction under local anaesthesia. .
- Patient in good health.
- Subjects of both the gender.

EXCLUSION CRITERIA:

- Patients with known allergy to shellfish.
- Existing moderate or severe infection.
- Medically compromised patients.
- Patients on anticoagulant therapy.
- Patient with known allergy to local anesthetic agent.
- Mentally challenged patients.
- Patients not willing to volunteer for study.

SAMPLING TECHNIQUE:

- 40 patients (80 extraction sites) who reported to the Oral and Maxillofacial Surgery department for tooth extraction procedure under the inclusion criteria were divided into two groups i.e. divided (Group A = 40 sites & Group B= 40 sites) randomly. Randomization was done by computer generated random list and sealed envelope technique. In Group A (study group), axiostat dental dressing was placed into the extraction socket after extraction of mandibular first molars. In group B (control group), conventional dental dressing with a sterile piece of gauze was placed after extraction of mandibular first molars. 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 shellfish, local anaesthesia and patients on anticoagulant therapy, medically compromised patients and mentally challenged patients were excluded from this study.

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 Existing moderate or severe periapical infection; if present then those patients were excluded from the study.

Routine investigations like recording of blood pressure, hematological assessments such as random blood sugar levels, especially 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 Wong–Baker FACES pain rating 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. 2ml disposable syringes - Luer lock (Unolok) , needle size - 0.45 X 38 mm, 25 gauge.
3. LOX 2%, lignocaine hydrochloride with 1:2,00,000 adrenaline available in 30ml vials, manufactured by Neon Laboratories Limited.
4. Standard exodontia armamentarium for mandibular molar extractions.
5. Axiostat dental dressing (D11 1cm x 1 cm).
6. Conventional dental dressing (sterile gauze piece).
7. Stop watch
8. Gloves
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.

In group A (study group) patients, atraumatic extraction was carried out using the standard extraction technique following the complete onset of anesthesia. After completion of the extraction of mandibular first molars, axiostat dental dressing was removed from its sterile packaging and was placed loosely fitted into the extraction socket, at the height of crestal bone and was stabilized in its place, direct under figure pressure for 20-30 seconds and it was removed by irrigating it with saline after achieving hemostasis. Time to achieve hemostasis was noted for Axiostat dental dressing using stopwatch in seconds.

In group B (control group) patients, extraction was done using conventional extraction technique, after adequate anesthesia was achieved. After completion of the extraction of mandibular first molars, conventional dental dressing with a sterile piece of gauze was placed into the extraction socket at the height of crestal bone and was stabilized in its place, wherever possible with direct finger pressure. Time to achieve hemostasis was noted for conventional dental dressing using stopwatch in seconds.

The stopwatch was set after the tooth was extracted completely out of the socket and the timer was stopped after achieving complete hemostasis. In both the groups socket was left open without placement of sutures. Both the surgeon and the patients could be aware of the use of axiostat dental dressing versus control method. For this reason to reduce the Bias, similar contralateral or counterpart teeth were extracted in all the cases.

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 the telephone number of surgeon who could be contacted in case of postoperative bleeding and were prescribed the following medications.

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

- Tab. Ranitidine 150 mg (Tab. Rantac 150, J.B Chemicals and Pharmaceuticals Limited) twice a day, for 5 days.

- Rescue medications T ab. Aceclofenac 100 mg and Paracetamol 325 mg combination (Tab. Zerodol-P, Ipca Laboratories Limited) were prescribed to be taken as and when needed.

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 3^{rd} , 7^{th} ,15^{th} and 30^{th} post extraction day and post operative complications such as delayed healing, pain and alveolar osteitis (dry socket) were assessed by another surgeon (the observer) who was unaware of which dental dressing is used to achieve hemostasis after extraction.

METHOD OF DATA ANALYSIS:

40 patients (80 Extraction sites) were assessed immediately after extraction and on 3^{rd},7^{th} , 15^{th} and 30^{th} post extraction day following extraction of mandibular first molar by another observer. Parameters such as time to achieve hemostasis after extractions, post-operative complications i.e. delayed healing, pain, and alveolar osteitis (dry socket) were evaluated between axiostat dental dressing and conventional dental dressing.

Assessment of duration required for post-operative hemostasis :

The duration required for post-operative hemostasiswas noted for both study and control sites from the beginning of the extraction till complete hemostasis was achieved and were measured in unit seconds using a stopwatch. Post-operative hemostasis was evaluated using scores of 1, 2, 3, and 4.(mins).

Score	Criteria
1	when bleeding is managed within 5 minutes postoperatively
2	when bleeding is managed within 5-10minutes postoperatively
3	when bleeding is managed within 10-20 minutes postoperatively
4	If additional hemostatic techniques are required such as pressure with surgical packs or sutures.

Table 1. Post-operative hemostasis evaluation scores.

ASSESSMENT OF POST OPERATIVE PAIN:

Pain perception was assessed with the help of a **Wong–Baker FACES pain rating scale** which was explained to the patient pre extraction and post extraction. The patient was asked to choose the face that best depicted the pain they were experiencing according to the 6 point Wong-Baker pain rating scale . These measurements were done after 30mins,1hr, 2hrs, hrs, 6hrs, 12hrs, 24hrs and 48hrs post-extraction by the patient and was evaluated by the observer on the 3rd pod. According to Wong-Baker FACES pain rating scale 0 indicated no pain, 2 indicated hurts little bit ,4 - hurts little more ,6 -hurts even more ,8 -hurts whole lot and 10-hurts worst (Figure 1).[42]

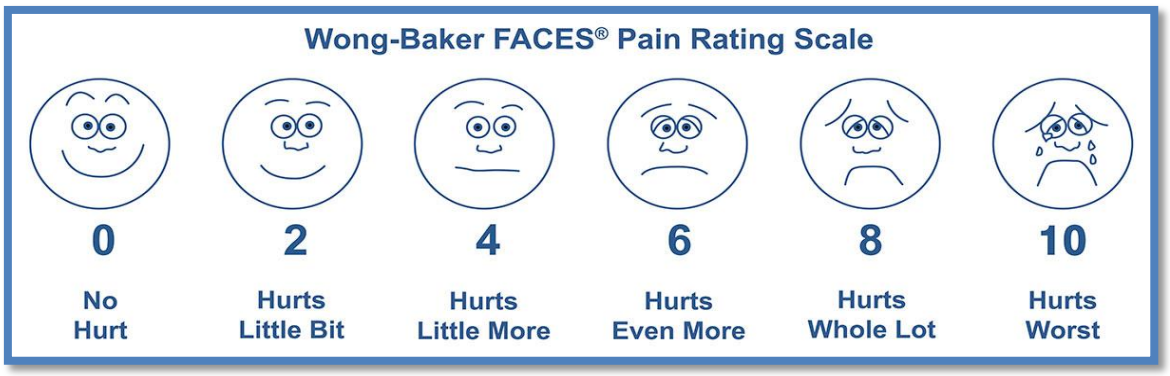


Figure 1. Wong–Baker FACES pain rating scale.[42]

ASSESSMENT OF POST OPERATIVE RESCUE MEDICATION TAKEN AND NUMBER.

Patient was asked to note the time of rescue medication taken and number of medications taken and this was recorded in the data for further evaluation

ASSESSMENT OF POST OPERATIVE HEALING:

Healing was considered to be delayed if there was incomplete soft tissue coverageover the extraction socket.It was assessed using the standardized index **by Landry, Turnbull and Howley** scores. These healing score index starts from 1 to 5. These measurements were done on **3rd, 7th, 15th and 30th**post-extraction day. According to Landry,Turnbull and Howley scores,1 indicated very poor healing, 2 indicated poor healing,3 indicated good healing,4 indicated very good healing and 5 indicated excellent healing.[47]

Healing Index	Score	Tissue Color	Response To Palpation	Granulation Tissue	cision Margin
1	Very Poor	>=50% Gingiva is Red With Suppuration	Bleeding	Present	Not epithelialized
2	Poor	>=50% Gingiva is Red	Bleeding	Present	Not epithelialized with connective tissue exposed
E	Good	>=25% And<50% Of Gingiva is Red.	No Bleeding	Absent	No Connective Tissue Exposed
4	Very Good	<25% Of Gingiva is Red	No Bleeding	Absent	No Connective Tissue Exposed
5	Excellent	All Tissue Pink	No Bleeding	Absent	No Connective Tissue Exposed

Table 2. Healing score index by **Landry, Turnbull and Howley.**[47]

ASSESSMENT OF POST OPERATIVE COMPLICATION (ALVEOLAR OSTETITS) :

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

STATISTICAL ANALYSIS:

The descriptive statistics like mean and standard deviation were obtained for continuous parameters, while frequencies and percentages were obtained for discrete parameters. Duration of hemostasis for two dressing methods were compared using paired t-test. The comparison of score distribution in patients treated with two dressing techniques was performed using Pearson's Chi-square test. The pain score distribution between two treatment groups at each time point was compared using Wilcoxon signed rank test. Further, the rescue medications required and the number of rescue medications needed were compared between groups using Pearson's Chi-square test. The comparison of healing score between two treatment groups was carried out using Wilcoxon signed rank test at each time point. Fisher's zexact test was used to determine the association between presence of alveolar osteitis and the groups.

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

PLATE I

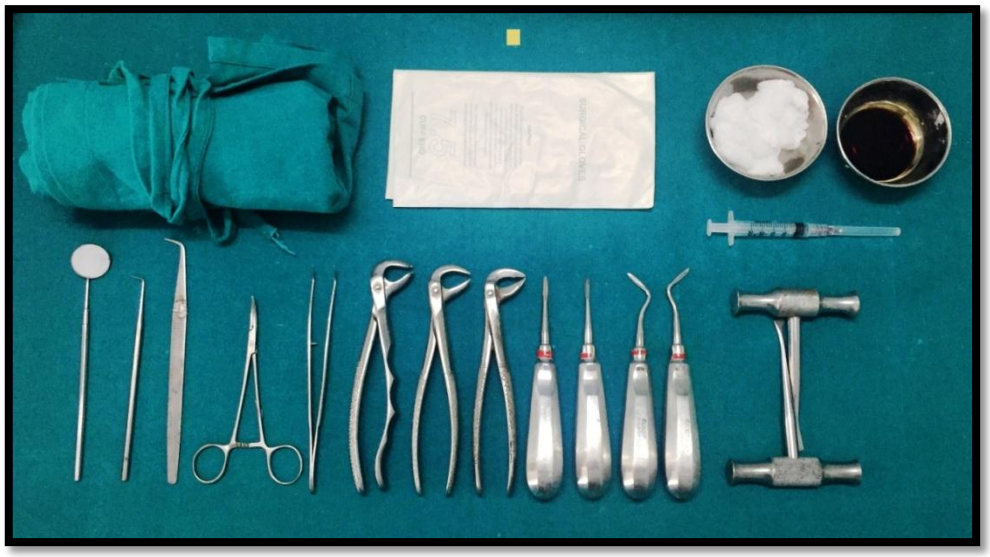


Figure 2: Armamentarium used for extraction in group- A

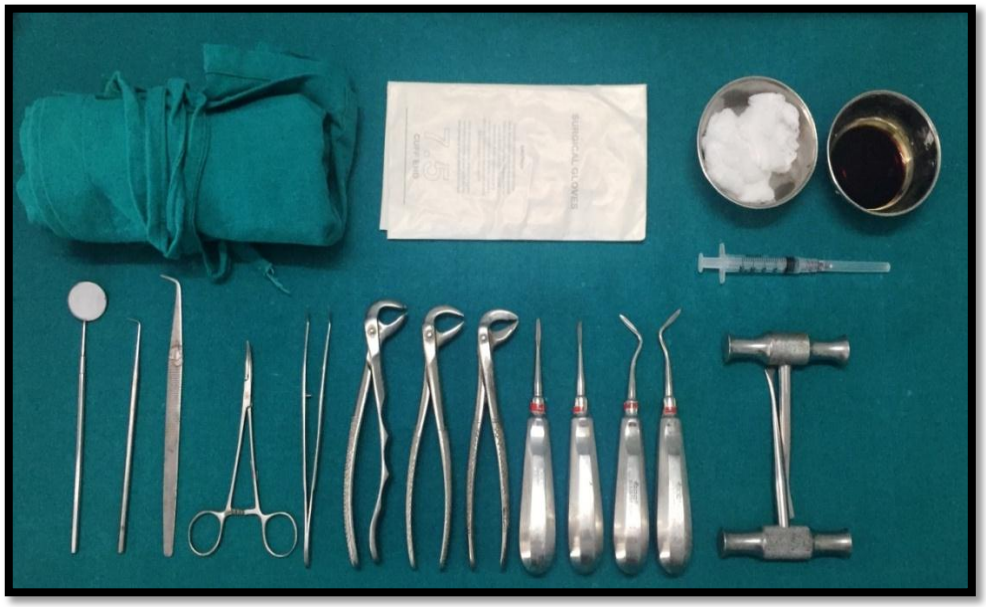


Figure 3: Armamentarium used for extraction in group- B

PLATE II

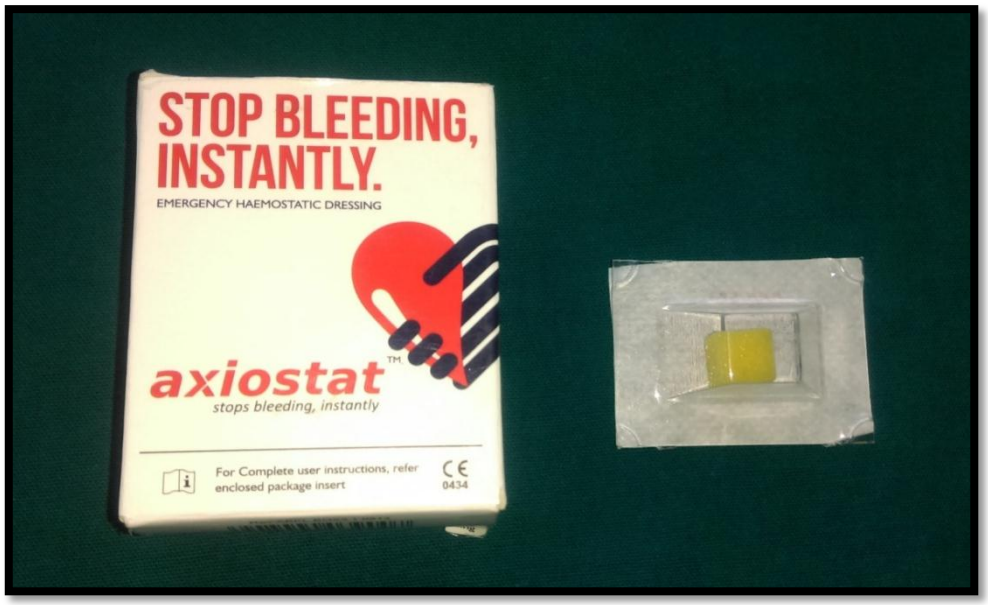


Figure 4: Axiostat dental dressing

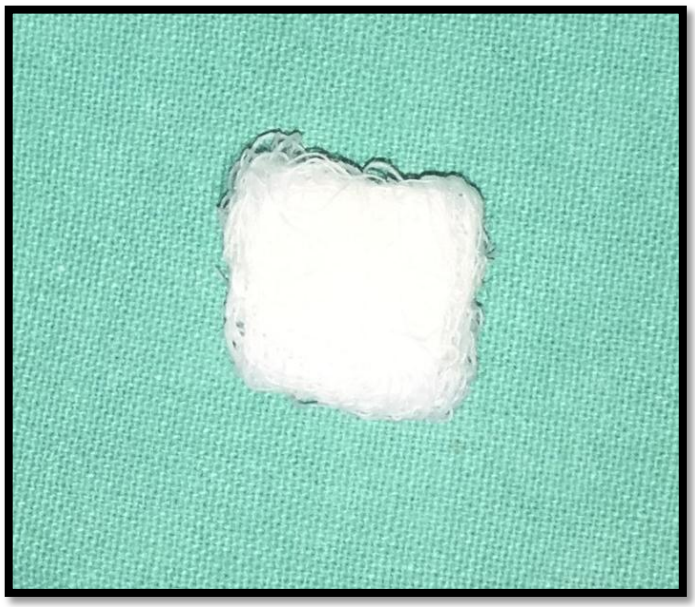


Figure 5: Conventional dental dressing with a sterile piece of gauze.

