# INTRODUCTION



# **REVIEW OF LITERATURE**



# **MATERIALS AND METHODS**



# RESULTS



# DISCUSSION



# SUMMARY



# LITERATURE CITED



# ABSTRACT (ENGLISH AND HINDI)



A CLINICAL AND RADIOLOGICAL STUDY ON REPAIR OF MANDIBULAR FRACTURE IN CAMELS (Camelus dromedarius)

ऊँटों (कैमेलस ड्रोमेडेरियस) में अधोहनु अस्थिभंग के विरोहण पर नैदानिक एवं क्षःरश्मिय अध्ययन

MUKESH CHAND PARASHAR M.V.Sc.

# **THESIS**

# **DOCTOR OF PHILOSOPHY**

(VETERINARY SURGERY AND RADIOLOGY)



2013

DEPARTMENT OF VETERINARY SURGERY AND RADIOLOGY COLLEGE OF VETERINARY AND ANIMAL SCIENCE RAJASTHAN UNIVERSITY OF VETERINARY AND ANIMAL SCIENCES, BIKANER-334001 (RAJASTHAN)



A CLINICAL AND RADIOLOGICAL STUDY ON REPAIR OF MANDIBULAR FRACTURE IN CAMELS (Camelus dromedarius)

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# THESIS

Submitted to the

Rajasthan University of Veterinary and Animal Sciences, Bikaner

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# **DOCTOR OF PHILOSOPHY**

(Veterinary Surgery and Radiology) FACULTY OF VETERINARY & ANIMAL SCIENCE

Ву

#### **MUKESH CHAND PARASHAR**

# 2013

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This is to certify that this thesis entitled "A CLINICAL AND RADIOLOGICAL STUDY ON REPAIR OF MANDIBULAR FRACTURE IN CAMELS (*Camelus dromedarius*)" submitted for the degree of DOCTOR OF PHILOSOPHY in the subject of VETERINARY SURGERY AND RADIOLOGY embodies bonafide research work carried out by Dr. MUKESH CHAND PARASHAR, M. V. Sc. under my guidance and supervision and that no part of this thesis has been submitted for any other degree. The assistance and help received during the course of investigation have been fully acknowledged. The draft of the thesis was also approved by Advisory Committee on .......

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#### LIST OF ABBREVIATIONS USED

СТ	Computed Tomography
Hb	Haemoglobin
PCV	Packed Cell Volume
TLC	Total Leukocyte Count
TEC	Total Erythrocyte Count
Са	Calcium
Р	Phosphorus
Mg	Magnesium
ALP	Alkaline Phosphatase
ACP	Acid Phosphatase
LDH	Lactate dehydrogenase
G-6-PD	Glucose-6- Phospho-dehydrogenase
G-6-P	Glucose-6- Phosphatase
СРК	Creatinine Phosphate Kinase
BS	Breeding Season
NBS	Non Breeding Season
SE	Standard Error



### A CLINICAL AND RADIOLOGICAL STUDY ON REPAIR OF MANDIBULAR FRACTURE IN CAMELS (Camelus dromedarius)

Ph.D. Thesis,

DEPARTMENT OF VETERINARY SURGERY AND RADIOLOGY COLLEGE OF VETERINARY AND ANIMAL SCIENCE RAJASTHAN UNIVERSITY OF VETERINARY AND ANIMAL SCIENCES, BIKANER-334001 (RAJASTHAN)

Submitted By: Major Advisor: Mukesh Chand Parashar Dr. T. K. Gahlot

#### **ABSTRACT**

The present study was conducted on 18 camels (16 males and 2 femals) which were diagnosed mandibular fractures. These animals were divided in 3 groups, comprising 6 animals in each group. Group I was considered as control group- animals of this group were treated by interdental wiring technique (I.D.W. technique). Group II animals were treated by I.D.W. and transfixation of pins with fiber cast technique. Group III animals of this group were treated by I.D.W. and a Scaffold of fiber cast bandage technique.

The maximum incidence of mandibular fracture in animals of present study was seen during the month February which is a favourable month of breeding season. In the present study, fracture of mandible occurred due to infighting between camels (7 animals), biting tree or fix objects (7 animals), forcible feeding (2 animals), electric shock (1 animal) and falling on ground (1 animal). The mandibular fracture was bilateral in nature in all the 18 camels. In the present study, the site of fracture was anterior to tushes (3), posterior to tushes (4) and across the alveoli (11), simple fractures (3) and compound fractures (15), line of fracture was transverse (10), oblique (5) and multiple (3) camels were recorded. The gingival wounds and buccal mucosa wire gall wounds occurred due to bite of either wire or knots of Interdental wiring technique in animals of present study. The occurrence of submandibular abscess was a sequel to the percolation of saliva and ingesta into these wounds through the buccal wounds leading to a potent contamination or infection.

The Interdental wiring technique together with application of a fiber cast even though proved costlier than I.D.W. technique alone but provided adequate immobilisation of fractured fragments even in multiple and oblique fractures where I.D.W. alone led to overriding and shortening of jaw. The fiber cast scaffold applied in animals of group-III prevented latero-medial and downward movements of mandible, thus loosening of wire did not occur. The technique proved costlier to I.D.W. due to additional cost of fiber cast bandage but proved slightly cheaper than the techniques used in animals of group-II which incurred an additional cost of intra-medullary pins.

Clinical and radiological union took place in 6-8 weeks in animals of group-II followed by 8-10 weeks in animal of group-III and 8-12 weeks in animal of group-I.

The CT Scan of specimen mandible of present study proved highly useful in detailing out the anatomy of horizontal ramus of mandible which helped understanding the weakest portion of mandible close or across the alveoli of tushes.

The lower values of Hb, PCV, TEC and neutrophils in camels more than 8 years of present study could be due to a poor physical health of these animals. The higher value of TLC in animals more than 4 years and 4-8 years range indicate their good immune system.

The higher P level in animals of age group 4-8 years and particularly males indicates a higher Ca: P ratio in these animals. The higher levels of Mg, ALP, LDH, CPK and Cholesterol in all age and sex groups indicate normal liver and pancreatic functions. The highly lower values of ACP, G- 6-PD, G-6-P, Glucose Vitamin- A and Vitamin- C could be due to poor physiological state of these animals. The mean value of proteins was gradually declined as the age advanced.

of group-I. ed understanding the weakest portion of

# ऊँटों (कैमेलस ड्रोमेडेरियस) में अधोहनु अस्थिभंग के विरोहण पर नैदानिक एवं क्ष:रश्मिय अध्ययन

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### अनुक्षेपणश्

वर्तमान अध्ययन 18 ऊँटों (16 नर तथा 2 मादा) के अधोहनू अस्थिभंग के निदान पर किया गया। इन जानवरों को 3 समूहों में विभाजित किया गया तथा प्रत्येक समूह में 6 जानवर रखे गये। कंट्रोल समूह के जानवरों का आई.डी.डब्लू. तकनीक द्वारा इलाज किया गया, द्वितीय समूह के जानवरों का आई.डी.डब्लू. तथा ट्रांसफिक्षेसन ऑफ पिन्स के साथ फाइबर कास्ट से इलाज किया गया तथा तृतीय समूह के जानवरों का आई.डी.डब्लू. तथा फाइबर कास्ट स्केफोल्ड तकनीक से इलाज किया गया।

वर्तमान अध्ययन के पषुओं में जबड़े में अस्थिभंग की अधिकतम घटना प्रजनन के मौसम के लिए अनुकूल महीना है जो माह फरवरी के दौरान देखा गया था। वर्तमान अध्ययन में जबड़े के अस्थिभंग, ऊँटों में आपसी लड़ाई (7 जानवर), पेड़ तथा स्थिर वस्तु को काटने से (7 जानवर), जबरन खिलाने से (2 जानवर), बिजली के झटके से (1 जानवर) तथा जमीन पर गिरने से (1 जानवर) के द्वारा पाये गये। जबड़े का अस्थिभंग सभी 18 ऊँटों में द्विपक्षीय प्रकृति का था। वर्तमान अध्ययन में अस्थिभंग की साइट, टसेस से पहले (3), टसेस के बाद (4) तथा टसेस के आस—पास (11) जो कि सरल अस्थिभंग (3) तथा कन्टामिनेटेड अस्थिभंग (15) थे। अस्थिभंग की रेखा अनुप्रस्थ (10), तिरछा (5) तथा मल्टीपल (3) ऊँटों में दर्ज किये गये। वर्तमान अध्ययन में आई.डी.डब्लू. के तार तथा गांठों द्वारा मसूडो तथा बक्कल म्यूकोजा तार घाव पाये गये। लार तथा इन्जेस्टा द्वारा मुख के घाव में शक्तिषाली संदुषण तथा संक्रमण से अबअधोहनू फोडा बना।

आई.डी.डब्लू. तथा फाइबर कास्ट स्केफोल्ड तकनीक यद्यपि आई.डी.डब्लू. अकेली तकनीक से महंगी है परन्तु यह तिरछे तथा मल्टीपल अस्थिभंग में एडीक्यूऐट स्थिरीकरण प्रदान करती है। जबकि आई.डी.डब्लू. द्वारा ऑवर राइडिंग तथा जबडा छोटा हो जाता है। फाईबर कास्ट स्केफोल्ड तीसरे समूह के जानवरों में प्रयोग में लाया गया जो कि अधोहनु के इधर–उधर तथा नीचे की मूवमेन्ट को रोकता है। यह तकनीक फाईबर कास्ट पटटी की अतिरिक्त मूल्य के कारण आई.डी.डब्लू. तकनीक से महंगी है परन्तु द्वितीय समूह में काम में ली गई तकनीक से सस्ती है। जिसमें इन्ट्रामेडूलरी पिनों का अतिरिक्त मूल्य शामिल है।

द्वितीय समूह में 6 से 8 सप्ताह, तृतीय समूह में 8 से 10 सप्ताह तथा प्रथम समूह में 8 से 12 सप्ताह में नैदानिक तथा क्षःरष्मिय यूनियन पाई गई।

वर्तमान अध्ययन में जबड़ा नमूना की सीटी स्कैन द्वारा क्षैतिज रैमस की विस्तृत शारीरिक रचना में बहुत मदद मिली जो टसेस की एल्वियोलाई के आसपास तथा अधोहनू के सबसे कमजोर हिस्से को समझने में मदद मिली।

वर्तमान अध्ययन के 8 वर्ष से ज्यादा उम्र के ऊँटों के कमजोर स्वास्थ्य के कारण Hb, PCV, TEC तथा न्युट्रोफिल्स की मात्रा कम पाई गई। 4 वर्ष तथा 4 से 8 वर्ष के जानवरों में TLC की अधिक मात्रा अच्छे प्रतिरक्षा प्रणाली का संकेत है।

इन जानवरों में उच्च Ca:P अनुपात के कारण 4 से 8 वर्ष के तथा विषेष रूप से नर में P की उच्च मात्रा पाई गई। सभी उम्र तथा सेक्स समूहों के Mg, ALP, LDH, CPK और कोलेस्ट्रोल के उच्च स्तर सामान्य यकृत तथा अग्नाष्य के कार्यों का संकेत मिलता है। ACP, G-6-PD, G-6-P, ग्लूकोज, विटामिन ए तथा विटामिन सी की अत्यधिक कम मात्रा इन जानवरों की खराब शारीरिक स्थिति के कारण हो सकता है। उम्र बढने के साथ प्रोटीन की मात्रा कम होती चली गई।

#### INTRODUCTION

Camel plays an important role in the socio-economic structure of the rural masses. Camel, one of the oldest mammals among the livings, is essentially a domesticated animal of arid zone. It has been a necessity of mankind in the desert and semi desert areas since its domestication about 2500 to 3000 years ago. Even in modern era of mechanization, its utility is not lessened.

The camel (*Camelus dromedarius*) is an important livestock species uniquely adapted to hot and arid environments. It produces milk, meat, wool, hair and serves for riding, as a beast burden and as a draft and animal for agriculture and short distance transport.

World Camel population is estimated to be around 25.89 million spread across 47 countries. About 85% of the camel population inhabits mainly eastern and northern Africa and rest in Indian subcontinent and Middle East counties. Somalia has the highest population of 7.00 million followed by Sudan 4.25 million, Ethiopia 2.40 million, Niger 1.65 million, Mauritania 1.49 million, Chad 1.39 million, Mali 1.15 million, Pakistan 0.95 million and Kenya 0.94 million. India stands tenth in the world ranking with 0.51 million camels (FAOSTAT, 2011). An India ranks 10<sup>th</sup> in the world for camel population and Indian camel population is mainly confined to the north-western part of the country. Eleven arid districts of Rajasthan contribute 78.86% to the total Rajasthan camel population and 55.70% to the Indian camel population. The camel possesses several unique virtues such as capacity for hard work, ability to withstand draught conditions and to remain without water for several days, which makes it indispensable means of transportation in the desert. It is used as a sole source of sustenance by nomads and people of desert, where camel is found in abundance.

On farm, as a beast of burden, camels can be indispensable at harvest time. A camel can carry a load of up to 300 kilos over long distances and more than 450 kilos over short distances. Other chores performed by camels include threshing, lifting water for irrigation and powering oil mills. The camels are also used for riding purposes. The Indian Border Security Force keeps > 1500 camels to patrol the border with Pakistan. Mostly camel herds are kept by pastoralists in subsistence production systems. They are also very reliable milk producers during dry seasons and drought years when milk from cattle, sheep and goats is scarce. In recent years, the picture of "moving" nomads has changed to great extent owing to growing urbanisation. In India, camel is an important means for transportation and for domestic use as drawing water from wells, rivers and dams (Gahlot, 2007).

The sturdy desert animal becomes helpless at times, in 'Rut' due to fracture of its mandible. A symbol of power in desert, the camel has a weak mandible from anatomical point of view. A simultaneous presence of the alveoli of tushes and mental canal, together make the horizontal ramus weak at this point and predispose it to fractures following severe stress forces exerted by the jaw muscles during 'rut' season when it becomes very aggressive. Many of these fractures are traumatic in origin and are found in female as well. The fracture line could be transverse or oblique or multiple across the horizontal rami, which may be just anterior or posterior to the tushes or premolar-I teeth. Most of the mandibular fractures are compound and infected. It has been experienced that the difficulties exist in the reduction of the bone fragments and then to keep them alignment in oblique or multiple fractures.

Camels prehense with the lips and fracture of lower jaw causes a downward hanging of the jaw, making upper and lower lips wide apart. The prehension is totally jeopardised in such a situation and camel is unable to eat or drink in and long standing cases it leads to "inanition".

A forced or artificial feeding and/or management is not feasible in camels because these cannot be fed with a stomach tube like a horse and cannot be maintained exclusively on liquid diet like a dog or a horse, if its draft capacity is to be maintained. A technique which can provide satisfactory immobilisation with earliest restoration of prehension and mastication would therefore be quite useful in camel.

The mandibular fracture in camel possesses a different problem, since the movements of the mandible are quite different from those which occur in dog and cat. In camel lateral as well as hinge joint movements occur so the success of fracture repair depends mainly on the use of a suitable method of immobilisation.

In dromedary camels, biting was the main cause of mandibular fractures which occurred more commonly in older males (P = .001) than in females. Open fractures were more common than closed ones (92.2% versus 7.8%, P = .0001) and single fractures were more frequent (82%) than multiple and comminuted fractures (18%; P = .001). Fractures were treated by interdental wiring (91.2%) or U-shaped aluminum bar (8.8%) and healing occurred in most (83.2%) fractures (Ahmed, 2011).

Although the camel is a very hardy animal, there is a peculiar anatomical problem that makes it vulnerable for mandibular fractures. The lower jaw is unique: it is too long and the space between teeth is too wide. The alveolar tooth creates a weak point in the lower jaw bone. When in rut (during winters), the males bite powerfully at hard objects they wouldn't bite usually and several animals break their lower jaw. This, in turn, prevents the lips from meeting so that browsing for fodder becomes impossible. If the animal can't eat, death is inevitable (Gahlot, 2005).

Fracture of mandible have been reported by Leese (1927), Rathore and Singh (1963), Chouhan (1972), Kumar *et al* (1977), Gahlot *et al* (1984), Gahlot and Chauhan (1992), Ramadan and Abdin Bey (1990), Ramadan (1990), Gahlot (1990) and Ramadan (1994) in camels. Various immobilisation techniques were reported by Garner and Thruman (1968), Nelson *et al* (1971), Gahlot *et al* (1989) and transfixation by Lawson (1957), Chouhan (1972), Kumar *et al* (1977), Purohit and Chouhan (1985) and Wilson *et al* (1990) with varying success. Mandibulectomy in camel was reported by Gahlot and Chouhan (1992) and Ramadan (1994).

Mandibular fractures are though uncommon in other species, yet diverse techniques have been attempted for repair, viz brass rod with wiring by Hort (1968), Gabel (1969), Monin (1977), Colahan and Pascoe (1983) in horse and wiring by Johnston and Farquharsan (1939), Armstead (1947), Rickards (1977), Chambers (1981) and Lewis et al (1991) in dogs.

Mandibular fracture occurs commonly in male camels because of powerful forces generated by the jaw muscle's action on the weakest part of mandible. Long inter-dental space, presence of alveoli of first premolar or tushes and presence of mental canal make the lower jaw weak and fracture occurs at this point. Camel's prehense with lips and when they go apart after fracture, they are unable to prehense. Camels dip half of the mouth for drinking water from bucket or any such source. Applications of plaster of Paris or internal fixation techniques do not prove successful to immobilise these fractures. Interdental wiring proves unique, economical and effective technique for immobilisation of mandibular fractures in camels. Wires are passed through spaces between first two check tooth and central incisors and knots are applied. Such an anatomical advantage is not seen in other species to treat similar fractures (Gahlot, 2010).

In few earlier studies, the fractured mandible has been repaired with transfixation, interdental wiring and mandibulectomy techniques (Gahlot and Chouhan, 1992). The transfixation technique requires general anaesthesia and leads to lot of orthopeadic trauma with associated complication. This technique is uneconomical too. On the other hand, interdental wiring technique is economical and does not require general anaesthesia. The technique is useful in transverse fractures only and leads to overriding and resultant shortening of the mandible i.e., "parrot jaw" condition in oblique or multiple fractures, hence needed a modification in the technique.

The interdental wiring technique was modified and was incorporated with a brass rod alongside the dental arc, thus named as "Reinforced Brass Rod Interdental Wiring (R.B.R.I.D.W.)" technique with a view to find out the suitable immobilisation technique for oblique and multiple fractures of horizontal ramus of mandible (Ram, 1997).

Computed tomography (CT) and Magnetic resonance imaging currently plays a prominent role in the diagnosis and evaluation of many human diseases (Goncalves-Fetreira *et al*, 2001). It was not initially used in Veterinary Medicine because of its limited accessibility and high costs. However, accessibility has improved, which has increased the need of expertise in the use of this technique in animals (Kazer-hotz *et al*, 1994; Ottesen and Moel, 1998; Bienert and Stadler, 2006; Bahgat, 2007 and Raji *et al*, 2009).