PLATE III

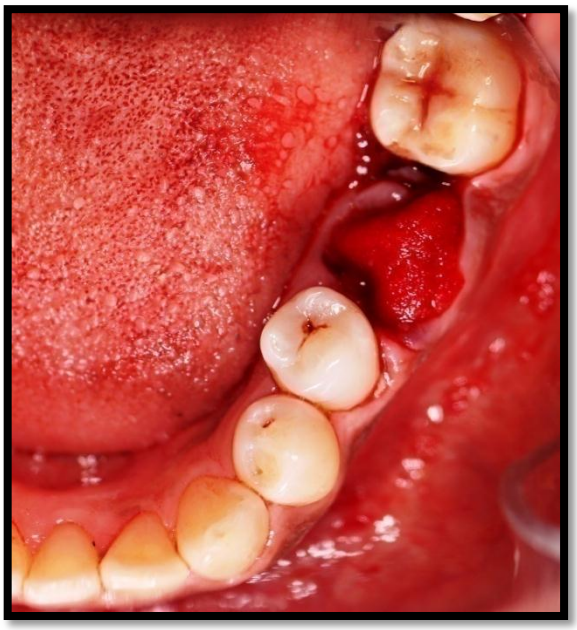


Figure 6: Application of axiostat dental dressing on extraction socket of mandibular first molar.

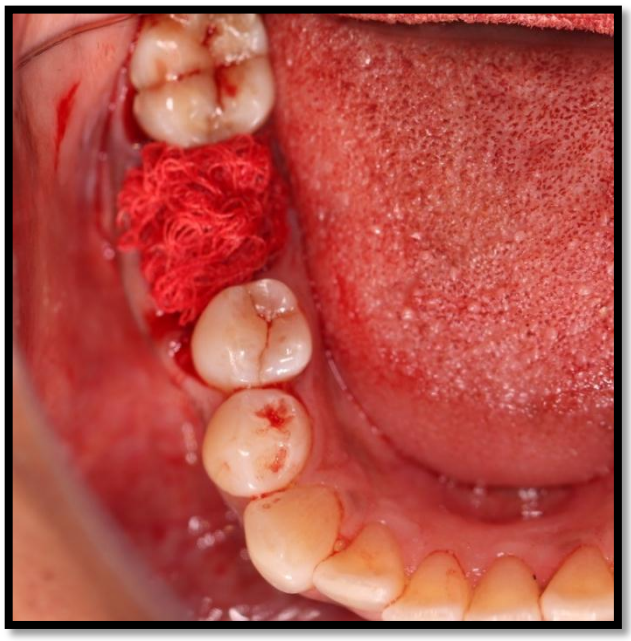


Figure 7: Application of conventional dental dressing with sterile piece of gauze on extraction socket of mandibular first molar.

PLATE IV

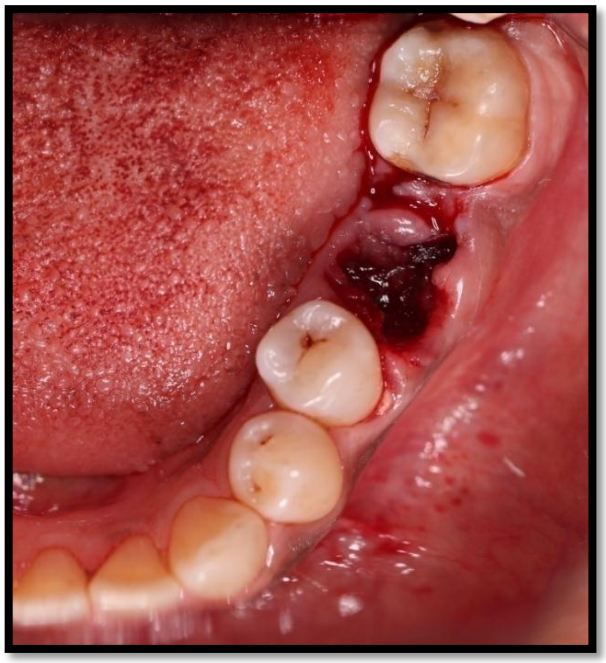


Figure 8: Early hemostasis achievement (ADD SITE)

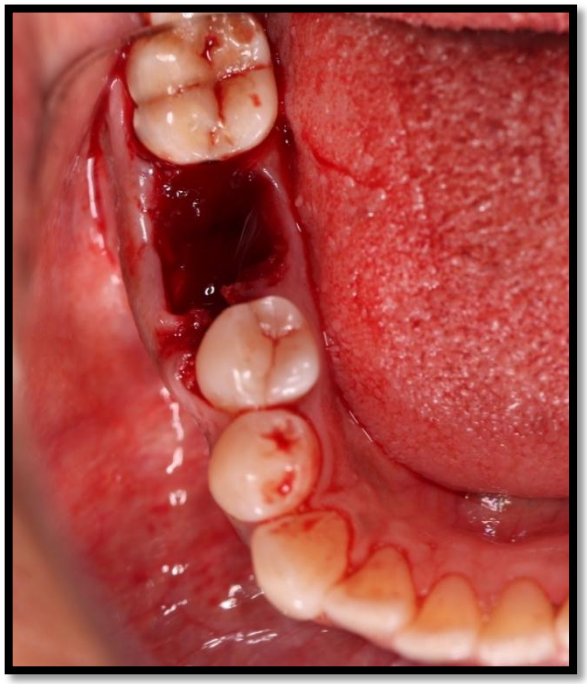


Figure 9: Hemostasis achievement
(Conventional dental dressing site)

PLATE V (3rd Pod)

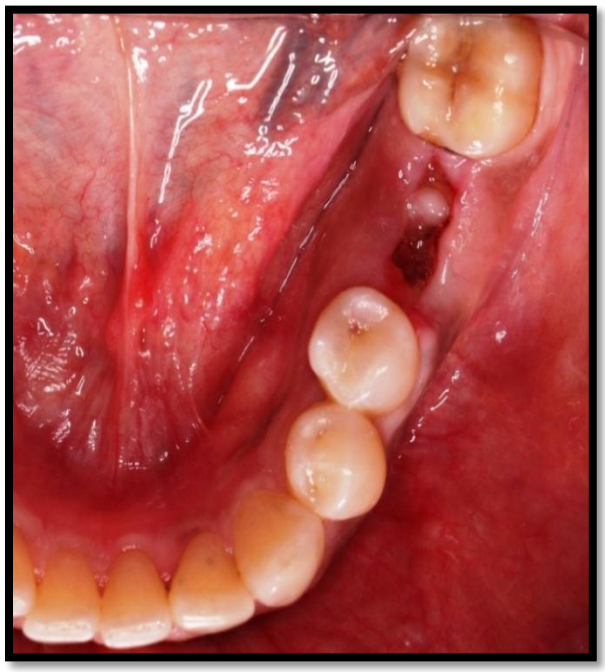


Figure 10: 3rd Post operative day follow up (ADD SITE)

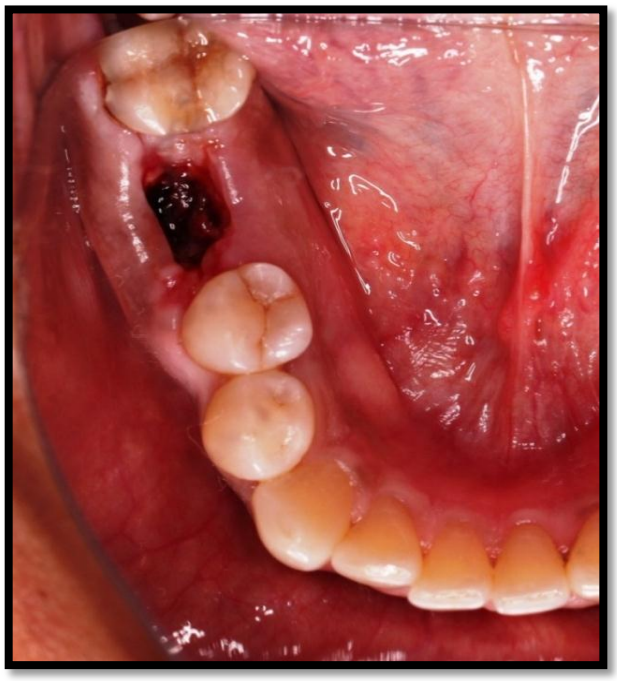


Figure 11: 3rd Post operative day follow up

(Conventional dental dressing site)

PLATE V (3rd Pod)

PLATE V (7th Pod)

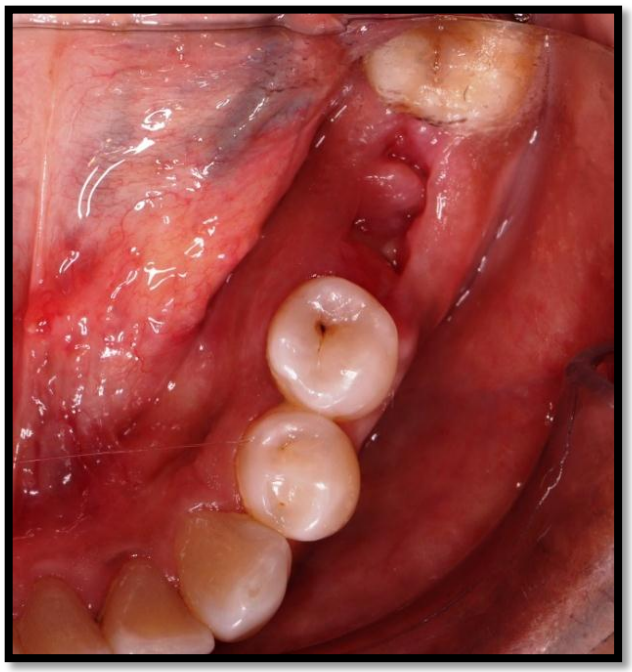


Figure 12: 7th Post operative day follow up (ADD SITE)

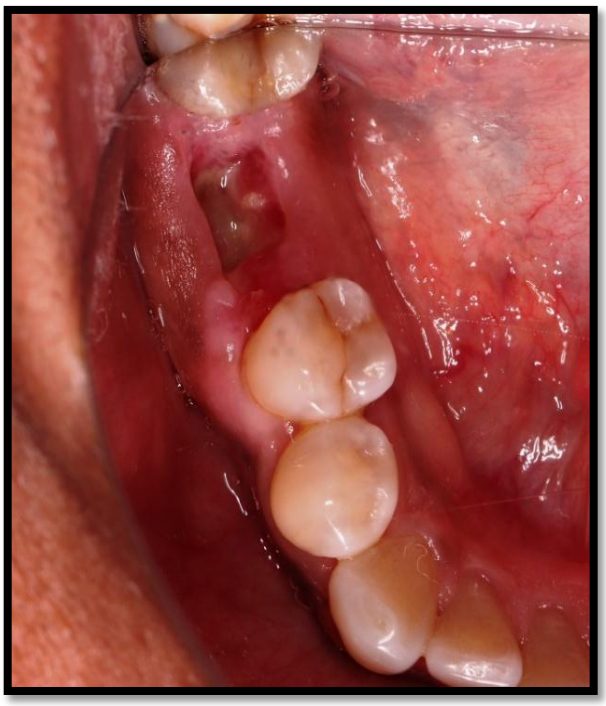


Figure 13: 7th Post operative day follow up

(Conventional dental dressing site)

PLATE V (15th Pod)

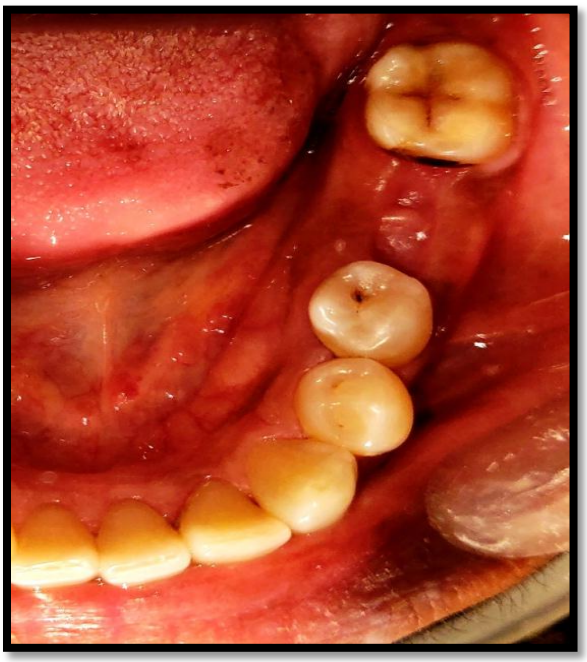


Figure 14: 15th Post operative day follow up (ADD SITE)