The major advantage of CT over conventional radiographs is improved spatial resolution. Veterinary patients are placed on the CT table while under anaesthesia. The CT table moves through the circular tunnel of the CT scanner (gantry) while an x-ray tube within the CT housing emits x-rays as it encircles the patient within the gantry. A detector array, on the opposite side of the x-ray tube, measures the x-rays that pass through the patient and computer-generated cross-sectional images are constructed from this data. Computed tomography is particularly useful for diagnosing abnormalities of the nasal passages, middle and inner ear, brain, abdomen, lung, mediastinum and the musculoskeletal system. Computed tomography is an advanced form of X-ray that obtains multi-plane images of bone used to diagnose problems in the musculoskeletal system. 2D images may also be reconstructed to obtain 3D images of complex or injured anatomy. CT, through its high spatial resolution and moderate differentiation of tissue contrast is a fastened exceptionally useful technique for visualising general anatomy. The use of CT in large animal medicine is currently limited by logistical problems of acquiring CT images; meanwhile a few CT studies on horse's foot have been done. The basic physics of CT are dependent on tissue density, similar to planar radiology but CT's cross-sectional nature eliminates superimposition of structures and dramatically improves resolution. C.T imaging is particularly useful in the skull, thorax, abdomen and limbs. C.T image interpretation is based on the principles of radiology, as it made of black color, white and shades of gray (called gray scale), assigned to tiny squares (pixels) arranged in columns and rows( a matrix) and can record thousands of opacities ranging from air to high density metal images. Accurate interpretation of ultrasonography or CT of the foot requires a thorough knowledge of the cross sectional anatomy of the region and accurate interpretation of the plain metric CT is necessary for th

Available literature suggests that some studies have been performed for repair of mandibular fractures in camel e.g. interdental wiring and reinforced brass rod interdental wiring. Mandibular fractures in camels need more elaborate studies in term of imaging of mandible and improvement of external fixation techniques. In view of this, present investigation was undertaken with the following objectives:

• To study the etiology and occurrence of mandibular fracture in camels.

- To evolve diverse immobilisation techniques for mandibular fracture repair in camels.
- To carry out the Computed Tomography and cross sectional studies of specimen mandible of camel.
- To study the haemato-biochemical changes in cases of mandibular fracture in camels.
- To monitor the healing of mandibular fracture clinically and radiologically (wherever feasible).



#### **REVIEW OF LITERATURE**

In one of the earlier studies, Leese (1927) reported mandibular fracture in camels, which occurred due to the chain of bridle. Fractures were immobilised with a sting or a piece of wire fixed across the fracture line. Injury to the gingiva was noticed. Immobilisation was supported with an iron splint.

Beckenhauser (1956) opined that a separated symphysis might be fixed by Interdental wiring or by Krichner's drill wire or Steinman pin in large animals. Fracture of ramus could treated by any of these methods, Interdental wiring, bone plated, Krischner's or Stader splint and cross pins.

Lundvall (1963) observed that the common sites for mandibular fracture were interdental space and symphysis in equines. He advised wiring of teeth across the fracture and animal was fed with stomach tube for seven to ten days.

Rathore and Singh (1963) treated two cases of mandibular fracture in camels. One stainless steel pin was fixed at right angle to the median plane in each fragment and the same was repeated on the side of the other side of each fragment. The fracture was reduced with a well padded plywood splint (2 X 6") put under the jaw and a plaster bandage applied including free ends of all the four pins. Both the jaws were apposed with a bandage which was removed after one hour.

An aluminium splint was fastened to the fractured mandible by two copper wires covered with plastic tubes which were placed proximal and distal to the fracture line in the interdental space of the horizontal rami in a horse by Hort (1968).

Ammann (1970) treated mandibular fracture in large animals by the use of Becker's quick setting plastic bridge. Wallace (1971) recorded a case of bilateral mandible fracture in a 16 year old stallion. Researcher used an electric drill to drill the site, 5 centimeter caudal to body of mandible on the ventral side of each horizontal ramus, for insertion of the 40 centimeter threaded Steinmann's intramedullary pins. Six millimeter diameter pin was used to tap the site of insertion of an 8 millimeter diameter pin, which was finally used to imobilise bilateral mandibular fracture in a stallion.

Chouhan (1972) studied 20 cases of mandibular fracture in camels, both clinically and experimentally and these were repaired by using transfixation and double triangle action type splint. A well padded plywood splint was kept under jaw next to skin. Plaster bandage was applied to include all the four points of splint. Double triangle type splint was found superior to the transfixation technique where anterior fragment was also anchored by pins.

Kumar *et al* (1977) treated six cases of bilateral mandibular fracture in camels. In all the six cases, examination revealed injured mucous membrane, exposing the fractured fragments. There was necrosis and suppuration at this point. Radiograph revealed marked deviation of bone with evidence of osteomyelitis. All six cases of mandibular fracture were immobilised with transfixation technique. First four cases were clinically satisfactory and animals resumed their normal activity of prehension and rumination by the end of seventh week, when the pin and plaster of paris bandage were removed, the holes left behind healed up on routine dressing. The injury of mucous membrane also healed up without any complications.

Monin (1977) repaired nine cases of fracture of the body of mandible in horses. These fractures were compressed and stabilised with an external thermoplastic brace mixed to the labial side of the incisors. A tension band was attached to the external splint on the fracture site and anchored to the horizontal ramus, 13mm to the second premolar and 13mm ventral to the dorsal border was applied to repair the fracture of the mandible.

Kumar *at el* (1979) noticed unilateral fracture of mandible in 10 to 15 years old camels. Camels were presented with the complaint of wound at lower jaw, dribbling of saliva and restricted prehension and rumination. Fracture was immobilised by using four inch Eggers stainless steel bone plates, plates were fixed with cortical stainless steel screws. Animals were kept on liquid diet (milk, porridge and jaggery) for one week. The upper and lower jaw was tied with one inch wide leather strap and was removed when animal was fed.

Ramakumar and Singh (1979) repaired two cases of bilateral mandibular fracture in camels. A ten centimeter long incision was made at the lateral surface of mandible. Periosteum was elevated to accommodate a four inch Eggers stainless steel bone plate. Three holes were drilled on each fragment and plate was fixed with coarse threaded stainless steel screw. As the drilled holes evidenced the presence of osteomyelitis, a small area was left unsutured for drainage while the remaining periosteum, muscles and skin were sutured. The animals were kept on liquid food for one week. The upper and lower jaw were drawn close and tied with one inch wide leather strap. During the subsequent week, the animals were fed green fodder. The cases were treated successfully led us to the conclusion that bone plating can be adopted in unilateral fractures of mandible.

Ramakumar *et al* (1981) repaired a bilateral mandibular fracture in bullock. The fracture was immobilised with 1/8 inch Steinmann pins introduced percutaneously into the antero-lateral aspect of the cranial segment and directed tangentially toward the caudal segment of the opposite side until it emerged through the skin. Another pin was fixed from the opposite side, across the I<sup>st</sup> pin, in the same manner. The projecting ends of the pins were carefully bent downward and encased in a supporting cast by applying plaster of paris bandage in figure of eight fashion. The cast of pins were removed after 8 weeks. Prehension and mastication were found normal in 6 months.

Gahlot *et al* (1984) repaired transverse fracture of mandible in 25 camels by silver wiring. Twenty animals were male and five females of age group ranging from 2-10 years. In 24 camels compound fracture of mandible was noticed. Fractures were repaired by interdental wiring between incisors and premolars using silver wires of 60 centimeters long and 2 millimeter diameter performed on both sides. The wire was ensheathed with polythene tube. All camels were fed gruel in milk or sweat oil for first week and dried soft leaves thereafter up to eight weeks.

Purohit *et al* (1984) recorded 5 cases of irrepairable mandibular fracture in camels. In all cases fracture occurred in male camels during rutting season. The fracture was close to root of canine teeth and fragments were visible due to loss of mucous membrane, necrosis and suppurations were also noticed. Chloral-Magnesium sulphate anaesthesia was given 'to effect'. The loss of sensation at the proposed site of incision was the guide of onset of anaesthesia. Non-union or unwanted mal-union occurred in irrespective of method of immobilisation. Thereafter amputation of anterior fragment of mandible was carried out in all cases.

Purohit and Chouhan (1985) reported 2 clinical cases of mandibular fracture in young calves. These were immobilised by transfixation technique. An intramedullary pin was pierced through both the rami at right angle to the long axis of the face just anterior to the premolars without entering the oral cavity. This pin was driven back and replaced by 9 centimeter long rod of the same diameter in such a way that its free ends were projected out on the lateral cortex through skin. The anterior ends of jaw was held firmly and 3 centimeters long Steinmann stainless steel pins were inserted on either side of the central deciduous incisors without penetrating the mucous membrane of the lower lip. The fracture fragments were reduced in normal anatomical position and a well padded plywood splint (7 x 4 cm) was placed under lower jaw and criss cross plaster bandage was applied incorporating the free ends of pins. The plaster cast and pins were removed after six weeks.

Gahlot *et al* (1988) reported a case of mandibular fracture of horizontal and vertical rami in an eight year old bullock. The fracture occurred due to traumatic collision of head against the concrete wall. Prehension and mastication were suspended after collision. Manipulation of lower jaw revealed crepitation and abnormal mobility. Open reduction of left ventral ramus was carried out, where a vertical incision was made extending from base of ear to the angle of the mandible. Two stainless steel plates were implanted across the fracture site and close reduction of horizontal rami

was performed by transfixation by passing 4 millimeter Steinmann's pin transversely, anterior to first cheek tooth and 5 x 10 centimeter wooden splint was placed under submandibular region applying plaster bandage diagonally. Mouth was muzzled. Gruel mixed with oil was fed to animal twice daily, till eight week.