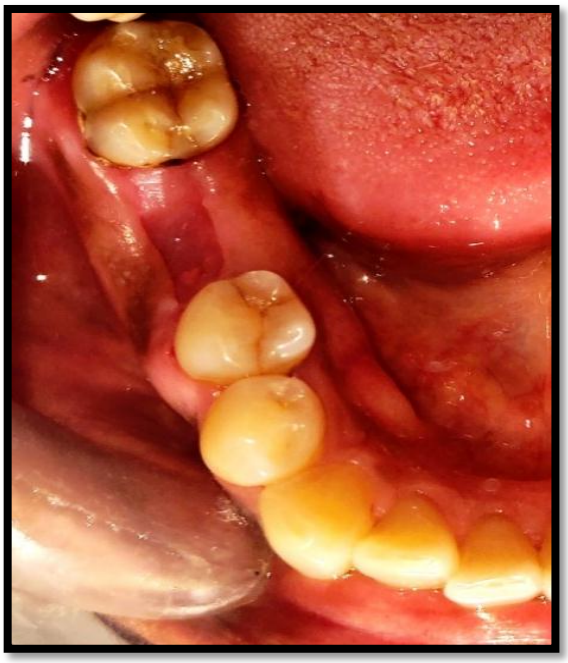


Figure 15 : 15th Post operative day follow up
(Conventional dental dressing site)

PLATE V (30th Pod)

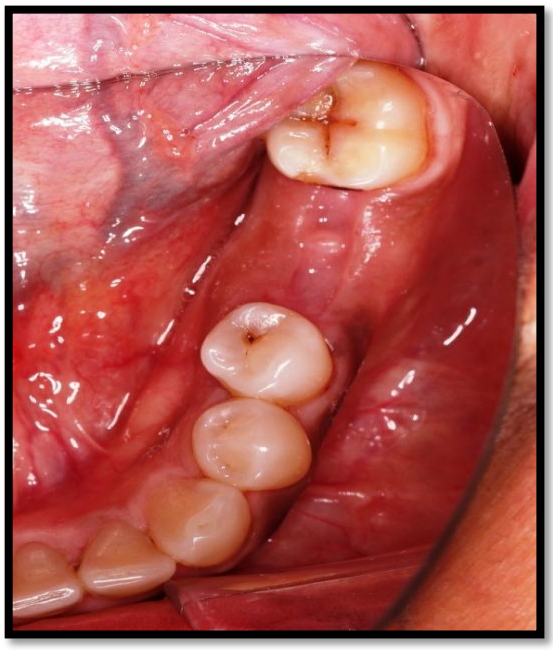


Figure 16 : 30th Post operative day follow up (ADD SITE)

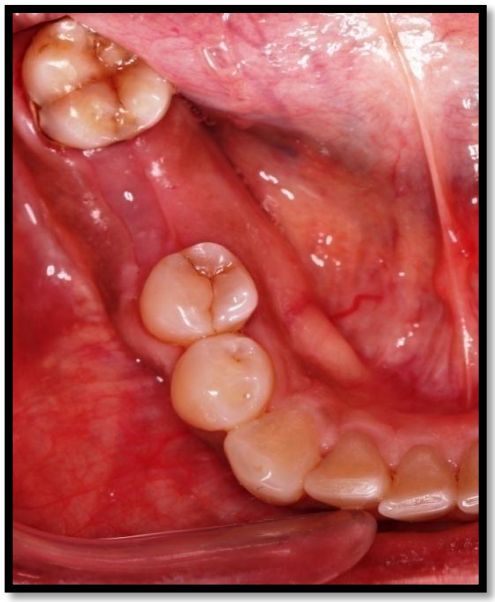


Figure 17 : 30th Post operative day follow up

(Conventional dental dressing site)

RESULTS

This prospective, randomized study was carried out on 40 patients (80 extraction sites),who 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 2017 to 30th June 2018. These patients were randomly divided into two groups of 40 extraction sites in each. In study group patients, axiostat dental dressing was placed into the extraction socket after mandibular first molars extraction while conventional dental dressing with a sterile piece of gauze was placed after mandibular first molars extraction in control group patients. All extractions were performed by the same operator.

Table 3 provides the distribution of patients according to age and the descriptive statistics for age. Out of 40 patients, maximum i.e. 37 (92.5%) were in the age range of 21-40 years and only 3 (7.5%) cases were below 20 years. The mean age of patients was 32.5 years with a standard deviation of 6.22 years and ranged between 18-40 years. A graphical representation of the distribution of the patient according to age category is illustrated through column chart in Graph 1.

Table 4 provides the distribution of patients according to gender in two treatment group. Out of 40 patients, 23 (57.5%) were females and 17 (42.5%) were males. Graph 2 illustrates graphical representation of distribution of patients according to gender through pie chart.

Table 5 provides the descriptive statistics for bleeding time. The mean time was 1.358 minutes with standard deviation of 0.332 minutes and range of 1.3 minutes and Table 6 gives the descriptive statistics for clotting time. The mean time was 5.186 minutes with standard deviation of 0.652 minutes and range of 2. 0 minutes. A graphical representation of the mean bleeding and clotting time is illustrated through column chart in Graph 3.

Table 7 gives the descriptive statistics for duration (Sec.) of hemostasis in axiostat dental dressing and in conventional dental dressing. Using conventional method (control), the mean duration was 231.18 sec with a standard deviation of 69.03 sec. The duration ranged between 132-420 sec. Using axiostat, the mean duration was 53.68 sec with a standard deviation of 4.96 sec and range 47-66 sec. The mean time difference between conventional and axiostat dental dressing methods for patients

compared using paired t-test and was statistically highly significant than zero as indicated by p-value < 0.0001. A graphical representation of mean duration of hemostasis according in two dressing methods is illustrated through column chart in Graph 4.

Table 8 gives the number of patients with scores as per conventional and axiostat dressing methods. In the conventional type, there were 32 (80%) cases with score of 1, while 8 (20%) had score 2. In the axiostat type, all 40 (100%) patients had score of 1. None of the patients had score of 3 and 4 in both the treatment methods. The distribution of scores in two dressing methods differed significantly as indicated by p-value of 0.009 using Pearson's Chi-square test and pulling the cells with values 0. A graphical representation showing distribution of patients according to score in two dressing methods is depicted through column chart in Graph 5.

Table 9 provides the descriptive statistics for pain score at different times in two dressing methods. It shows that the mean pain score at all the time points in axiostat dressing sites were smaller as compared to that of conventional dressing sites (control). At 30 min, the scores were the same i.e. 0.0 for both methods resulting into insignificant difference with p-value of 0.999. After 1 hr., the mean score in conventional method was 0.45 (median: 0.0), while in axiostat method, the mean was 0.0 (median:0.0), and the difference in the distribution of scores between groups was statistically significant with p-value of 0.003.

Similarly, after 2 hrs, the mean score in conventional group was 1.9 (median: 2), while in axiostat group was 0.7 (median: 2), and the difference in the distribution of scores was statistically highly significant with p-value < 0.0001. At the end of 4 hrs, the mean score in conventional group was 1.35 (median: 1), while in axiostat group was 0.8 (median: 0), and the difference in the distribution of scores was statistically significant with p-value of 0.022.

At the end of 6 hrs, the difference in the distribution was statistically insignificant. After 12 hrs, the mean score in conventional method was 2.7 (median: 2.0), while for axiostat group was 1.65 (median: 2.0). The difference of score distribution between two groups was statistically significant with p-value of 0.043. After 24 hrs, the mean score in conventional group was 4.50 (median: 4.0), while for axiostat group was 3.05 (median: 2.0). The difference of score distribution between two groups was statistically significant with p-value of 0.004.

At the end of 48 hrs, the mean score in conventional group was 2.65 (median: 4.0), while for axiostat group was 0.35 (median: 0.0). The difference of score distribution between two groups was statistically highly significant with p-value of < 0.0001. Obtained using Wilcoxon sign rank test; Line diagram showing mean pain score at different time points in two dressing methods is illustrated in Graph 6.

Table 10 gives the distribution of patients according to rescue medication required in two dressing methods. In conventional type, all 40 (100%) cases required rescue medication, while in the Axiostat type, 24 (60%) cases required medication. The proportion of cases requiring rescue medication differed highly significant as

indicated by p-value < 0.0001 using Pearson's Chi-square test. Column chart showing number of patients according to rescue medication in two dressing methods is illustrated graph 7.

Table11 gives the distribution of patients according to number of medications required in two dressing methods. In conventional type, majority i.e. 20 (50%) patients required 2 medications, followed by 13 (32.5%) patients requiring 3 medications, 5 (12.5%) requiring 4 and 2 (5%) requiring 1. In the axiostat type, there were 15 (62.5%) cases who required only one medication, followed by 8 (33.3%) with 2 and 1 (4.2%) required 3 medications. The difference in the distribution was statistically highly significant with p-value < 0.0001 obtained using Pearson's Chi-Square test. Graph 8 provides the column chart representation patients according to number of rescue medication in two dressing methods.

Table 12 gives the descriptive statistics for healing score according to days for two dressing methods. Using Wilcoxon sign rank test On 3rd day, the difference between median score of conventional [3.00] and axiostat [4.00] method was highly significantly different as indicated by p-value < 0.0001. Similarly, on 7th day, the median score of conventional [4.00] and axiostat [5.00] method differed highly significantly with p-value < 0.0001. However, beyond this time, at 15th and 30th day, the median scores were same [5.00] in both the treatment methods indicating statistically insignificant difference with p-values 0.317 and 0.999 respectively. Line diagram showing mean healing score at different time points in two dressing methods is illustrated in graph 9.

Table 13 is a depiction of the distribution of patients according to presence / absence of alveolar osteitis in two dressing methods. It shows that alveolar osteitis was absent in all the cases in both the groups obtained using Fisher's exact test; Column chart showing number of patients as per alveolar osteitis in two dressing methods is illustrated in graph 10.

DISCUSSION

Tooth extraction or removal is a basic procedure taught to all trainees in dental school and most commonly practiced by general clinicians.

Post-extraction bleeding can be caused due to local or systemic factors. Locally, it may result due to soft tissue or bone bleeding. There are many reasons for soft tissue bleeding, one of which is traumatic extraction, leading to laceration of blood vessels (arterial, venous or capillary). Osseous or bone bleeding can be from either the nutrient canals or from the central vessels. It can be associated with inflammation at the site of extraction, presence of infection, traumatic extraction and failure of the patient to follow post-extraction instructions. Some of the systemic factors include platelet problems, coagulation disorders or excessive fibrinolysis and inherited or acquired problems (medication induced).[3]

Hemostasis is a physiological process that stops bleeding from the site of injury while maintaining normal blood flow elsewhere in the circulation. It is the first step of wound healing. Blood loss is stopped by formation of haemostatic plug. Endothelium in the blood vessels acts as an anticoagulant surface which helps in maintaining blood in its fluid state, but if the blood vessel gets damaged, the components of the sub endothelial matrix are exposed to blood. Some of these components will activate two main processes of hemostasis to initiate formation of a blood clot which will be predominantly composed of platelets and fibrin. This process is activated within seconds of an injury and remains localized to the site of injury.[7]

Newer hemostatic agents and techniques used in the field of exodontia to achieve faster hemostasis have also been described in the recent years for the perfection in exodontia procedures and benefit to the patients undergoing tooth extraction. These advancements aim for early hemostasis and post extraction healing with lesser post operative complications after extraction of tooth.

AXIOSTAT DENTAL DRESSING

There are wide array of techniques suggested for the management of postextraction bleeding, both in healthy and medically compromised patients.[3] Chitin/Chitosan-based products are a new generation of hemostatic medical products that have been shown to achieve early hemostasis as well as improve postoperative healing.[5]

Axiostat dental dressing is manufactured from Chitin, and obtained from shells of crustaceans.[11] Chitin is a co-polymers of N-acetylglucosamine and N-glucosamine units randomly or block distributed throughout the biopolymer chain depending on

the processing method used to derive the biopolymer. The biopolymer is termed chitin when the number of N-acetyl-glucosamine units is higher than 50%. On the other hand when the number of N-glucosamine units is higher, the term chitosan is used.[27]

Chitin is basically polysaccharide, polymer of glucosamine that is purified & partially deacetylated to form soluble chitosan aqueous gel, which is dried in moulds that converted into a sponge like material that is highly electropositive in nature.[5]

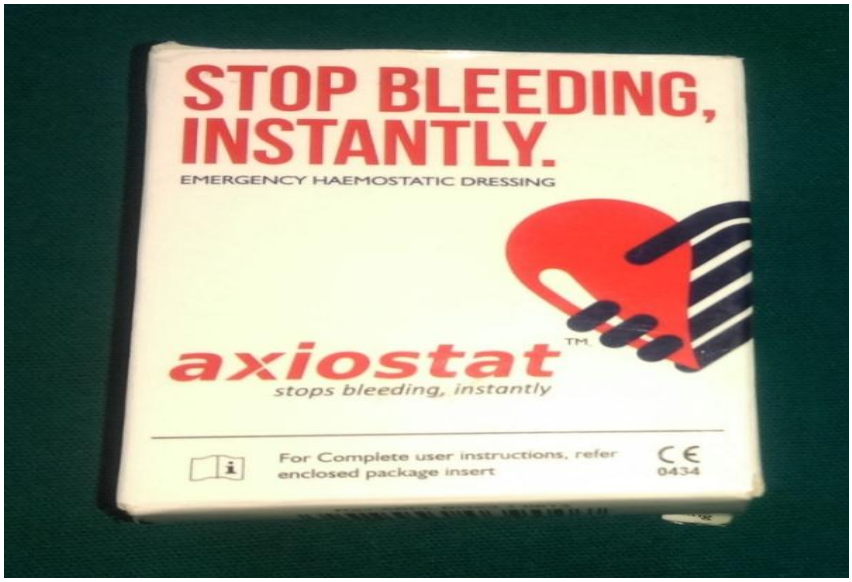


Figure 18. Axiostat dental dressing.

Axiostat dental dressing (ADD) is made-up from Poly [-(1, 4)-2-amino-2-deoxy-D-glucosamine] which is a natural biomaterial, polysaccharide, isolated and purified from non-mammalian sources (Axio Biosolutions Pvt. Ltd., Ahmedabad, India). It comes under GRAS (Generally Recognized as Safe) category of USFDA and ISO accredited & FDCA approved material.[10]

It has some unique characteristics such as it is polycationic and insoluble in nature, biodegradable, bioadhesive, and non-toxic which is why it has been extensively used all around the world as an emergency haemostatic dressing for accidents, pre-hospital emergency care, combat wounds to arrest bleeding .[5]

Chitosan enhances hemostasis by interacting with cellular components forming a cellular lattice that entraps cells to form an artificial clot. The creation of a clot occurs independently of the extrinsic or intrinsic clotting pathways.[6]

Mechanism of hemostatic action of axiostat is based on the charge interactions. It attracts blood components through ionic interactions and forms strong seal at wound site, while reducing pain. Although hemostasis proceeds rapidly, there is no heat generation during hemostasis that might cause thermal injury to the wound site.