Nair *et al* (1988) recorded a case of mandibular fracture in 2 years old crossbred heifer, with history of automobile accident. Animal was restrained in lateral recumbency under triflupromazine hydrochloride and atropine sulphate with local infiltration of 2 percent lignocaine hydrochloride. A longitudinal incision was made on both side of ventral border and periosteum was reflected. Wiring in a figure of '8' pattern was performed for immobilisation.

Gahlot *et al* (1989) evaluated Interdental wiring (I.D.W.) technique for mandibular fracture repair in 78 camels. The fractures were bilateral and compound and commonly resulted from fighting and lathi blow among male dromedaries during rutting season. It was concluded that I.D.W. was a suitable, economical and practical technique for transverse, oblique and multiple fractures.

Parsania *et al* (1989) repaired bilateral mandibular fracture in a 4 year old camel. Animal had violent fight with another camel and had a bilateral compound fracture of mandible causing hanging of lower jaw. Animal was administered 10 per cent chloral hydrate solution (760 milliliter) intravenously to achieve deep narcosis. Steinmann's intramedullary pins, by retrograde method of pinning were used for immobilisation of fractured mandible. Pins were drilled up to level of first premolar tooth.

Gahlot (1990) reported bilateral mandibular fracture in camels and these mandibular fractures were immobilised or treated with I.D.W., transfixation and partial mandibulectomy in 150 clinical cases of which 135 were compound and 15 were simple. The I.D.W. was used for all kinds of mandibular fractures but provided good immobilisation in transverse fractures. The transfixation technique was used in oblique fractures only but had many associated disadvantages and required general anaesthesia. The partial mandibulectomy was performed in cases of non-union, short or necrosed anterior fragment. It was concluded on the basis of clinical trials and observation recorded that the I.D.W. was most suitable, economical and practical technique for repair of mandibular fracture of horizontal ramus of mandible in camels.

Ramadan (1990) reported that fractures of the lower jaw of camels are predominantly bilateral and compound in nature and occur during the rutting season because of fighting with other camels. Unilateral fractures are not common. The fracture lines are in most cases located in front of canine teeth of the lower jaw. Surgically bilateral plating afforded reasonable jaw stability. The clinical experience and surgical treatment of about 50 cases of such fractures will be highlighted.

Ramadan and Abdin Bey (1990) discussed 47 cases of lower jaw fractures in camels. Forty two of these were bilateral and compound and occurred mostly during the rutting season as the result of fighting with other camels, while the remaining 5 had unilateral fractures. Surgically each bilateral fracture was fixed in position by two plate screws, one plate on either side, with great success. Unilateral fractures were either fixed with one plate or treated conservatively. The possible role of trauma and low serum calcium and phosphorus levels was highlighted.

Gahlot (1991) immobilised or treated the bilateral mandibular fractures with interdental wiring, transfixation or partial mandibulectomy in 150 clinical cases of which 135 were compound and 15 were simple. The interdental wiring was used for all kinds of mandibular fractures and provided good immobilization in transverse fractures. The transfixation technique was used in oblique fractures only but had many associated disadvantages and required general anaesthesia. The partial mandibulectomy was performed in cases of non-union, short or necrosed anterior fragment. It was concluded that on the basis of clinical trials and observations recorded the interdental wiring was the most suitable, economical and practical technique for repair of fractures of horizontal rami of the mandible in camels.

David *et al* (1992) reported an adult dromedary camel (*Camelus dromedarius*) which was referred for treatment of bilateral fractures of the horizontal rami of the mandible. Cross-pin fixation in combination with tension-band wires were used to stabilise the fractures. Healing was complicated by formation of a large sequestrum and involucrum at the fracture site. Following sequestrectomy, the fracture healed and the camel was clinically normal 1.5 yr after surgery.

Gahlot and Chouhan (1992) described that mandibular fractures are very common malady in camels particularly in 'rut' or breeding season. Fractures were bilateral and compound in nature and were immobilised by interdental wiring, transfixation technique but in some old cases, necrosed anterior fractured fragment treated with partial mandibulectomy.

Singh *et al* (1993) found the mandibular fracture to be uncommon in bovines and small ruminants but common in camels. In bovines, more cases are recorded in neonatal calves because of obstetrical injuries due to application of a snare for forced extraction of the foetus. Fractures through interdental space with involvement of horizontal ramus are the most common. These fractures are usually bilateral and compound but unilateral fractures occur. The fractures may be transverse, oblique or comminuted in nature. Mandibular symphysis is more frequently involved in young calves. In camel, a report of 78 cases showed high incidence on male (72) and these were bilateral and compound. Fractures of vertical ramus were rare due to protection from the masseter pterygoid muscles. Both unilateral as well bilateral fractures of horizontal ramus can be treated successfully using wiring, pins and bone plate.

Gahlot and Chouhan (1994) studied 317 cases of fracture in camels recorded over a period of 13 years. The incidence for various bones in upper jaw (1.26%), lower jaw (55.20%), humerus (3.78%), radius-ulna (1.89%), metacarpus (7.88%), femur (3.47%), tibia (1.57%), metatarsus (9.46%), first phalanx (4.73%), second phalanx (3.15%), third phalanx (0.63%), os-calcis (4.73%) and cervical vertebrae (0.63%) were recorded. Frequency was higher in males (87.69%) than females (12.31%). Head region fractures had highest incidence (22.082%) followed by limb (20.825%). A number of techniques were used to treat selected cases.

Gahlot *et al* (1994) described the importance of removing the upper canines in case of mandibular fracture. The upper canines touch and fumble the wire placed in lower jaw with an attempt to dislodge it. It occurs due to lateral movement of the lower jaw seen after interdental wiring.

Ramadan (1994) described that fractures of the lower jaw in camels occur due to various forms of trauma but occur predominantly in male animals during the rutting season. In females, it follows occasionally as a multi fragment fracture due to accidents of stumbling or falls on its head in an attempt to escape being mounted by a male camel. The fractures are treated with wooden support, metallic support, bone wiring, plate and screws, transfixation technique, intramedullary pining and amputation of the cranial fragment of mandible.

Lischer *et al* (1997a) treated a four months pregnant, 4-year-old Brown Swiss cow with mandibular fractures of the right horizontal ramus and the symphysis was treated surgically with a new pin less external fixator. Healing was complicated by the sequestration of bone at the fracture site. After the sequestrum had been removed a radiographic examination showed that the fracture had healed completely.

Lischer *et al* (1997b) developed a new technique for stabilisation of mandibular fractures in 7 female Swiss Braunvieh dairy cattle between 1 and 5 years of age. Fractures were stabilised with a pin less external fixator, which is a modification of a unilateral AO/ASIF (Association for the Study of Internal Fixation)-fixator in which pins are replaced with bone clamps. Three to 10 days after surgery 6 cows masticated comfortably. The only failure was a yearling with a 10-day-old open infected fracture. This animal was slaughtered 9 days after surgery because of additional problems. In 6 cases there was enough callus formation 33 to 54 days after surgery to stabilise the fracture. The fixation devices were removed under heavy sedation. The major complication was bone sequestration at the fracture site, which required additional treatment. It is concluded that the pin less fixator is satisfactory for external stabilisation of unilateral horizontal ramus fractures of the

mandible in cattle. The technique provides good stability without penetration of the medullary cavity and damage to the tooth roots. Other advantages of the technique include ease of application, minimal surgical trauma, and the short surgical time for application.

Ram (1997) repaired mandibular fracture in 54 camels. Out of which 51 and 3 cases were recorded in male and females camels, respectively. Fracture of mandible was multiple and oblique in 25 cases and transverse in 29 cases. The etiology of fracture of mandible was biting to other animals (38 cases), falling on ground (5 cases), accidents (5 cases) and lathi blow (6 cases). In all cases of mandibular fracture were treated by the interdental wiring technique was modified and was incorporated with a brass rod alongside the dental arc, thus named as "Reinforced Brass Rod Interdental Wiring (R.B.R.I.D.W.)" technique with a view to find out the suitable immobilisation technique for oblique and multiple fractures of horizontal ramus of mandible

Lavania (1998) studied a new, simple, practical and field oriented technique for the repair of mandibular fracture in 18 camels using plaster of Paris bandage and a wooden plate as a splint. The recovery after one and a half month was uneventful.

Henninger *et al* (1999) recorded 89 cases of fracture of mandible and maxilla in horse due to kick from another horse or self inflicted injury. Fractures were recorded in 36 intact males, 32 females and 21 geldings. Location of fracture was mandible in 55 cases, premaxilla 28 cases and both in mandible and premaxilla in 6 cases. Immobilisation of fractures of rostral portion of the mandible and maxilla in 58 horses was done by wiring and with bar in one horse. Wires were placed from the incisors of mandible in interdental space to premolars in a figure '8' fashion.

Lavania *et al* (1999) studied a field oriented immobilisation technique for repair of mandibular fracture in 18 camels. All camels had bilateral mandibular fracture of compound nature, while fighting with other male camels during the rut season. Fracture was immobilised by using plywood splint and plaster of Paris bandage. The fractured segment of mandible was kept in normal alignment with the help of 6" wide cotton bandage. Plywood about 4-5 millimeter thickness was used as a splint on ventral side. A plaster of Paris bandage was used to fix the splint in position.

Martens *et al* (1999) studied 54 horses with mandibular and/or maxillary fractures which were referred for treatment over 12 years (1985-1996). The fracture was recent in 48 cases. The remaining 6 horses had an older and poorly healing fracture. In 26 cases, a conservative treatment was applied. This included extraction of loosened teeth in recent fractures and curettage of fistula in older fractures, followed in all cases by treatment with antibiotics. In 28 horses, surgery was performed. 26 were treated with cerclage. In the remaining 2 horses, an amputation of the rostral part of the mandible was performed. Follow-up results could only be obtained for 42 horses (19 conservative, 23 surgical). Healing was considered satisfactory when the animals showed only clinically insignificant abnormalities such as slight malocclusion or the absence of incisor teeth. Overall, perfect or satisfactory healing was obtained in 93% of the cases. Surgical treatment resulted in a higher percentage of perfect results (61%) compared with conservative treatment (37%). Fracture localisation had no apparent influence on the final outcome. Despite the serious contamination of some open fractures, abcedation or fistulation were only occasionally reported as complications.

Gahlot (2000) opined that the fracture of horizontal rami of mandible in camels occurred mainly during breeding season either due to in fight or due to tendency to grip or bite other stationary objects like tree or pole. Whereas, fracture of vertical rami of mandible caused by external violence or automobile accidents. Characteristic signs of mandibular fracture in camels are downward hanging or inclination of anterior portion of mandible, exposing tongue, drooling of blood tinged saliva, abnormal mobility of fractured fragment. Swelling of oral mucosa in simple fracture and wound in mucosa at fracture site in compound fracture. In all cases immobilisation were achieved by external fixation technique as interdental wiring and percutaneous transfixation technique and internal fixation technique as bone plating, intramedullary pining and partial mandibulectomy for the treatment of mandibular fracture in camels.

Reif *et al* (2000) recorded mandibular fractures in 42 cattle. Nine had fractures of two or more anatomic regions where as 33 had only one region affected. Out of 42 cattle only 17 were treated conservatively or surgically. The median age at the time of admission was 30 months there were 2 males and 15 females and most common cause was an accident at pasture. Fractures
were classified as simple transverse to oblique (12 animals) and bone fragment was visible in 5 cows. Application of pin less external fixator in fourteen cows, interdental wiring in one cow and carried out conservative treatment in two cows, for evaluation of long- term results bovine mandibular fractures involving molar teeth.

Belsito and Fischer (2001) studied 53 cases of equine mandibular fractures which were managed surgically at the Chino Valley Equine Hospital, California from 1988-1998, of which 16 (30%) were repaired by external skeletal fixation (ESF). Three surgical methods were utilised: transmandibular 4.76 or 6.35 mm Steinmann pins incorporated into fiberglass casting material or non sterile dental acrylic (methyl methacrylate - MMA) bars reinforced with steel; transmandibular 9.6 mm self-tapping threaded pins ±4.76 or 6.35 mm Steinmann pins incorporated into MMA bars reinforced with steel; and 4.5 mm or 5.5 mm ASIF cortical bone screws incorporated into MMA bars reinforced with steel or a ventral MMA splint. Fourteen horses were presented to the hospital for fixator removal at an average of 56.2 days. At removal, fractures were stable and occlusion of incisor and cheek teeth was considered adequate. Complications of the procedure occurred in 3 horses. Two horses with persistent drainage and ring sequestra from pin tracts required curettage 4 or 5 months after ESF removal. A third horse required replacement of the original fiberglass ESF with MMA bars to regain access to open, infected wounds. Another horse required removal of the second premolar at the time of fixator removal because the tooth root had been damaged in the original injury. ESF for the surgical management of mandibular fractures in horses has produced good results, with incisive and cheek tooth alignment reestablished in all horses. Horses that were managed via ESF had a rapid return to full feed and did not require any supplementation via nasogastric tube or oesophagostomy to maintain body weight or hydration status.

Ram and Gahlot (2001) evolved Reinforced Brass Rod Interdental Wiring (R.B.R.I.D.W.) technique for bilateral and compound mandibular fractures (oblique, multiple and transverse) were immobilised using the in R.B.R.I.D.W. technique 25 camels. Clinical union occurred in 45, 60, 75 and 90 days in the age groups of 5-7, 7-9, 9-11 and 11-12 years, respectively. The device was removed between 94-110 days. Radiological union occurred at 45 days, but moderate callus formation was noticed at the 60th day and mature callus at the 75th day post fracture. Healing occurred faster in young animals. Although R.B.R.I.D.W. was found to be effective for the repair of oblique and multiple fractures, it was cumbersome and slightly expensive as compared to I.D.W. alone.

Al-Dughaym *et al* (2003) studied 59 camels with mandibular fractures by clinical, radiographical and microbiological parameters. It was demonstrated that males were more affected than females with an average age of 7 years. Unilateral and bilateral fractures with wounds and pus formation were diagnosed through clinical and radiographic examination. Microbiological tests revealed *Proteus mirabilis* to be the most frequent isolate from injured sites followed by *Proteus vulgaris, Corynebacterium pseudotuberculosis, Arcanobacterium pyogenes, Micrococcus spp.* and *Staphylococcus aureus* together with other species. Of the fungi, *Candida krusei, Cryptococcus laurentii* and *Aspergillus penicillioides* were isolated. From the buccal cavity of 21 normal camels, Micrococcus spp. was the predominant isolate followed by other bacterial and fungal species. Antibiogram studies of some of the isolates, showed varying degrees of susceptibility. The significance and implications of the isolates on post-traumatic cases of osteomyelitis were discussed.

Shahid and Kausar (2005) studied the skull of camel when viewed from above. It was irregularly pentagonal in outline. It was widest in the frontal region and contained the orbits laterally. The occipital bone formed the entire nuchal surface and encroached upon the dorsal surface about 1.75 to 2 inches. It joined the parietal bone at transverse suture. A rough transverse ridge separated the parietal and nuchal surfaces. The mastoid foramen was very large and situated in a deep fossa in the occipital bone in contrast to ox, where it lay at the junction of occipital and temporal bones. The cornual processes were absent. The supraorbital foramen was in the form of a deep fissure, at the rostrolateral margin of the orbit. There was no maxillary tuberosity and facial crest. The pre maxilla had a dorsomedially concave and narrow pointed body. The nasal bones were notched rostromedially and nasal apertures were oval in outline. The body of mandible was long, narrow and concave dorsomedially. The intermandibular space was "V" shaped. The vertical ramus of mandible was thin and convex caudally and the angles were not pronounced, while the rostral border was thick and wide. The coronoid process was almost straight with caudal end slightly pointed. The condyloid process was large and its dorsal surface contained the extensive articular surfaces, which were convex. There was a shallow mandibular notch. The mandibular foramen was in the middle of the medial surface of the ramus of mandible.

Gahlot *et al* (2007) studied the treatment of injuries to mandible, soft palate, lips, nostrils, parotid duct, eyeball, eyelids, ear, etc during last five years (2001-2006) in the Surgery Clinics. Surgical affections recorded were mandibular fractures, abscess and gangrene of soft palate, laceration at commissure and nostrils, salivary and buccal fistula, lacerations of eyelids and cornea, rupture of eyeball and otitis externa. Majority of surgeries were performed by securing the camel in sternal recumbency under xylazine sedation and local infiltration of anaesthesia or nerve block. Surgical procedures used were interdental wiring, reinforced brass rod interdental wiring, and resection of soft palate, commissurrhaphy, ligation of Stenson's duct and repair of buccal fistula, blepharoplasty, enucleation, corneal suturing, tarsorrhaphy and Zepp's operation. Majority of these treatments were developed in the clinic and were successfully performed on clinical cases. The etiology, clinical signs and postoperative care are also discussed.

Chaudhary (2009) studied 6 male camels suffering from bilateral mandibular fractures. Bilateral mandibular fractures were recorded in age group of 5-13 years of camels. Camels were presented for surgical intervention in between 1-3 days after occurrence of fracture. In 5 camels, fracture of mandible occurred due to fighting and in one camel fracture occurred while attempting grip hook of cart. Examination of buccal cavity revealed bilateral mandibular fracture with downward deviation of anterior lower jaw. Site of fracture was near to tushes (5 cases) and 1st premolar (1 case). Necrosis and foul smell were noticed in cases which were presented after 3 day of occurrence of fracture. Animals were restrained in sitting position, sedated with xylazine and resting of head over wooden table facilitated IM pinning for the repair of bilateral mandibular fracture. Steinmann pin of 4-6 mm diameter provided satisfactory immobilisation. Retrograde pinning procedure was easier than normograde pinning. Normograde pinning was time consuming and misdirected pins were not properly seated into posterior fractured fragment. This resulted rigid immobilisation at the site of fracture. Intramedullary pinning and interdental wiring performed in one camel also showed satisfactory immobilization. Interdental wiring is rapid and easier to perform.

Siddique *et al* (2012a) treated 4 cases of atypical mandibular fractures in the dromedary camel by Cerclage and standard interdental wiring technique. All the animals had an uneventful recovery except development of submandibular abscess in one animal. No slipping or loosening of the fixation wires was not in any case and all the fractures were healed at variable time intervals ranging from 2.5 to 3 months period.

Siddiqui *et al* (2012b) reported that mandibular fractures in camels are normally the result of camel bites and usually occur across the first premolars. Majority of these fractures are bilateral, compound and transverse in nature and can routinely be immobilised with the standard interdental wiring technique. However, it has been observed that at variable time intervals in the postoperative period, the lateral limbs of the wires slip down in majority of cases. This results in loosening of the wires with consequent movement at the fracture site and ventral deviation of the cranial fracture fragment necessitating their repeated re-adjustment and re-tightening. A slight modification in the standard technique has proven quite useful to overcome this problem. However, intactness of all the incisor teeth is a prerequisite to this modification.