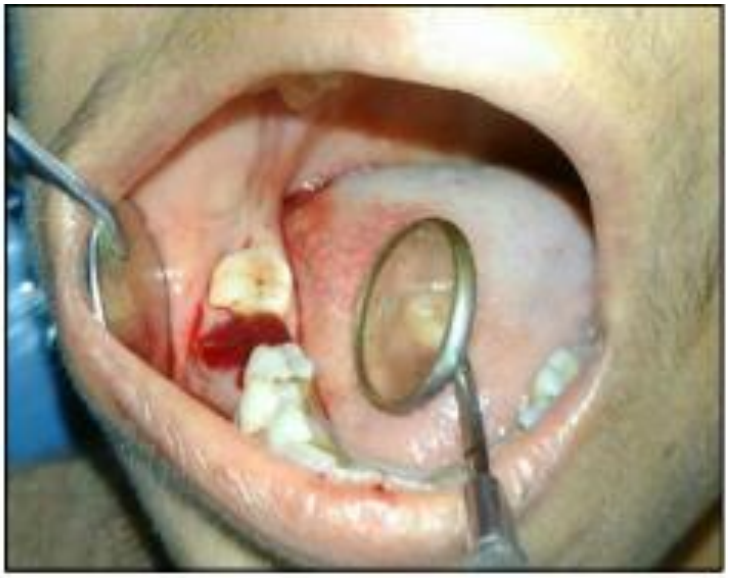


Figure 19: Axiostat dental dressing placed immediately post extraction of the first molar.[9]

Axiostat dental dressing being highly electropositive attracts red blood cells and platelets, having negative charge. Axiostat dental dressing while forming a strong seal at the mucosal wound site, allows the body to effectively activate its coagulation pathway. The platelets and red blood cells continue to be drawn towards axiostat and strengthen the initial seal.[5,11]

Chitin/chitosan dressings are believed to promote hemostasis by local vasoconstriction and by acting as a scaffold for erythrocyte agglutination. These topical dressings also physically occlude the bleeding surgical site and possess antimicrobial properties due to having an acidic pH. Axiostat dental dressings are designed to maintain this seal and serve as a scaffold for aggregation of platelets and red blood cells until hemostasis is achieved. It does not rely solely on the clotting cascade to stop bleeding. One advantage is its application on an actively bleeding surface, in contrast to the use of other local hemostatic agents which are preferably applied on dry surfaces.[5, 11]

The additional antibacterial property of chitosan (Axiostat) provides a barrier in opposition to a wide range of oral microbes along with early hemostasis which is beneficial to lessen the postoperative pain.[11]

Analgesic activity of chitosan (Axiostat dental dressing) acts by absorbing proton ions via chitosan which are released in the inflammatory area. The free fundamental −NH2 groups on chitosan protonate decreases the pH of effected area and causes the effective analgesic impact in an acidic environment[12].

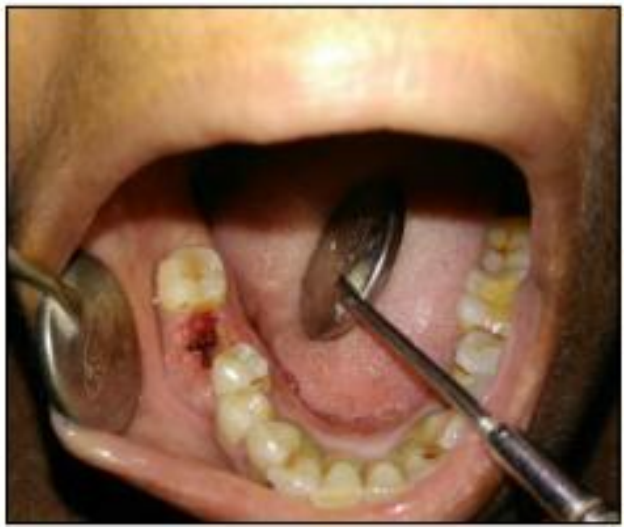


Figure 20: Extracted first molar socket healing next day after removal of axiostat dental dressing.[9]

Chitosan biopolymer effectively depolymerizes to release N-acetyl-d-glucosamine, which initiates fibroblast proliferation during the process of wound healing. Healing is the process which restores the integrity of injured tissues preventing organisms from deregulation of homeostasis.Chitosan monomer helps in ordered deposition of collagen and stimulates increased level of natural hyaluronic acid synthesis at the wound site. Chitosan based dressings (Axiostat) have a strong tissue adhesive property and provide an antibacterial barrier against a wide range of gram positive & gram negative organisms. Chitosan provides a cellulosic matrix for the regeneration of skin tissues and promotes macrophages to cease abnormal growth activity, helping in quicker full thickness healing of the wound.[12]

Our study aimed to compare the efficiency of axiostat dental dressing with conventional dental dressing for hemostasis after extraction of mandibular first molars. A prospective, randomized study was carried out on 40 patients (80 extraction

sites) reportedto 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 40 extraction sites each. In the study Group axiostat dental dressing was placed into the extraction socket after mandibular first molars extraction while conventional dental dressing with a sterile piece of gauze was placed after mandibular first molars extraction 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 range of age of patients in two groups were obtained. Out of 40 patients, maximum i.e. 37 (92.5%) were in the age range of 21-40 years and only 3 (7.5%) cases were below 20 years. The mean age of patients was 32.5 years with a standard deviation of 6.22 years and ranged between 18-40 years, as given in Table 3. A graphical representation of the distribution is illustrated through column chart in graph 1.

The distribution of patients according to gender in two treatment group is provided in Table 4. Out of 40 patients, 23 (57.5%) were females and 17 (42.5%) were males. Graph 2illustrates graphical representation of distribution of patients according to gender through pie chart.

During dental extraction procedures, it is important to maintain a fine balance between bleeding and clotting, so that blood circulation is maintained at the extraction site without excessive loss of blood, for optimum surgical outcome.

Table 5 provides the descriptive statistics for bleeding time. The mean time was 1.358 minutes with standard deviation of 0.332 minutes and range of 1.3 minutes.

Table 6 gives the descriptive statistics for clotting time. The mean time was 5.186 minutes with standard deviation of 0.652 minutes and range of 2,0 minutes. A graphical representation of the mean bleeding and clotting time is illustrated through column chart in Graph 3**.**

In our study using Axiostat, the mean duration was 53.68 sec. with a standard deviation of 4.96 sec and range 47-66 sec. While that of using conventional method (control), the mean duration was 231.18 sec with a standard deviation of 69.03 sec and rang between 132-420 sec. The difference between the mean time required for hemostasis for conventional and Axiostat dressing methods for patients was compared using paired t-test and was statistically highly significant with p-value < 0.0001. In Table 7 gives the descriptive statistics for duration (sec) of hemostasis in two dressing types. A graphical representation of the means is depicted through column chart in Graph 4.

Table 8 gives the number of patients with scores (time to achieve hemostasis scores) as per conventional and Axiostat dressing methods. In the conventional type, there were 32 (80%) cases with score of 1, while 8 (20%) had score 2. In the Axiostat type, all 40 (100%) patients had score of 1. None of the patients had score of 3 and 4 in both the treatment methods. The distribution of scores in two dressing methods differed significantly as indicated by p-value of 0.009 using Pearson's Chi-square test and pulling the cells with values 0. A graphical representation showing distribution of

patients according to score in two dressing methods is depicted through column chart in Graph 5**.**

Comparable results were found in study conducted on cardiac patients under antiplatelet therapy by **S Sharma et al (2017)**[11], in Study group (ADD) hemostasis achieved in a mean of 1 minute 13 seconds, compared with control which took a mean of 14 minutes 1 second, which was statistically significant, demonstrating improved hemostasis with the use of Axiostat Hemostatic Dressing.

Similar study conducted by **Nishant Sinha (2018)**[9]on cardiac patients undergoing tooth extraction and average time taken for the haemostatic action of the axiostat dental dressing was 1.5 minutes suggest that axiostat dental dressing (Chitosan based) is quite effective as the hemostatic agent and minimizes the risk of thromboembolism by allowing the continuation of antiplatelet therapy.

A study conducted by **Jay P.Malmquist et al (2008)**[5]on patients taking oral anticoagulation therapy (OAT) were included for treatment without altering their anticoagulant medication regimens and they found that HemCon chitosan-based dental dressing treated sites, achieved hemostasis in <1 min & control wounds in 9.53 mins (P< .001).

Study conducted by **Kale TP et al (2012)**[44]conducted a study on patients taking oral anticoagulation therapy (OAT) and they found that in study sites Hemostasis was found to be achieved quicker (mean = 53 seconds) than the control sites (mean = 918 seconds) which was statistically significant (P <0.001) with all HemCon chitosan based placed sites.

While on contrary, study conducted by **Pippi R et al (2017)[49] in study group** the HDD chitosan based was applied, whereas in the control site, a common hemostatic sponge (CollaPlug, Zimmer Dental) was applied and stabilized in situ with a suture. They compare the mean application time, the mean bleeding time and the total time required for the entire procedure.

The mean application time was significantly lesser in the test group than in the control group, the mean bleeding time was considerably shorter in the control group as compared to the test group. The total time required for the entire procedure (hemostatic application and hemostasis achievement) showed no positive difference because the values observed in the control group were slightly lower than those in the test group.

Post operative complications such as post operative Pain, healing and dry socket were also recorded in our study.

PAIN

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.[50]

In the present study pain perception was assessed with the help of Wong-Baker Faces Pain Rating Scale (WBS) which was explained to the patient pre extraction and post extraction The patients were asked to rate the intensity of pain by marking on a 6 point (WBS). These measurements were done on 3rd and 7th post-extraction day.

In our study using Axiostat, the mean WBS pain score at all the time points in axiostat dressing sites were smaller as compared to that of conventional dressing sites (control). After 30 mins, the WBS scores were the same i.e. 0.0 for both methods resulting into insignificant difference with p-value of 0.999. After 1 hr., the mean WBS score in conventional method was 0.45 (median: 0.0), while in axiostat method, the mean was 0.0 (median:0.0), and the difference in the distribution of WBS scores between groups was statistically significant with p-value of 0.003.

Similarly, at the end of 2 hrs, the mean WBS score in conventional group was 1.9 (median: 2), while in axiostat group was 0.7 (median: 2), and the difference in the distribution of WBS scores was statistically significant with p-value < 0.0001. After 4 hrs., the mean WBS score in conventional group was 1.35 (median: 1), while in axiostat group was 0.8 (median: 0), and the difference in the distribution of WBS scores was statistically significant with p-value of 0.022.

After 6 hrs, the difference in the distribution was statistically insignificant. At 12^{th} hr., the mean WBS score in conventional method was 2.7 (median: 2.0), while for axiostat group was 1.65 (median: 2.0). The difference of WBS score distribution between two groups was statistically significant with p-value of 0.043. At the end of 24 hrs., the mean WBS score in conventional group was 4.50 (median: 4.0), while for axiostat group was 3.05 (median: 2.0). The difference of WBS score distribution between two groups was statistically significant with p-value of 0.004.

After 48 hrs., the mean WBS score in conventional group was 2.65 (median: 4.0), while for axiostat group was 0.35 (median: 0.0). The difference of WBS score distribution between two groups was statistically significant with p-value of < 0.0001. Obtained using Wilcoxon sign rank test; Table 9 provides the descriptive statistics for pain WBS score at different times in two dressing methods. Line diagram showing mean pain WBS score at different time points in two dressing methods is illustrated in graph 6.

Table 10 gives the distribution of patients according to rescue medication required in two dressing methods. In conventional type, all 40 (100%) cases required rescue medication, while in the axiostat type, 24 (60%) cases required medication. The proportion of cases requiring rescue medication differed highly significantly as indicated by p-value < 0.0001 using Pearson's Chi-square test. Column chart showing number of patients according to rescue medication in two dressing methods is illustrated graph 7**.**

Table 11 gives the distribution of patients according to number of medications required in two dressing methods. In conventional type, majority i.e. 20 (50%) patients required 2 medications, followed by 13 (32.5%) patients requiring 3 medications, 5 (12.5%) requiring 4 and 2 (5%) requiring 1. In the axiostat type, there were 15 (62.5%) cases who required only one medication, followed by 8(33.3%) with 2, and 1 (4.2%) required 3 medications. The difference in the distribution was statistically highly significant with p-value < 0.0001 obtained using Pearson's Chi-Square test. Graph 8 provides the column chart representation patients according to number of rescue medication in two dressing methods.

Similar inferences were found in studies conducted by **S Sharma et al (2017)** using ADD[11] and **Kale TP et al (2012)** who used HDD[44] (chitosan based dental dressing), Pain experienced by the patients throughout the week during daily activities was documented on 7th post operative day, with the visual analog scale in a range of 0 to 10, with 0 depicting no pain and 10 depicting worst pain experienced by the patient. Average pain score in study group was considerably lower than in the control group and is also statistically significant.

Results of the study conducted by **Pippi R et al (2017)[49]** in study group the HDD chitosan based was applied, whereas in the control site a common hemostatic sponge (CollaPlug, Zimmer Dental) was applied and stabilized in situ with a suture **,** The mean postoperative pain score on the evening of surgery was slightly lower in the control group compared with the test group, The mean postoperative pain score in the morning after surgery was slightly lower in the test group compared with the control group. Significant differences were found at the time of suture removal .The mean postoperative pain score in the test group was considerably lower than the control group.

Conversely, results of the study conducted by **Jay P.Malmquist et al (2008)[5]** indicated HDD (chitosan based dental dressing) relative pain score lower than control, but these findings were not statistically significant in the study.

Healing

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.

Amler MH et al (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.[16]

In our study healing was assessed using the standardized index **by Landry, Turnbull and Howley** scores. These healing score index starts from 1 to 5. These measurements were done on **3rd, 7th, 15th and 30th**post-extraction day.

In our study table 12 gives the descriptive statistics for healing score according to days for two dressing methods. Using Wilcoxon sign rank test On 3rd day, the difference between median score of conventional [3.00] and axiostat [4.00] method was significantly different as indicated by p-value < 0.0001. Similarly, on 7th day, the median score of conventional [4.00] and axiostat [5.00] method differed highly significantly with p-value < 0.0001. However, beyond this time, at 15th and 30th day, the median scores were same [5.00] in both the treatment methods indicating statistically insignificant difference with p-values 0.317 and 0.999 respectively. Line diagram showing mean healing score at different time points in two dressing methods is illustrated in graph 9.