Ahmed and Al-Sobayil (2012) studied the frequencies and classification of fractures in young camels and evaluated the clinical relevance of external fixation as a method of treatment. Cases of fractures (n = 75) in young camels (less than 2 years old) were studied. On admission, the cause, site, classification, and radiography of the fractures as well as the methods of treatment were investigated. Factors affecting fracture healing after treatment were investigated and analysed. The frequencies of fracture were affected by breed (P = 0.001) and age (P = 0.01) but not sex. Trauma was the most common cause of fractures (P = 0.001). Tibial fracture was the most common. Treatment was performed either by plaster of Paris bandage alone (82.1%) or in combination with polyvinylchloride (PVC) splints (70.6%), interdental wiring (14.8%), or 2 Steinmann pins (1.9%). Satisfactory healing was recorded in 81.5% of the treated cases. In conclusion, breed and age affected the frequencies of fracture. There was a significant effect of camel age on the cause of fracture. Moreover, there was a significant effect of camel age on the fractured bone. External fixation using plaster of Paris bandage with/without PVC splints and interdental wiring are successful treatment methods of fractures in young camels.

## HAEMATO- BIOCHEMICAL

Robinson (1923) reported an enzyme in bone and named it as "bone enzyme". It was later known as "alkaline phosphatase". The enzyme was found to be active against hexosemonophosphatase, hexosediphosphate, glycerophophates, nucleotides etc (Mitchell, 1939).

George (1948) estimated phosphorus content and phosphatase activity during bone healing in cats at varying intervals from 6 hours to 90 days. Author observed decrease in both phosphorus content and phosphatase activity in serum on the sixth day after infection of bone defect. There was rise in blood serum phosphorus content on 7<sup>th</sup> day and the mild fluctuations during the course of study. Phosphatase initially showed increased activity in blood serum on 4<sup>th</sup> and 5<sup>th</sup> day and remained constant there after till complete healing.

Lorch (1949) reported that alkaline phosphatase was an essential factor in calcification. There was no calcification in the animals at the site of fractures which were deprived of extra cellular phosphatase. Jones (1951) found out the role played by extracted bone alkaline phosphatase in the healing of fracture in rabbits. Author noticed increased calcification at the site of phosphatase deposit. Siffert (1951) reported that alkaline phosphatase is closely related to pre osseous callus metabolism. The phosphatase might be involved in making organic salts available to the calcification. Bourne (1958) tried to accelerate the rate of bone healing in drilled holes in the femur with crude alkaline phosphatase powder. There were no signs of increased rate of the healing.

Fleisch and Neuman (1961) suggested that the role of alkaline phosphatase in mineralising the tissues would be to stimulate the calcification through removal of mineralisation inhibitor inorganic pyrophosphates.

Leonard (1964) had doubt about the activity of phosphatase in releasing phosphate from the plasma, thus causing the super saturation of fracture fluid with calcium phosphate.

Keile and Neileric (1965) found that the phosphatase was present in osteoblasts capillaries, periosteum and endosteum including Haversian canals, superficially placed osteocytes and in hypertrophic cartilage cells.

Struck *et al* (1970) determined serum alkaline phosphatase activity and serum calcium, phosphorous, magnesium and hydroxyproline concentration in three groups of dogs under treatment of fracture. The calcium level decreased during first week after operation and returned to normal in the fourth week. The phosphorous level remained constant until third week then it rose significantly. A slight decrease in phosphatase activity during first week was followed by increase during second third week. Values thereafter were normal.

Chouhan (1972) studied the serum alkaline phosphatase activity during healing of mandibular fracture in camels and noticed initially low activity of serum alkaline phosphatase during first week and higher level in the following weeks which tended towards normal by eight week.

Gahlot and Bhatia (1989) reported the normal meal values of serum alkaline and acid phosphatase enzymes in camels were found to be 4.99±0.07 and 1.35±0.03 BU/dl, respectively. For both the enzymes, significantly higher mean values were obtained in extreme hot season compared to extreme cold, in males compared to females and in animals below 4 years of age compared to higher age groups, those above 10 years recording the lowest.

Kataria and Bhatia (1991) studied the activities of asparate aminotransferase (AST), alanine aminotransferase (ALT), alkaline phosphatase (ALP), acid phosphatase (ACP), lactate dehydrogenase (LDH) and isocitric dehydrogenase (ICD) in the serum of 60 healthy dromedary camels of either sex and different ages (one to 25 years) were determined. The results were analysed with respect to time of year (December-January and May- June), sex and age groups (below 4 years; 4 to 10 years and over 10 years). The overall mean activities of AST, ALT, ALP, ACP, LDH and ICD were 36.1± 0.35, 4.65±0.35, 27.21±0.43, 7.18±0.21, 479±7.33 and 7.74±0.17 iu litre<sup>-1</sup>, respectively. Activities of AST, ALP, ALT and ACP were significantly higher during extremely hot conditions (May-June) than in extreme cold (December- January) while the activity of LDH was higher in extremely cold conditions. Analysis of data based on sex revealed that AST, ALT and ALP

activities in the serum of male animals were significantly higher than in female animals. The activities of all the enzymes were highest in animals under four years and gradually decreased with age being lowest in the animals over 10 years.

Kataria *et al* (1991) reported total serum protein and major protein fractions in apparently healthy camels either sex between 1 to 25 years of age. The effect of climatic conditions, sex and age was studied on the total serum proteins. Agewise, animals were divided in to three groups, group I (below 4 years), group II (4 to 10 years) and group III (above 10 years). The overall mean of total serum proteins obtained from 182 observations on 122 camels was 7.53+0.09 gm/dl. While climatic conditions and sex had no significant effect, age affected the total serum protein significantly. Mean activity was highest in the group I and then gradually declined as the age advanced. Gel electrophoresis of 50 serum samples from 50 healthy camels irrespective of sex and age for four major fractions revealed 45.27± 0.46, 17.77± 0.13, 14.89± 0.28 and 22.27± 0.26 percent of albumin, alpha-, beta- and gama- globulin respectively. The mean globulin ratio was 0.82± 0.01.

Kumar *et al* (1992) found the levels of calcium and inorganic phosphorus during fracture healing in dogs to be lowered (3.63mg/dl and 1.45mg/dl, respectively) gradually when observed for 21 days.

Kumar *et al* (1997) reported that the levels of calcium remained high in between 45<sup>th</sup> to 90 days and alkaline phosphatase remained elevated between 15 to 30 days during fracture repair with hydroxyapatite- fibrillar collagen implants in calves.

Yadav and Bissa (1998) reviewed levels of some blood biochemical parameters in camels. These were blood glucose, blood urea nitrogen, total serum proteins, alkaline phosphate and amylase enzymes activities. The paper discussed the effect of some factors on camel blood biochemical parameters such as age, sex and breed.

Rashed (2002) determined that trace and minor element concentrations differ in animal tissues as the result of the surrounding environment (feeding plants, soil contaminated with food and drinking water) and animal absorption of these elements. Concentrations of Ag, Au, Ca, Co, Cr, Cu, Fe, K, Mg, Mn, Na, Ni, and Zn were determined from different tissues of camel (inter-costal, scapula, loin, flank, front knuckle and front limb) from the semi-arid areas of the Aswan desert (Wadi El-Allaqi) and from Aswan city, Egypt. The study included an assessment of these same elements in the desert and city plants used as food by the camels and in soils from the study areas. The results revealed that camel tissues from the desert areas exhibited higher concentrations of Na, Mg, K, Au, Ag, Cu, Co and Zn than in those of the city camels. These higher levels of element were because of the high concentrations of the same elements in the desert plants and soil of the desert area. This, in turn, depends upon the geological formation differences between the desert area and the city area. Camel tissues appear to concentrate high levels of Mn, Ni, Co and Mg in the scapula while flank portions concentrate high levels of Mg and K. The levels of elements in the camel tissues under study were within the recommended safety baseline levels for camel health and human use, as well as within the appropriate limits in the desert and city plants for camel use.

Al-Busadah (2003) measured blood calcium (Ca) and magnesium (Mg) levels were in 30 camel calves at 3, 6, 9 and 12 months of age. Ca and Mg concentrations in sera were high at 3 months, and tended to decrease with increasing age. Infusion of EDTA into experimental animals resulted in decreased serum Ca levels, but treatment yielded no effects on Mg levels. Administration of calcium borogluconate led to increased serum Ca concentrations within 30-60 min, but this later declined to pretreatment levels. The same treatment had no effect on Mg. Partial parathyroidectomy resulted in decreased Ca and Mg levels, which returned to pre surgical levels 24 h after the operation. These results indicate the possible involvement of the parathyroid gland in the regulation of Ca and Mg metabolism in young camels.

Al-Sultan (2003a) studied the concentration of some biochemical constituents in the serum of healthy, male and female, Majaheem camel in Saudi Arabia. Ten milliliter of blood was collected from each camel aged 2-7 years. Sex had no significant effect on biochemical parameters. The creatinine concentrations were 1.36±2.66 and 1.7±0.24 mg dl in male and female camels,

respectively. Cholesterol concentrations were 55.74±7.40 and 52.05±2.78 mg dl in male and female camels, respectively. Comparable means and ranges of glucose in the serum were observed. The mean triglyceride concentrations obtained in male and female sera were within the range reported by Bengoumi et al (1997). The magnesium concentrations recorded for males and females were 1.07±0.04 and 1.42±0.37 Meq litre, respectively. The recorded values of the examined biochemical parameters in camel serum are considered to be within the normal limits.