In a study by **Klokkevold PR et al (1999)** observed that chitosan leads to differentiation of osteoprogenitor cells, facilitating the formation of bone and helps in healing which can be attributed to superior healing in study group.[22]

Shen EC et al (**2006)** in their study stated that human platelets which are stimulated by chitosan exposure releases growth factors, which helps in better healing which is observed with Axiostat dressing. [34]

According to Cunha-Reis et al ADD is a chitosan-based material, which has got cell adhesion potential and is consistent.[35]

Similar inferences were found in studies conducted by **S Sharma et al (2017)** using ADD[11] **Kale T et al (2012)[44] , Jay P.Malmquist et al (2008)[5]** HDD (chitosan based dental dressing) and they concluded that healing was significantly better in study group compared with the control group.

A study on cardiac patients undergoing tooth extraction done by **Nishant Sinha (2018)[9]** also concluded that axiostat improves post extraction healing.

Results of the study conducted by **Pippi R et al (2017)[49]**in study group the HDD chitosan based was applied, whereas in the control site a common hemostatic sponge (CollaPlug, Zimmer Dental) was applied and stabilized in situ with a suture concluded that postextraction socket healing was better in the test group as compared with the control group.

Alveolar Osteitis

Alveolar Osteitis is a well known complication after removal or extraction of tooth. The precise etiology of Alveolar osteitis is not well known. It may be due to increased local fibrinolysis which leads to disintegration of clot. The fibrinolysis is due to of plasminogen pathway activation, which can either occur through direct (physiologic) or Indirect (non – physiologic) activator substances. Clot Stabilization is very

important after dental extractions in order to prevent alveolar ostetis (dry socket) in future. The extraction sites becomes more prone to infections and alveolar osteitis (dry socket), if the clot disintegrates.[51]

Table 13 is a depiction of the distribution of patients according to presence / absence of alveolar osteitis in two dressing methods. It shows that alveolar osteitis was absent in all the cases in both the groups Obtained using Fisher's exact test; Column chart showing number of patients as per alveolar osteitis in two dressing methods is illustrated in graph 10.

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 **Kale TP (2012)[44], S Sharma et al (2017)[11]**, **Pippi R et al (2017)[49]** no case of dry socket was noted.

While the study was done by **Jay P.Malmquist et al (2008)[5]** concluded that**,** although while using HDD alveolar osteitis incidence was lower than control, these findings were not statistically significant in this study.

Considering the competency of Axiostat Dental Dressing, only a small amount is required to attain complete hemostasis. Hence there is no clinical indication to fully pack the extraction socket.

The anti-bacterial property of chitosan (axiostat), providing a barrier against wide range of oral microbes & early hemostasis can also explain the reason behind minimal pain & complications in the study group compared to control and also for superior postoperative healing in study group.

Features	Benefits
Broad use	To achieve early hemostasis in patients after extraction of teeth.
Pain relief	Provides a seal to protect wound bed
Safety profile	Biocompatible
	No adverse effects reported in clinical use
	No systemic reactions
Application	Simple, available in appropriate size, place on wound & apply pressure
Handling	Flexible, conformable to tissue surfaces
Removal	Can be removed as soon as hemostasis is achieved

Table 14. Advantages of using axiostat dental dressing.[11]

SUMMARY AND CONCLUSION

Tooth extraction is one of the most universal persistent oral surgical procedures performed in regular dental practice and post extraction bleeding being the repeatedly encountered complication in dental practice.[1]Before the patient leaves the clinic hemostasis at the site of a dental extraction should be achieved. Failure of hemostasis could occur in any patient.[52] With the use of local hemostatic agents rapid hemostasis with the uneventful healing of extraction wounds and lesser post operative pain have gained importance and may become the standard technique for hemostasis after extractions of teeth.

A randomized prospective split mouth study was carried out in the Department of Oral and Maxillofacial Surgery for tooth extraction procedure within the inclusion criteria, over the period of 18 months where patients were randomly divided into two groups of 40 extraction site in each. In study group patients, axiostat dental dressing

was placed into the extraction socket after mandibular first molars extraction while conventional dental dressing consisted of sterile piece of gauze was placed after extraction of mandibular first molars in control group patients. The parameters of the study were to observe and compare time required for hemostasis, post operative healing, pain and alveolar osteitis.

The results of our study indicate that the mean time required to achieve post extraction hemostasis using axiostat dental dressing was significantly lesser as compared to that of conventional dental dressing. Pain experienced by the patients during daily activities was documented on 3rd postoperative day, using the Wong–Baker FACES pain rating scale **,** average pain score in study group was considerably lower than in the control group and is also statistically significant as in terms of rescue medications taken and number of rescue medications taken. Healing after extraction was better in axiostat dental dressing group compared with the control group in terms of better tissue color, epithelialization and response to palpation on 3rd and 7th post operative day and while it was insignificant on 15th and 30th post operative day. However, the difference in the proportion of post operative complications (alveolar osteitis) between two groups were found statistically insignificant.

One of the limitations of the study was restricted sample size. Hence, further large-scale clinical trials are necessary to explore additional applications of axiostat dental dressing in the field of oral and maxillofacial surgery and collection of such studies would provides greater insights into the therapeutic effects of the aforesaid agent.

As a result, it can be concluded that axiostat dental dressing is modern approach hemostatic agent which is superior to conventional dental dressing as it achieves early post extraction hemostasis. It also performs well in managing postoperative pain while post operative healing is faster as compared with conventional measures. It offers a promising role in routine extraction procedures to achieve early post extraction hemostasis at the same time post operative sequelae are reduced.

BIBLIOGRAPHY

1. Gupta G, Muthusekhar MR, Kumar SP. Efficacy of Hemocoagulase as a Topical Hemostatic Agent After Dental Extractions: A Systematic Review. Cureus. 2018 Mar;10(3).

2. Peterson LJ. Principles of uncomplicated exodontia. In: Peterson LJ, Ellis E, Hupp JR, Tucker MR. Contemporary oral and maxillofacial surgery, 4th edition; Mosby, St. Louis; 2003; pg no.116–7.

3. Sumanth KN, Prashanti E, Aggarwal H, Kumar P, Lingappa A, Muthu MS, Kiran Kumar Krishanappa S. Interventions for treating post-extraction bleeding. The Cochrane Library. 2016 Jan 1.

4. Kamoh A, Swantek J. Hemostasis in oral surgery. Dental Clinics of North America. 2012 Jan;56(1):17-23.

5. Malmquist JP, Clemens SC, Oien HJ, Wilson SL. Hemostasis of oral surgery wounds with the HemCon Dental Dressing. Journal of Oral and Maxillofacial Surgery. 2008 Jun 30;66(6):1177-83.

6. MP SK. Local hemostatic agents in the management of bleeding in oral surgery. Asian J Pharm Clin Res. 2016;9(3):35-41.

7. Gale AJ. Continuing education course# 2: current understanding of hemostasis. Toxicologic pathology. 2011 Jan;39(1):273-80.

8. Vezeau PJ. Topical Hemostatic Agents: What the Oral and Maxillofacial Surgeon Needs to Know. Oral and Maxillofacial Surgery Clinics of North America. 2016 Nov 30;28(4):523-32.

9. Sinha N, Mazumdar A, Mitra J, Sinha G, Baunthiyal S, Baunthiyal S. Chitosan based Axiostat Dental Dressing following Extraction in Cardiac Patients under Antiplatelet Therapy. Int J Oral Health Med Res 2017;3(5):65-67.

10. P. V. Mohanan1, Leo Mavely, and AshishPandya, Toxicity and hemostatic potential of poly [ß-(1, 4)-2- amino-2-deoxy-D-glucosamine] based hemostatic material on albino rabbits. Toxicology Mechanisms and Methods, 2011;

11. Sharma S, Kale TP, Balihallimath LJ, Motimath A. Evaluating Effectiveness of Axiostat Hemostatic Material in achieving Hemostasis and Healing of Extraction Wounds in Patients on Oral Antiplatelet Drugs. The journal of contemporary dental practice. 2017 Sep;18(9):802-6.

12. Bano I, Arshad M, Yasin T, Ghauri MA, Younus M. Chitosan: A potential biopolymer for wound management. International journal of biological macromolecules. 2017 Sep 1;102:380-3.

13. Kavitha K, Keerthi TS, Mani TT. Chitosan polymer used as carrier in various pharmaceutical formulations: brief review. International Journal of Applied Biology and Pharmaceutical Technology. 2011;2(2):249-58.

14. Saikia C, Gogoi P, Maji TK. Chitosan: A promising biopolymer in drug delivery applications. J. Mol. Genet. Med. S. 2015;4:006.

15. Scales JL. Control of Post-Extraction Hemorrhage. Journal of the National Medical Association. 1953 Jan;45(1):25.

16. Amler MH. Histological and histochemical investigation of human alveolar socket healing in undisturbed extraction wounds. J. Am. Dent. Assoc.. 1960;61:32-44.

17. Amler MH. The time sequence of tissue regeneration in human extraction wounds. Oral Surg Oral Med Oral Pathol. 1969 Mar 1;27(3):309-18

18. Malette WG, Quigley HJ, Gaines RD, Johnson ND, Rainer WG. Chitosan: a new hemostatic. The Annals of thoracic surgery. 1983 Jul 1;36(1):55-8.

19. Sindet-Pedersen S. Distribution of tranexamic acid to plasma and saliva after oral administration and mouth rinsing: a pharmacokinetic study. The Journal of Clinical Pharmacology. 1987 Dec 1;27(12):1005-8.

20. Wallerstein Jr RO. Laboratory evaluation of a bleeding patient. Western Journal of Medicine. 1989 Jan;150(1):51.

21. Koide SS. Chitin-chitosan: properties, benefits and risks. Nutrition research. 1998 Jun 1;18(6):1091-101.

22. Klokkevold PR, Fukayama H, Sung EC, Bertolami CN. The effect of chitosan (poly-N-acetyl glucosamine) on lingual hemostasis in heparinized rabbits. Journal of oral and maxillofacial surgery. 1999 Jan 1;57(1):49-52.

23. Matocha DL. Postsurgical complications. Emergency medicine clinics of North America. 2000 Aug 1;18(3):549-64.

24. Mi FL, Shyu SS, Wu YB, Lee ST, Shyong JY, Huang RN. Fabrication and characterization of a sponge-like asymmetric chitosan membrane as a wound dressing. Biomaterials. 2001 Jan 15;22(2):165-73.

25. VandeVord PJ, Matthew HW, DeSilva SP, Mayton L, Wu B, Wooley PH. Evaluation of the biocompatibility of a chitosan scaffold in mice.J Biomed Mater Res. 2002 Ma, r 5; 59(3):585-90.

26. Pusateri AE, McCarthy SJ, Gregory KW, Harris RA, Cardenas L, McManus AT, Goodwin Jr CW. Effect of a chitosan-based hemostatic dressing on blood loss and survival in a model of severe venous hemorrhage and hepatic injury in swine. Journal of Trauma and Acute Care Surgery. 2003 Jan 1;54(1):177-82.

27. Khor E, Lim LY. Implantable applications of chitin and chitosan. Biomaterials. 2003 Jun 1;24(13):2339-49.

28. Chou TC, Fu E, Wu CJ, Yeh JH. Chitosan enhances platelet adhesion and aggregation. Biochem Biophys Res Commun. 2003 Mar 14;302(3):480-3.

29. Connolly RJ Application of the poly-n-acetyl glucosamine–derived rapid deployment hemostat trauma dressing in severe/lethal swine hemorrhage trauma models. Journal of Trauma and Acute Care Surgery. 2004 Jul 1;57(1):S26-8.

30. Kheirabadi BS, Acheson EM, Deguzman R, Sondeen JL, Ryan KL, Delgado A, Dick EJ Jr, Holcomb JB. Hemostatic efficacy of two advanced dressings in an aortic hemorrhage model in Swine.J Trauma. 2005 Jul;59(1):25-34; discussion 34-5.

31. Adeyemo WL, Ladeinde AL, Ogunlewe MO. Clinical evaluation of postextraction site wound healing. J Contemp Dent Pract. 2006 Jul 1;7(3):40-9.

32. Wedmore I, McManus JG, Pusateri AE, Holcomb JB. A special report on the chitosan-based hemostatic dressing: experience in current combat operations. Journal of Trauma and Acute Care Surgery. 2006 Mar 1;60(3):655-8.

33. Burkatovskaya M, Tegos GP, Swietlik E, Demidova TN, Castano AP, Hamblin MR. Use of chitosan bandage to prevent fatal infections developing from highly contaminated wounds in mice. Biomaterials. 2006 Aug 1;27(22):4157-64.

34. Shen EC, Chou TC, Gau CH, Tu HP, Chen YT, Fu E. Releasing growth factors from activated human platelets after chitosan stimulation: a possible bio-material for platelet-rich plasma preparation. Clinical oral implants research. 2006 Oct;17(5):572-8.

35. Cunha-Reis C, El Haj AJ, Yang X, Yang Y. Fluorescent labeling of chitosan for use in non-invasive monitoring of degradation in tissue engineering. Journal of tissue engineering and regenerative medicine. 2013 Jan;7(1):39-50.

36. Al-Khateeb TH, Alnahar A. Pain experience after simple tooth extraction. Journal of oral and maxillofacial surgery. 2008 May 1;66(5):911-7.

37. Burkatovskaya M, Castano AP, Demidova-Rice TN, Tegos GP, Hamblin MR. Effect of chitosan acetate bandage on wound healing in infected and noninfected wounds in mice. Wound Repair and Regeneration. 2008 May;16(3):425-31.

38. Yang J, Tian F, Wang Z, Wang Q, Zeng YJ, Chen SQ. Effect of chitosan molecular weight and deacetylation degree on hemostasis. Journal of Biomedical Materials Research Part B: Applied Biomaterials. 2008 Jan;84(1):131-7.

39. Dai T, Tegos GP, Burkatovskaya M, Castano AP, Hamblin MR. Chitosan acetate bandage as a topical antimicrobial dressing for infected burns. Antimicrobial agents and chemotherapy. 2009 Feb 1;53(2):393-400.

40. Muzzarelli RA. Chitins and chitosans as immunoadjuvants and non-allergenic drug carriers. Marine drugs. 2010 Feb 21;8(2):292-312.

41. Mao S, Sun W, Kissel T. Chitosan-based formulations for delivery of DNA and siRNA. Advanced drug delivery reviews. 2010 Jan 31;62(1):12-27.

42. Garra G, Singer AJ, Taira BR, Chohan J, Cardoz H, Chisena E, Thode Jr HC. Validation of the Wong-Baker FACES pain rating scale in pediatric

emergency department patients. Academic Emergency Medicine. 2010 Jan;17(1):50-4.

43. Kong M, Chen XG, Xing K, Park HJ. Antimicrobial properties of chitosan and mode of action: A state of the art review. Int J Food Microbiol 2010;144:51–63

44. Kale TP, Singh AK, Kotrashetti SM, Kapoor A. Effectiveness of HemCon dental dressing versus conventional method of haemostasis in 40 patients on oral antiplatelet drugs. Sultan Qaboos University Medical Journal. 2012 Aug;12(3):330.

45. Sanandam M, Salunkhe A, Shejale K, Patil D. Chitosan bandage for faster blood clotting and wound healing. International Journal of Advanced Biotechnology and Research. 4: 1: 47. 2013;50.

46. Chang HH, Wang YL, Chiang YC, Chen YL, Chuang YH, Tsai SJ, Heish KH, Lin FH, Lin CP. A novel chitosan-γPGA polyelectrolyte complex hydrogel promotes early new bone formation in the alveolar socket following tooth extraction. PloS one. 2014 Mar 21;9(3):e92362.

47. Ashraf S. Use of aloe vera and honey on post extraction healing.

48. Sirintawat N, Sawang K, Chaiyasamut T, Wongsirichat N. Pain measurement in oral and maxillofacial surgery. Journal of dental anesthesia and pain medicine. 2017 Dec 1;17(4):253-63.

49. Pippi R, Santoro M, Cafolla A. The Use of a Chitosan-Derived Hemostatic Agent for Postextraction Bleeding Control in Patients on Antiplatelet

Treatment. Journal of Oral and Maxillofacial Surgery. 2017 Jun 1;75(6):1118-23.

50. Monheim LM, Bennett CR. Monheim's local anesthesia and pain control in dental practice. Mosby; 1984.

51. Gowda GG, Viswanath D, Kumar M, Umashankar DN. Dry socket (alveolar osteitis): incidence, pathogenesis, prevention and management. Med Radiol. 2013 Jul 1;25(3):196-9.

52. McCormick NJ, Moore UJ, Meechan JG. Haemostasis part 1: the management of post-extraction haemorrhage. Dental update. 2014 May 2;41(4):290-6

Table 3: Age distribution of patients

Age (in years)	No.	%
0-20	3	7.5
21-40	37	92.5
Mean	32.50	
SD	6.22	
Range	18-40	

Table 4 : Gender distribution of patients

Gender	No.	%
Male	17	42.5
Female	23	57.5
Total	40	

Table 5 :Descriptive statistics for bleeding time

Bleeding time (min)	Value
Mean	1.358
Standard deviation	0.332
Range	1.3

Table 6: Descriptive statistics for clotting time

Clotting time (min)	Value
Mean	5.186
Standard deviation	0.652
Range	2.0

Table 7 : Descriptive statistics for duration of hemostasis according to two groups

Duration of hemostasis (in sec.)	Dressing type	
	Conventional (n=40)	Axiostat (n=40)
Mean	231.18	53.68
SD	69.03	4.96
Range	132-420	47-66
Mean difference	177.53	
P-value	**< 0.0001 (HS)**	

*Obtained using *paired t-test*; HS: Highly Significant

Table 8 : Distribution of patients according to score for two dressing methods

Score	Dressing method [No. (%)]		P-value*
	Conventional (n=40)	Axiostat (n=40)	
1	32 (80%)	40 (100%)	**0.009 (S)**
2	8 (20%)	0	
3	0	0	
4	0	0	

*****Using *Pearson's Chi-square test;* S: Significant

Table 9 :Descriptive statistics for pain score according to time in two dressing methods

Time point	Dressing method						Median difference	P-value*
	Conventional (n=40)			Axiostat (n=40)				
	Mean	SD	Median	Mean	SD	Median		
30 min.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.999 (NS)
1 hr.	0.45	0.85	0.00	0.00	0.00	0.00	0.00	**0.003 (S)**
2 hr.	1.90	1.86	2.00	0.70	1.24	0.00	2.00	**< 0.0001 (HS)**
4hr.	1.35	1.66	1.00	0.80	1.18	0.00	1.00	**0.022 (S)**
6 hr.	1.95	2.19	2.00	1.55	1.66	2.00	0.00	0.243 (NS)
12 hr.	2.70	2.42	2.00	1.65	1.92	2.00	0.00	**0.043 (S)**
24 hr.	4.50	1.62	4.00	3.05	2.26	2.00	2.00	**0.004 (S)**
48 hr.	2.65	1.78	4.00	0.35	1.00	0.00	4.00	**< 0.0001(HS)**

*Obtained using *Wilcoxon sign rank test;* HS: Highly Significant;S: Significant; NS:

Not Significant

Table 10 :Distribution of patients according to rescue medication in two groups

Rescue medication	Dressing methods [No. (%)]		P-value*
	Conventional (n=40)	Axiostat (n=40)	
Yes	40 (100.0)	24 (60.0)	**< 0.0001 (HS)**
No	0	16 (40.0)	

*Obtained using *Pearson's Chi-square test*; HS: Highly Significant

Table 11: Distribution of patients according to number of rescue medication administered

No. of rescue Medication	Dressing methods [No. (%)]		P-value*
	Conventional (n=40)	Axiostat (n=24)	
1	2 (5.0)	15 (62.5)	**< 0.0001 (HS)**
2	20 (50.0)	8 (33.3)	
3	13 (32.5)	1 (4.2)	
4	5 (12.5)	0	

*Obtained using *Pearson's Chi-Square test*; HS: Highly Significant

Table 12 : Descriptive statistics for healing score according to two study groups

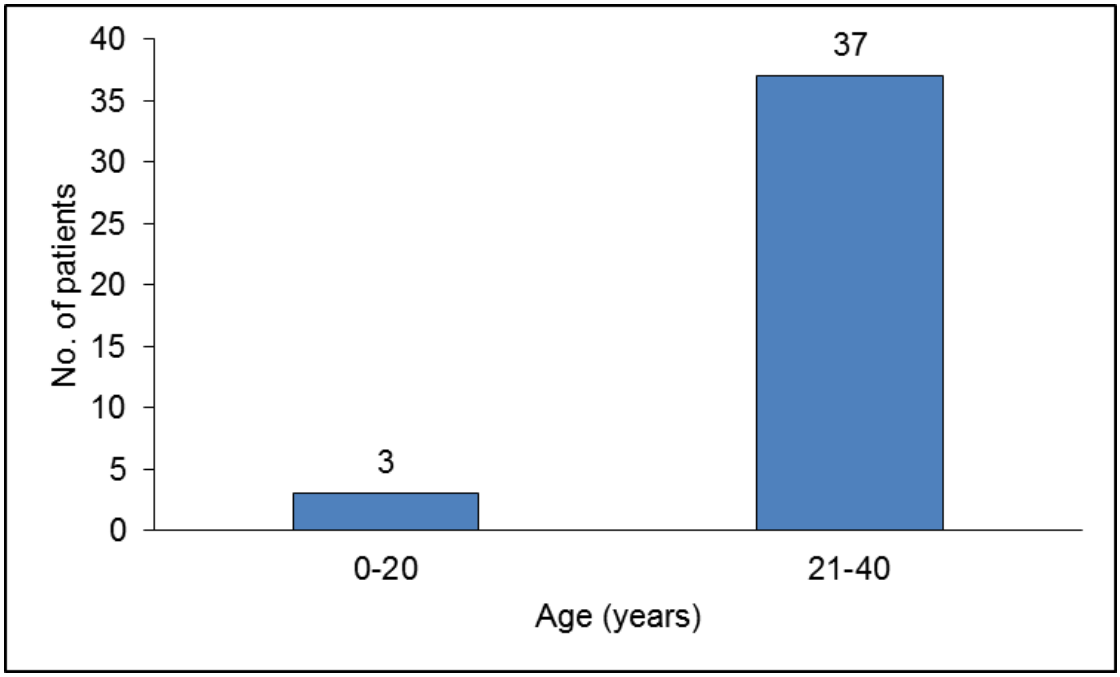
Time point	Dressing methods						Median Difference	P-value*
	Conventional (n=40)			Axiostat (n=40)				
	Mean	SD	Median	Mean	SD	Median		
3rdDay	3.25	0.67	3.00	3.88	0.40	4.00	1.00	< **0.0001 (HS)**
7thDay	4.33	0.69	4.00	4.98	0.16	5.00	1.00	< **0.0001 (HS)**
15thDay	4.98	0.16	5.00	5.00	0.00	5.00	0.00	0.317 (NS)
30thDay	5.00	0.00	5.00	5.00	0.00	5.00	0.00	0.999 (NS)

*Obtained using *Wilcoxon sign rank test;* HS: Highly Significant; NS: Not Significant

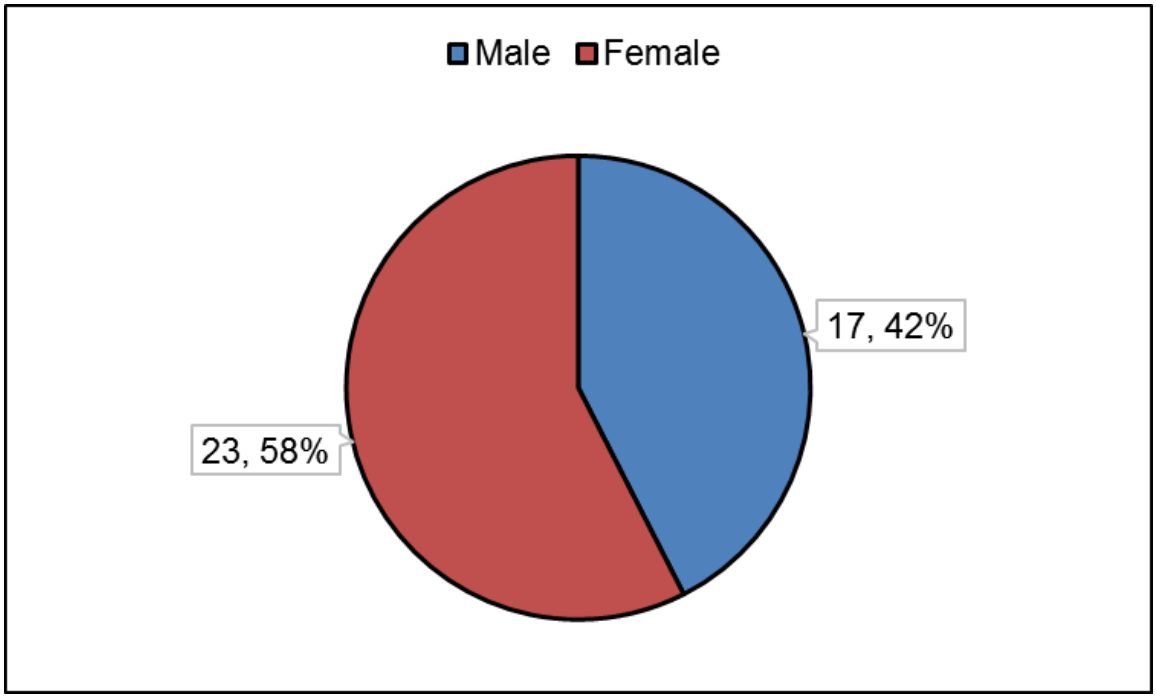
Table 13:Distribution of patients in two groups according to alveolar osteitis

Alveolar osteitis	Conventional (n=40)	Axiostat (n=40)
Present	0	0
Absent	40(100.0)	40 (100.0)

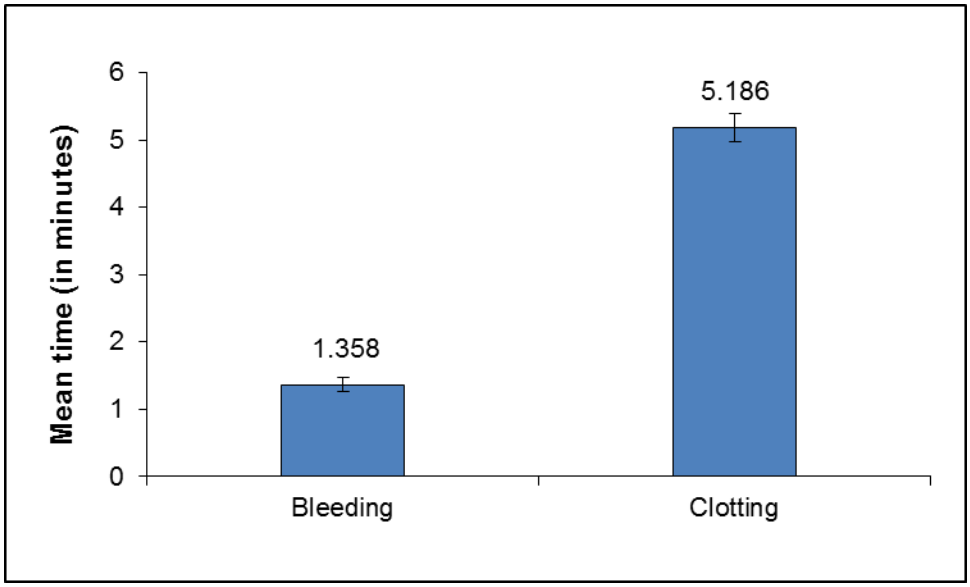
*Obtained using *Fisher's exact test*; NS: Not Significant



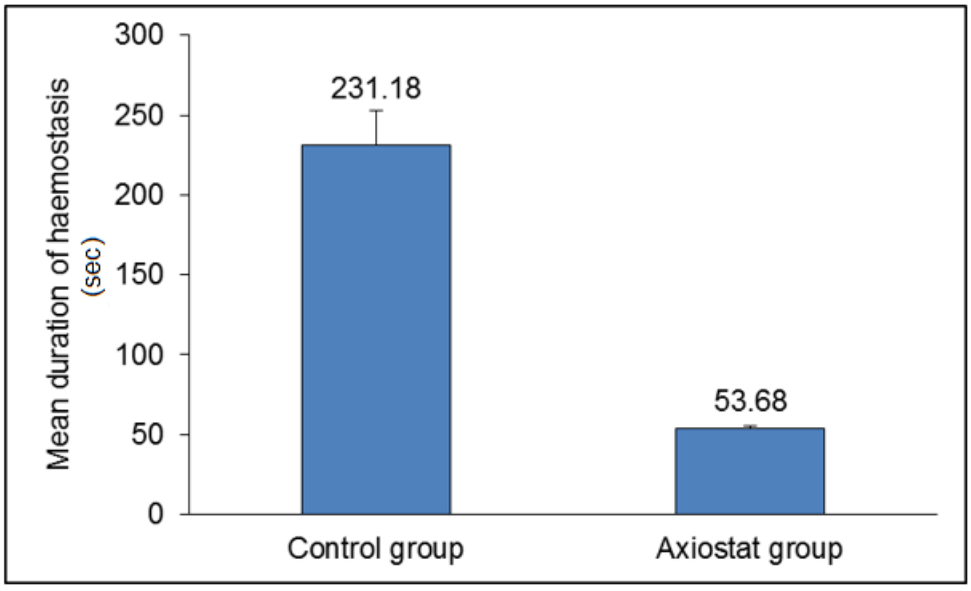
Graph 1: Column chart showing distribution of patients according to age category.