Al-Sultan (2003b) examined serum samples of healthy Majaheem dromedaries (2-7 years old) maintained in Saudi Arabia to study some of the serum biochemical parameters in this breed. Results showed that sex does not have a significant effect on the parameters studied. Creatinine concentration was 1.36±2.66 mg/dl in males and 1.7±0.24 mg/dl in females. Mean glucose levels were higher in males (58 mg/dl) than in females (48.06 mg/dl). Cholesterol, triglyceride, calcium and magnesium concentrations in males and females, respectively, were 55.74±7.90 and 52.03±2.78 mg/dl; 40.20±6.89 and 32.84±4.37 mg/dl; 9.89±0.47 and 7.45±0.71 mg/dl; and 1.07±0.04 and 1.42±0.37 mg/dl.

Romdhane *et al* (2003) determined some reference serum biochemical values for dromedaries in Tunisia, and evaluated the potential sources of physiological variability such as age, sex and reproduction stage on serum data. Serum biochemical values were determined in blood samples from 165 apparently healthy dromedaries, 85 males and 80 females, aged 1 to 17 years. Reference ranges and physiological variations were determined for calcium (Ca), organic phosphate (P), magnesium (Mg), sodium (Na), potassium (K), glucose, triglycerides (TG), cholesterol, urea, creatinine, total proteins and fractions and enzyme activities of alanine aminotransferase (ALAT), aspartate aminotransferase (ASAT), creatine kinase (CK), lactate dehydrogenase (LDH), alkaline phosphatase (ALP) and gamma -glutamyltransferase (GGT). Results showed statistically significant (p<0.05) differences between sexes for Ca, P, glucose, TG, cholesterol, urea, creatinine, albumin, alpha - and gamma -globulins, CK, LDH, ALP and GGT. Statistically significant (p<0.05) differences between ages were also observed for Ca, P, K, glucose, urea, TG, beta and gamma -globulins, ASAT, CK, LDH, ALP and GGT. Moreover, the same trend was observed for Ca, P, Na, urea, creatinine, TG, cholesterol, ASAT, LDH, CK, ALP and GGT in dromedaries which are at different stages of reproduction.

Ahsan *et al* (2004) studied total protein, albumin, globulin, blood urea nitrogen (BUN), creatinine, cholesterol and triglycerides in 101 camels of different age groups, Group A (1 and 1/2 years upto 2 years old), Group B (2 and 1/2 years of age upto 3 and 1/2 years old) and Group C (4 years old and above). Significant effect of age (groups A, B and C) was observed on globulin (2.12±0.03 g/dl, 2.26±0.03 g/dl and 2.20±0.03 g/dl, respectively), blood urea nitrogen (14.50±0.52 mg/dl, 12.70±0.44 mg/dl, 17.45±0.72 mg/dl, respectively), creatinine (1.78±0.03 mg/dl, 1.54±0.04 mg/dl, and 2.11±0.05 mg/dl respectively) and triglycerides (28.32±1.42 mg/dl, 19.35±0.89 mg/dl, and 17.40±0.71 mg/dl, respectively). However, age was non significant in respect of total protein, albumin and cholesterol levels.

Mohamed (2004) reported the major causative agents of camel morbidity in the Butana area as well as the plasma levels of retinol, alpha -tocopherol and L-ascorbate in relation to the health status of animals. A field survey was conducted from January to December 2000. A total of 594 camels (*Camelus dromedarius*), aged one month to 1.5 years, were inspected for diseases. Blood and faecal samples were taken for confirmatory tests. Out of the camels examined, 283 were healthy and 311 suffered from various diseases. The prevalence levels of haemonchosis, trichostrongylosis, pneumonia and trypanosomiasis in camels were 32.0, 20.8, 7.8 and 5.7%, respectively. All the infected camels had reduced plasma levels of antioxidants. Trypanosomiasis caused the highest degree of reduction in the plasma antioxidant status of camels.

Barri *et al* (2005) studied serum calcium (Ca) and magnesium (Mg) concentrations in 30 calf camels at different 5 age groups (1-12 month), and were compared to that of adult camels. At the age of 1-4 month, serum Ca and Mg concentrations were found to be higher than adult values. Inorganic phosphorus concentration was found to be comparable to adult values. At the age above 4 month, serum calcium and magnesium concentrations started to decline to values below the adult ones. The results of this study may suggest that, the hypercalcaemia and hypermagnesaemia

observed in other mammals late in pregnancy and early neonatal life may persist in the calf camel up to the age of 4 month emphasising a role for calcium and magnesium in the young growing calf camel.

Komnenou *et al* (2005) correlated serum alkaline phosphatase activity with healing process of fractures in dogs. Changes in serum alkaline phosphatase activity, calcium and phosphorus were studied in 83 dogs. Alkaline phosphatase reached a maximum level on day 10 and returned to normal after complete healing of fracture. Serum P and Ca changes followed a proportional and inverse pattern to ALP changes, respectively.

Kuria *et al* (2006) assessed the levels of important macro and trace minerals in the plasma of lactating camels kept by pastoralists in Kenya. A total of 90 and 88 camels were sampled during the dry and wet seasons, respectively. The average plasma Ca and Na concentrations were below the reported range, whereas the mean concentrations of K, P, Fe, Zn and Co were within the limits established. The Mg concentration was above the reported range. Plasma concentrations of Ca, K, Na and Zn decreased from dry to wet seasons, whereas that of Mg, P and Co increased. Plasma Fe and Co was the same in both seasons. Other factors that might affect the plasma concentrations of these minerals were also assessed.

Mohammed *et al* (2007) studied 11 adult dromedaries introduced into a sub-humid climate which were bled monthly for 36 months to establish mean serum biochemical reference values for the zone. Mean sodium concentration was 144.57±1.31 mmol/l, potassium 5.03±0.42 mmol/l and chloride 104.06±2.05 mmol/l. Others were bicarbonate 23.57±1.04 mmol/l, calcium 2.39±0.05 mmol/l and phosphate 1.07±0.04 mmol/l. The urea value was 4.92±0.55 mmol/l and that of creatinine was 85.70±8.85, while glucose had 2.62±0.18 mmol/l, total protein 64.94±1.55 g/l and albumin 33.98±0.98 g/l. The male camels had significantly (P<0.05) higher potassium and creatinine levels while urea, total protein and albumin values were higher (P<0.05) in the she-camels. Wet season samples had higher (P<0.05) blood urea nitrogen, creatinine and glucose values while potassium was insignificantly (P>0.05) higher in the dry season samples.

Zabady and Al-Mujalli (2011) studied the effect of different types of mandibular fractures in 20 camels on some blood and biochemical's parameters. The age, sex, breed and clinical signs were recorded and the fracture type was determined by radiograph. Camels with fractured mandible showed significant increase (P < 0.0001) in WBCs, granulocytes%, AST, ALT and creatinine concentrations as well as highly significant decrease in haemoglobin (P < 0.0001), lymphocyte%, and albumin. Females of the same group showed a significant decrease (P < 0.05) in packed cell volume (PCV). It could be concluded that mandibular fractures in camels have a direct impact on the haematological and biochemical parameters of the blood.

Al-Mujalli (2012) studied the relationship between the blood concentrations of some macro-minerals particularly magnesium, calcium and inorganic phosphate in camels with fractured jaw compared to their concentrations in healthy camels. Twenty camels with jaw fractures were included in this study; another 29 apparently healthy camels served as control group. The affected camels were subjected to a detailed physical examination. They showed obvious clinical signs of mandibular fracture. In some cases bilateral fracture was observed, the fractured part of the mandible being dropped ventrally from a site just cranial to the first premolar. Also, there was a wound in the buccal cavity exposing the fractured bone ends, dribbling of saliva from mouth commissure associated with partial or complete loss of appetite. Blood samples were obtained from the affected and healthy camels. The obtained results revealed that the mean values of these macro minerals concentrations in the blood were significantly lower in camels with jaw fracture (2.85±0.29 mmol/L, 0.92±0.17 mmol/L and 0.13±0.07 mmol/L for calcium, magnesium and inorganic phosphate respectively) compared to respective values in healthy camels.

## **CT Scan**

Computed tomography (CT) and magnetic resonance imaging (MRI) are established in equine medicine (Wollanke *et al*, 2006). Tomographic examinations in horses are costly and labour intensive, and they are not available for every case. Certain diseases of the equine head cannot be interpreted or treated without tomographic images. On the other hand, the many information can

be provided by tomographies which justify the costs and efforts in certain cases. Indications for CT or MRI in periorbital diseases are particularly protrusions of the globe due to retrobulbar or retroorbital tumour growth. In fractures of the temporal bone and suspicion of an injury at the temporo-mandibular joint, the preoperative knowledge of the CT or MRI images provide tremendous advantage for surgery. In tumour diagnosis, information from MRI-images is more superior than CT-images. However, in periocular fractures, the information provided by CT-images is more superior than MRI-images. Basically, both techniques are suitable for verifying indications for surgery as well as for evaluating the prognosis and detailed planning of the optimal surgical approach. In some cases, the costs of surgeries with a poor prognosis can be avoided. In other cases, information from CT or MRI images are vital for preserving the globe or even vision of the animal.

# MATERIALS AND METHODS

The present study was conducted on 18 camels which were diagnosed mandibular fractures at Surgery Clinics of TVCC of College of Veterinary and Animal Science, RAJUVAS, Bikaner, between January 2012 to December 2012. These animals were divided in 3 groups, comprising 6 animals in each group.

Group I: Control group- Animals of this group were treated by interdental wiring technique (I.D.W. technique) (Fig. 4).

Group II: Animals of this group were treated by I.D.W. technique and transfixation of pins with fiber cast (Fig. 5).