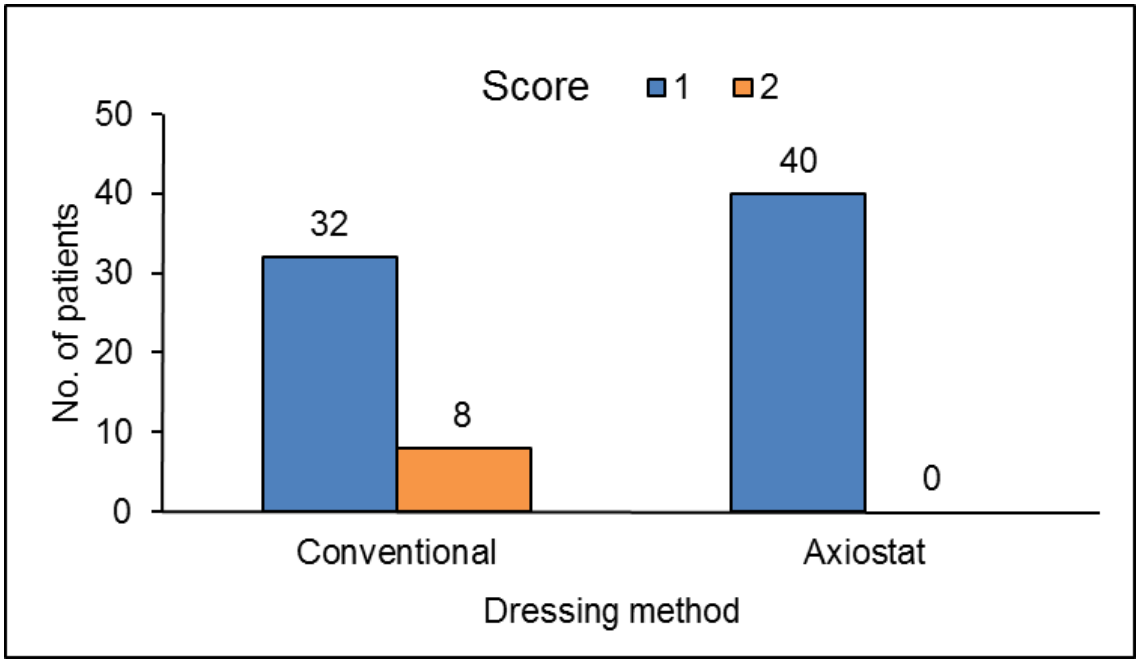
Graph 2: Pie chart showing distribution of patients according to gender.



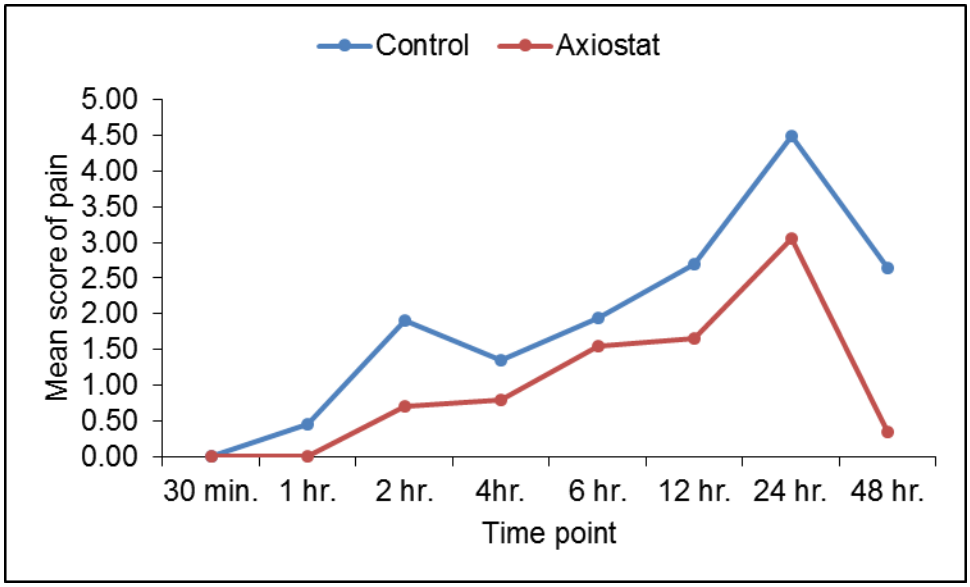
Graph 3 :Column chart showing mean bleeding and clotting time with error bars.



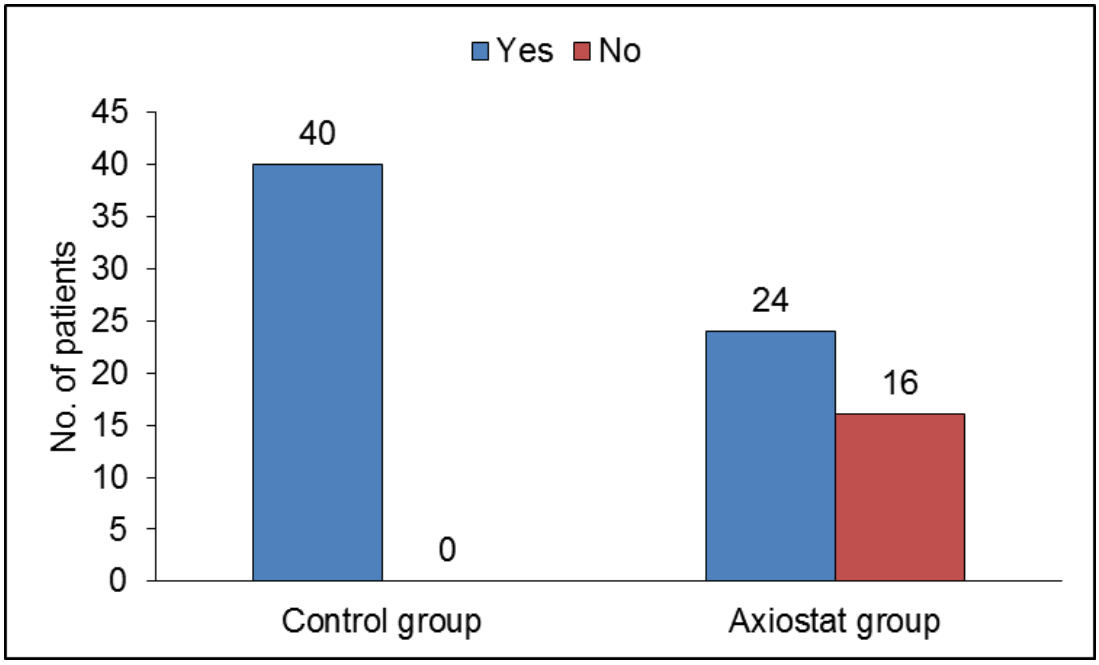
Graph 4 : Column chartshowing mean duration of hemostasis according to two study groups.



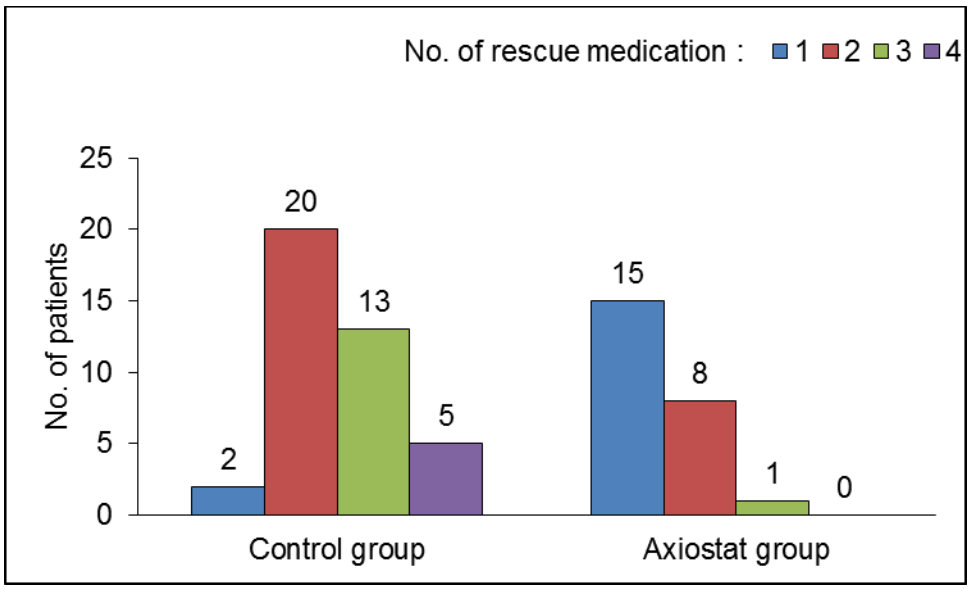
Graph 5 :Column chart showing distribution of patients according to score in two dressing methods.



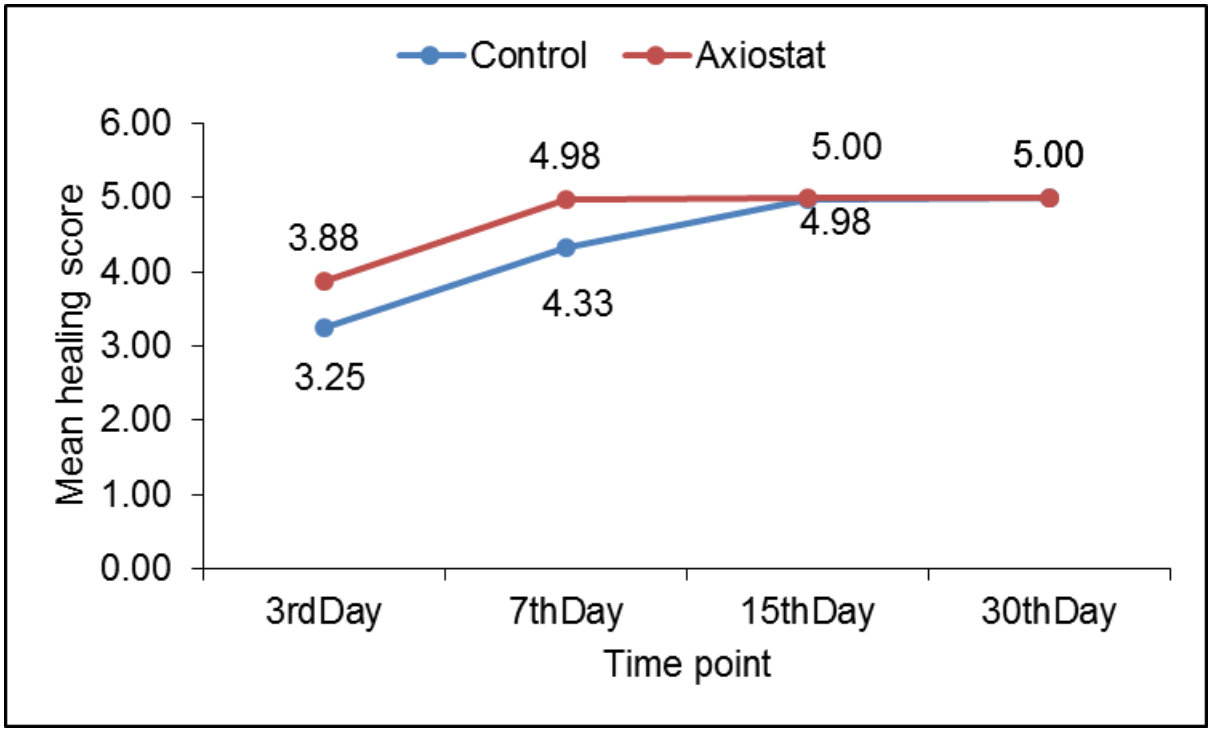
Graph 6:Line diagram showing mean pain score at different time points in two groups



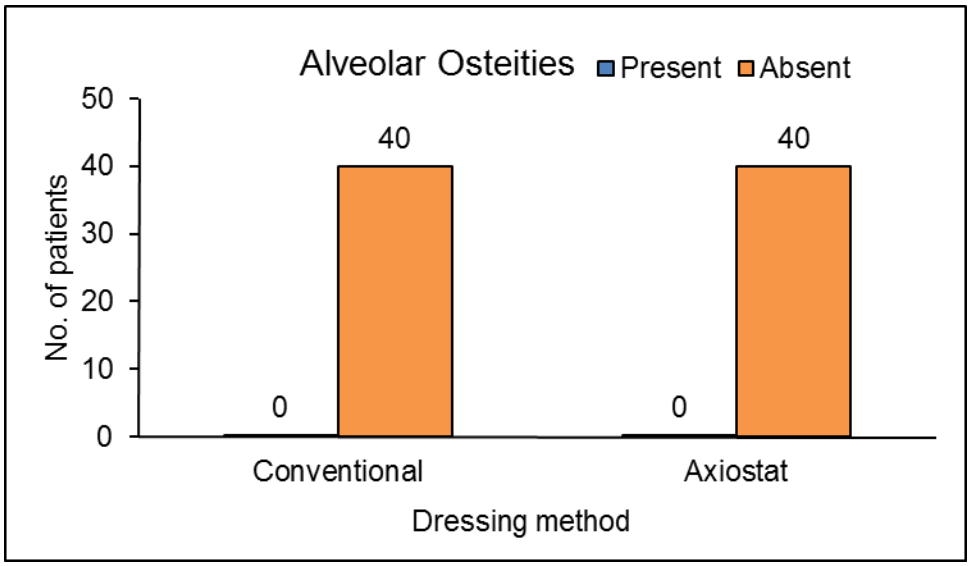
Graph 7: Column chart showing number of patients according to rescue medication in two groups.



Graph 8 :Column chart showing patients according to number of rescue medication in two groups.



Graph 9:Line diagram showing mean healing score at different time points in two groups.



Graph 10:Column chart showing number of patients for alveolar osteitis in two 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. Pre operative assessment of bleeding time and clotting time.

Bleeding time	**Clotting time**

2. Time required to achieved hemostasis-

	Study site	**Control site**
Time required to achieved hemostasis (in sec)		
Score (in mins)		

Score	**Criteria**
1	when bleeding managed within 5 minutes postoperatively
2	when bleeding managed within 5-10minutes postoperatively
3	when bleeding managed within 10-20 minutes postoperatively
4	It additional hemostatic techniques required such as pressure with surgical packs or sutures.

3. Post operative pain

Self –reported pain score **on Wong–Baker FACES pain rating scale (For pain)**

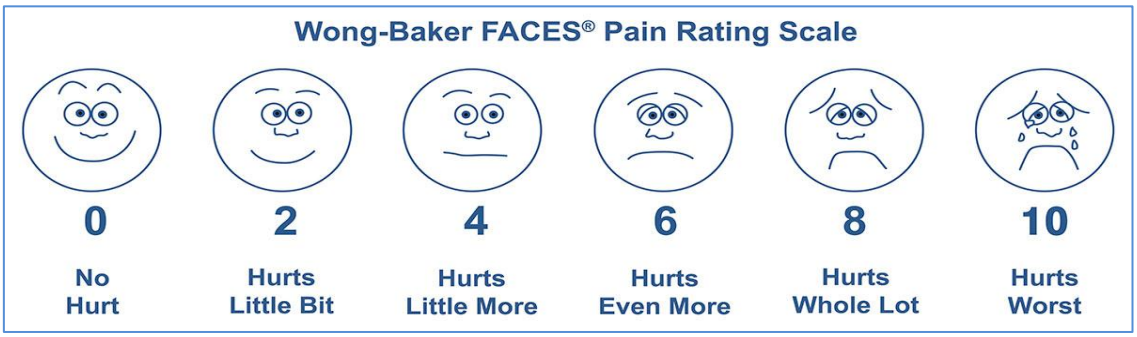
(STUDY SITE)

	0	**2**	**4**	**6**	**8**	**10**
30 mins						
1 hours						
2 hours						
4 hours						
6 hour						
12 hours						
24 hours						
48 hours						

(CONTROL SITE)

	0	**2**	**4**	**6**	**8**	**10**
30 mins						
1 hours						
2 hours						

4 hours						
6 hour						
12 hours						
24 hours						
48 hours						



4. Rescue medicines taken or not?

	STUDY SITE	**CONTROL SITE**
YES (1)		
NO (0)		

5. Number of rescue medicines taken after extraction

STUDY SITE	CONTROL SITE

6. Post operative Healing

(STUDY SITE)

	1	2	3	4	5
3rd POD					
7th POD					
15th POD					
30th POD					

(CONTROL SITE)

	1	2	3	4	5
3rd POD					
7th POD					
15th POD					
30th POD					

Healing Index	Score	Tissue Color	Response To Palpation	Granulation Tissue	Incision Margin
1	Very Poor	>=50% Gingiva Red With Suppuration	Bleeding	Present	Not Epithelized
2	Poor	>=50% Gingiva Red	Bleeding	Present	Not Epithelized With Connective Tissue Exposed
3	Good	>=25% And<50% Of Gingiva Red.	No Bleeding	Absent	No Connective Tissue Exposed
4	Very Good	<25% Of Gingiva Red	No Bleeding	Absent	No Connective Tissue Exposed
5	Excellent	All Tissue Pink	No Bleeding	Absent	No Connective Tissue Exposed

7. Post operative complication (alveolar Osteitis) Present-1, absent- 0.

ALVEOLAR OSTEITIS	Study site	Control site
Present (1)		
Absent (0)		

ANNEXURE-III

DEPARTMENT OF ORAL & MAXILLOFACIAL SURGERY

INFORMED CONSENT FORM

(Confidential)

"A Comparative Evaluation Of Axiostat With Conventional Dental Dressing methods For Hemostasis After Extraction Of Molars–

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	Sign/Thumb print	Date &Time
2._____	_____	_____
Witness' name	Sign/Thumb print	Date &Time
3._____	_____	_____
Investigator's name	Sign/Thumb print	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

46- Mandibular right first molar

Bleeding time –V

Clotting time-VI

Time required to achieved hemostasis (in secs)—VII

Score of post-operative hemostasis 1,2,3,4,5 (in mins.) – VIII

PAIN **Wong–Baker FACES pain rating scale (For pain)** –
30 mins IX

1 hour X

2 hours XI

4 hours XII

6 hours XIII

12 hours XIV

24 hours XV

48 hours XVI

Analgesic Consumed following extraction - XVII

Numbers of analgesic Consumed following extraction - XVIII

Healing was assessed using the standardized index **by Landry, Turnbull and Howley** scores.

3rd POD - XIX

7th POD - XX

15th POD - XXI

30th POD -XXII

POST OPERATIVE COMPLICATIONS: Alveolar osteities XXIII

Present-1, Absent-0

MASTER CHART (Control Group)

Sr No.	Age	Sex	Tooth No.	Bleeding Time	Clotting Time	Duration of hemostasis in secs.	Score	post operative Pain								Rescue Medic-ation	No. of Rescue Medication	Post operative Healing				Alveolar Osteitis
								30 min.	1hr	2hr	4hr	6hr	12hr	24hr	48hr			3rd pod	7th pod	15th pod	30th pod	
i	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI	XVII	XVIII	XIX	XX	XXI	XXII	XXIII
1	35	f	36	1.12	5	240	1	0	0	0	2	6	0	4	0	1	2	3	4	5	5	0
2	20	f	46	1.15	4.45	320	2	0	0	2	4	0	0	4	4	1	3	3	4	5	5	0
3	28	m	36	1.3	5	165	1	0	0	2	2	0	0	4	4	1	2	4	5	5	5	0
4	18	f	46	1.15	5.15	270	1	0	0	0	2	4	0	6	4	1	3	3	4	5	5	0
5	38	m	46	1.15	6	200	1	0	0	0	0	2	6	4	0	1	2	3	4	5	5	0
6	27	f	36	1.45	4.45	420	2	0	2	2	6	0	4	8	4	1	4	1	3	4	5	0
7	39	f	36	2.3	6	189	1	0	0	0	2	2	6	0	4	1	2	3	4	5	5	0
8	40	f	36	1.3	5.5	290	1	0	0	4	0	0	6	4	0	1	3	3	4	5	5	0
9	19	m	46	1.5	5	180	1	0	0	0	0	2	2	4	4	1	2	4	5	5	5	0
10	30	f	46	1.3	6	401	2	0	2	2	2	4	0	6	4	1	3	2	3	5	5	0
11	40	m	36	1	5	210	1	0	0	4	0	0	0	6	4	1	3	3	4	5	5	0
12	32	f	36	1.15	5	180	1	0	0	0	0	0	6	4	4	1	3	4	5	5	5	0
13	28	m	46	2	6.2	278	1	0	2	6	0	0	6	2	4	1	3	3	4	5	5	0
14	39	f	36	1	5.1	198	1	0	0	2	2	4	0	6	0	1	2	3	5	5	5	0
15	40	f	46	1	4.5	170	1	0	0	2	0	0	2	6	2	1	2	4	5	5	5	0
16	35	m	36	1	4.4	199	1	0	0	2	2	4	2	6	0	1	2	3	4	5	5	0
17	32	f	46	1.35	5	297	1	0	2	4	0	0	0	4	4	1	3	3	4	5	5	0
18	35	m	46	1	4.2	200	1	0	2	6	0	0	6	6	2	1	3	4	5	5	5	0
19	21	m	36	1.3	5.2	301	2	0	0	2	2	2	4	0	4	1	2	3	4	5	5	0
20	27	f	46	2.1	6	194	1	0	2	2	4	0	0	4	4	1	3	4	5	5	5	0
21	35	f	36	1.3	4.3	256	1	0	0	0	2	6	0	6	2	1	2	3	4	5	5	0
22	32	m	46	1.4	5.3	163	1	0	0	0	2	0	4	4	4	1	3	4	5	5	5	0
23	34	f	46	1	4.2	201	1	0	0	2	0	2	2	4	4	1	2	3	5	5	5	0
24	36	f	36	1.3	6	145	1	0	0	0	0	2	6	4	2	1	2	4	5	5	5	0
25	40	m	36	1.4	5.3	299	1	0	2	2	2	6	0	4	4	1	3	3	5	5	5	0
26	32	f	46	1.6	6	314	2	0	0	2	4	2	4	6	4	1	4	3	4	5	5	0
27	35	f	46	1.3	4.6	190	1	0	0	2	0	0	2	4	0	1	1	4	5	5	5	0
28	39	m	36	1.5	5.5	223	1	0	2	2	6	0	6	6	4	1	4	3	4	5	5	0
29	31	m	46	2.1	6	187	1	0	0	2	0	0	2	4	4	1	2	4	5	5	5	0
30	29	f	36	1.3	6	301	2	0	0	6	0	0	4	6	4	1	4	3	4	5	5	0
31	39	m	36	1.3	5	265	1	0	0	2	2	6	0	4	0	1	2	3	5	5	5	0
32	40	f	46	1.15	4.2	132	1	0	0	0	0	2	6	4	0	1	2	4	5	5	5	0
33	31	f	46	1.35	4.6	205	1	0	0	2	0	0	2	6	4	1	2	3	5	5	5	0
34	36	m	36	1.1	4.5	169	1	0	0	0	0	2	2	4	0	1	1	4	5	5	5	0
35	30	f	46	1.5	6	199	1	0	0	2	0	6	2	4	2	1	2	3	5	5	5	0
36	26	m	46	2.1	6.2	300	2	0	2	6	0	4	2	6	0	1	3	3	4	5	5	0
37	33	f	46	1.15	5	143	1	0	0	0	2	2	6	2	4	1	2	4	3	5	5	0
38	40	f	36	1.4	4.6	305	2	0	0	4	2	2	6	4	4	1	4	2	3	5	5	0
39	34	m	36	1.3	6	199	1	0	0	0	2	0	2	6	4	1	2	3	4	5	5	0
40	25	m	46	1.15	5	149	1	0	0	0	0	6	0	4	0	1	2	4	3	5	5	0

MASTER CHART (Study Group)

Sr No.	Age	Sex	Tooth No.	Bleeding Time	Clotting Time	Duration of hemostasis in secs.	Score	post operative Pain								Rescue Medic-ation	No. of Rescue Medication	Post operative Healing				Alveolar Osteitis
								30 min.	1hr	2hr	4hr	6hr	12hr	24hr	48hr			3rd pod	7th pod	15th pod	30th pod	
I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI	XVII	XVIII	XIX	XX	XXI	XXII	XXIII
1	35	f	46	1.12	5	53	1	0	0	2	2	2	4	0	0	1	1	4	5	5	5	0
2	20	f	36	1.15	4.45	49	1	0	0	0	2	0	2	0	0	0	0	4	5	5	5	0
3	28	m	46	1.3	5	50	1	0	0	2	2	4	0	4	0	1	2	4	5	5	5	0
4	18	f	36	1.15	5.15	48	1	0	0	0	0	2	2	0	0	0	0	5	5	5	5	0
5	38	m	36	1.15	6	55	1	0	0	0	0	0	2	4	0	1	1	4	5	5	5	0
6	27	f	46	1.45	4.45	58	1	0	0	0	2	2	6	0	4	1	2	3	5	5	5	0
7	39	f	46	2.3	6	66	1	0	0	0	0	0	2	4	0	1	1	4	5	5	5	0
8	40	f	46	1.3	5.5	52	1	0	0	0	0	0	2	6	0	0	0	4	5	5	5	0
9	19	m	36	1.5	5	60	1	0	0	0	2	2	0	6	0	1	1	3	5	5	5	0
10	30	f	36	1.3	6	54	1	0	0	2	4	0	0	4	0	1	2	4	5	5	5	0
11	40	m	46	1	5	49	1	0	0	2	0	0	2	0	0	0	0	4	5	5	5	0
12	32	f	46	1.15	5	51	1	0	0	0	2	2	0	2	0	0	0	4	5	5	5	0
13	28	m	36	2	6.2	59	1	0	0	2	2	6	0	6	0	1	2	4	5	5	5	0
14	39	f	46	1	5.1	57	1	0	0	0	0	0	2	4	0	1	1	3	5	5	5	0
15	40	f	36	1	4.5	52	1	0	0	0	0	2	0	2	0	0	0	4	5	5	5	0
16	35	m	46	1	4.4	49	1	0	0	0	0	2	0	2	0	0	0	4	5	5	5	0
17	32	f	36	1.35	5	51	1	0	0	2	0	0	4	2	0	1	1	4	5	5	5	0
18	35	m	36	1	4.2	48	1	0	0	0	0	2	2	6	0	1	1	4	5	5	5	0
19	21	m	46	1.3	5.2	55	1	0	0	0	0	2	0	2	0	0	0	4	5	5	5	0
20	27	f	36	2.1	6	63	1	0	0	0	0	2	4	0	0	1	1	4	5	5	5	0
21	35	f	46	1.3	4.3	51	1	0	0	2	0	2	0	2	2	0	0	4	5	5	5	0
22	32	m	36	1.4	5.3	53	1	0	0	0	0	2	4	0	0	1	1	4	5	5	5	0
23	34	f	36	1	4.2	48	1	0	0	2	0	0	2	2	0	0	0	4	5	5	5	0
24	36	f	46	1.3	6	54	1	0	0	2	0	2	0	6	0	1	1	4	5	5	5	0
25	40	m	46	1.4	5.3	62	1	0	0	0	2	6	0	4	0	1	2	3	5	5	5	0
26	32	f	36	1.6	6	54	1	0	0	0	2	0	4	0	0	1	1	4	5	5	5	0
27	35	f	36	1.3	4.6	53	1	0	0	0	0	0	2	2	0	0	0	4	5	5	5	0
28	39	m	46	1.5	5.5	58	1	0	0	0	4	0	0	6	0	1	2	4	5	5	5	0
29	31	m	36	2.1	6	60	1	0	0	2	0	6	0	4	0	1	2	3	5	5	5	0
30	29	f	46	1.3	6	56	1	0	0	0	0	0	0	6	2	1	1	4	5	5	5	0
31	39	m	46	1.3	5	49	1	0	0	0	2	2	0	2	0	0	0	4	5	5	5	0
32	40	f	36	1.15	4.2	52	1	0	0	0	0	2	0	4	0	1	1	4	5	5	5	0
33	31	f	36	1.35	4.6	54	1	0	0	2	0	0	6	6	2	1	2	4	5	5	5	0
34	36	m	46	1.1	4.5	47	1	0	0	0	0	0	2	2	0	0	0	4	5	5	5	0
35	30	f	36	1.5	6	53	1	0	0	0	0	2	0	2	0	0	0	4	5	5	5	0
36	26	m	36	2.1	6.2	65	1	0	0	6	0	2	6	6	4	1	3	3	4	5	5	0
37	33	f	36	1.15	5	49	1	0	0	0	0	2	0	2	0	0	0	4	5	5	5	0
38	40	f	46	1.4	4.6	50	1	0	0	0	2	0	0	6	0	1	1	4	5	5	5	0
39	34	m	46	1.3	6	52	1	0	0	0	2	2	4	0	0	1	1	4	5	5	5	0
40	25	m	36	1.15	5	47	1	0	0	0	0	2	2	6	0	0	0	4	5	5	5	0