Group III: Animals of this group were treated by I.D.W. technique and a Scaffold of fiber cast bandage technique (Fig. 6).

#### **History and Clinical Examination**

The owners of camels showing mandibular fractures were asked about the possible etiology of fracture such as, external trauma, falling, forceful feeding, fighting, biting of tree and other fix objects, etc. The clinical examination was carried out by a careful per-oral examination of lower jaw. The gingiva was noted for its discontinuity and wounds. The location of fracture was ascertained in terms of its location anterior, posterior or across the tushes. The nature of fracture was also noted in terms of whether fracture was transverse, oblique or multiple. **Radiological Examination** 

Lateral radiographs of horizontal ramus of docile camels were taken in the Department of Veterinary Surgery and Radiology. Radiographs were also taken during the healing period after a minimum of 15 days interval. The technical factors used were 70 KVP and 12 mAs. The developed radiographs were analysed for confirmation of type of fracture. The radiological description of the fracture callus was made in order to describe the radiological signs of fracture healing (Marino *et al,* 1979).

## Immobilization techniques

All animals were restrained in sitting position and sedated with xylazine @ 0.4 mg per kg body weight administered intravenously. The oral cavity was irrigated with light potassium permanganate solution (1:10000).

On the basis of clinical and radiological examination, suitable immobilisation techniques were selected.

# Group: I. (Control group) Interdental wiring technique (I.D.W. technique)

Six animals having transverse fractures were subjected to I.D.W. technique. The instruments needed in I.D.W. technique have been shown in fig 4. The technique was performed under xylazine sedation. Oral cavity was irrigated of with light potassium permanganate solution. The tunnel were drilled across the gingiva lateromedially between first two cheek teeth on both the sides and also between the central incisors, using 3 mm intramedullary pin with a carpenter's hand drill in cases where sufficient space to pass the wire did not exist.

A 2.38 mm thick and 4 feet long copper wire was passed through pre-drilled tunnels between the first two cheek teeth on either side. The medial ends of both side's wire were taken out anteriorly through the space between central incisors. In order to accomplish the reduction and alignment of the bone, a cotton rope or a piece of bandage was tied around the incisoral arcade and rostral fracture fragment was pulled anteriorly till the reduction occurred.

After achieving a proper reduction and alignment, the medial and lateral ends of copper wire of respective sides were pulled forward by nose plier and each side's wire was then knotted together. Knots were trimmed and twisted towards roots of incisors (Fig. 1).

## Group: II. I.D.W. and Transfixation of pins with fiber cast

Six camels having oblique or multiple fracture were subjected to the Interdental wiring and transfixation of pins using fiber cast technique. Interdental wiring was performed similar to those in animals of group I. Two intramedullary pins (3.5mm) were inserted transversely into the horizontal ramus of caudal part latero-medially pattern and two pins were inserted into rostral fractured part in ventro-dorsally. Adequate cotton padding was applied between the all four pins then a fiber cast bandage was applied. The fiber cast bandage (5 inch x 3.5 metre) was dipped into water for half a

minute and then it was applied across the all four pins in a square fashion. Both the fractured ends of mandible were kept in perfect apposition at the time of fiber cast bandage application. The cast was allowed to dry for 2-3 minutes (Fig. 2).

# Group III. I.D.W. technique and a Scaffold of fiber cast bandage

Six camels having mandibular fracture were subjected to the Interdental wiring technique with a scaffold of fiber cast bandage. Interdental wiring was performed as done in animals of group I. Cotton wool was applied across the mandible laterally from angle of mandible to the incisors as padding material. Then a fiber cast bandage (5 inch x 3.5 metre) was dipped into the water and applied across the lower mandible in form of a scaffold. Holes were drilled on all the four corners of scaffold. One elastic bandage was tied over the nose bridge after passing from anterior holes of scaffold and another elastic bandage was tied behind the ears after passing from posterior holes of scaffold (Fig. 3).

# Postoperative care:

Postoperatively, broad spectrum antibiotic (Oxytetracycline 2500mg, IV) and analgesic (Meloxicam 160mg, IM) were administered for 5 and 3 days, respectively. The oral cavity was flushed daily with light potassium permanganate solution for 10- 15 days. Animals were offered soft leaves fodder, devoid of straws for two weeks and thereafter routine roughage was allowed. A submandibular abscess at the fracture site on ventral aspect developed in all the cases, 10-15 days after fracture. It was drained by incising at the depending part and was dressed routinely. The wires were removed following satisfactory clinical and/or radiological union.

# CT Scan of mandible:

The skull was disarticulated from atlanto-occipital joint. The computer tomography of skull was done with a scan machine (Philips 64 slice) using 100kVp, 120 mAs technical factors on 14 x

17 inches screened film (Fig. 7).

# 6. Haemato- biochemical examination

All animals of present study underwent the following haemato-biochemical tests. Approximately, 15 ml of blood from jugular vein was aspirated and to conduct the parameters.

# (a) Haematological tests

- 1. Haemoglobin (Hb): Hb (g/dl) was determined by Sahlie's method as described by Jain (1986).
- 2. Packed cell volume (PCV): PCV (%) was determined by Wintrobe method as described by Jain (1986).
- 3. Total leukocyte count (TLC): TLC (1000/cubic mm) was done using haematocytometer as described by Jain (1986).
- 4. Total erythrocyte count (TEC): TEC (1000/cubic mm) was done using haematocytometer as described by Jain (1986).
- 5. Differential leukocyte count (DLC): DLC (%) was done using haematocytometer as described by Jain (1986).

# (b) Biochemical tests

- 1. Calcium (Ca): Ca was determined by commercially available kits (Qualigens Diagnostics).
- 2. Phosphorus (P): P was determined by commercially available kits (Qualigens Diagnostics).
- 3. Magnesium (Mg): Mg determined by commercially available kits (Qualigens Diagnostics).
- 4. Alkaline phosphatase (ALP): ALP was determined by commercially available kits (Qualigens Diagnostics).
- 5. (ACP): ACP was determined by commercially available kits (Qualigens Diagnostics).
- 6. (LDH): LDH was determined by commercially available kits (Qualigens Diagnostics).
- 7. (G-6-PD): G-6-PD was determined by commercially available kits (Qualigens Diagnostics).

- 8. (G-6-P): G-6-P was determined by commercially available kits (Qualigens Diagnostics).
- 9. (CPK): CPK was determined by commercially available kits (Qualigens Diagnostics).
- 10. Glucose: Glucose was determined by commercially available kits (Qualigens Diagnostics).
- 11. Cholesterol: Cholesterol was determined by commercially available kits (Qualigens Diagnostics).
- 12. Protein: Protein was determined by commercially available kits (Qualigens Diagnostics).
- 13. Vitamin A: Vitamin A was determined by commercially available kits (Qualigens Diagnostics).
- 14. Vitamin C: Vitamin C was determined by commercially available kits (Qualigens Diagnostics).

#### Statistical analysis

The data obtained in the research work were statistically analyzed and compared using standard formula given for mean, standard error and analysis of variance as per the procedures explained by Snedecor and Cochran (1994) and significance of mean difference were tested by Duncan new multiple range test (DNMRT).

# RESULT

The etiology and occurrence of mandibular fracture was noted in animals of present study (Fig. 8). However, the etiology was recorded in 18 animals of present study and occurrence of mandibular fracture was drawn from the fracture cases recorded in Surgery Clinics during the year January 2012 to December 2012. The diverse etiological agents have been enlisted in table 4 and analysis of etiology revealed that the mandibular fractures occurred due to external trauma and powerful muscular contraction of jaw muscles. However, in two cases the powerful muscular contraction occurred by pulling apart the upper and lower lips for a forcible administration of food. This led to the fracture of mandible across the horizontal rami. In 7 animals of present study the powerful muscular contraction caused mandibular fracture following an attempt of violent bite to other animals.

The occurrence of mandibular fracture among the fracture cases of camel during the January to December 2012 was 56.25% out of which 88.88% were males and 11.11% were females (Fig. 9). In animals of present study, the mandibular fracture was seen across the horizontal rami in all the cases and these were bilateral in nature. However, out of 18 cases of mandibular fractures the simple fractures were seen in 3 cases and compound in 15 cases (Table. 1).

The clinical signs of present study were hanging of rostral fracture fragment, drooling of saliva, disruption of buccal mucosa (15 cases), suspended prehension and mastication. In present study, 5 camels were furious and rest 13 camels were docile and cooperative in nature.

The majority of cases of present study were of age group 8-12 years followed by those above 12 years and remaining animals were upto the age of 8 years (Fig. 10).

The site of fracture was categorised as anterior to tushes, across the alveoli of tushes and posterior to tushes (Fig. 11). In animals of present study, the mandibular fractures occurred across the alveoli of tushes in majority of cases (61.11%). However, the occurrence of fractures anterior and posterior to tushes was 16.6% and 22.2%, respectively.

In animals of present study, the occurrence of mandibular fracture was found higher (61.11%) in breeding season (October to March) and less (38.88%) in non breeding season (April to September). However, the maximum incidence was recorded during month of February (Fig. 12).

The diverse immobilisation techniques used for mandibular fracture repair in camels were modification of Inter Dental Wiring technique described by Gahlot *et al* (1984), Gahlot and Chouhan (1992) and Gahlot *et al* (1989). These techniques were:-

- 1. I.D.W. and Transfixation of pins with fiber cast.
- 2. I.D.W. technique and scaffold of fiber cast bandage

# Group-I (Control group)

However, the Interdental wiring technique was used as control in this study. Interdental wiring provided adequate immobilisation in cases where fracture was transverse in nature (Fig. 14). Animal was able to hold the rostral fractured fragment straight following immobilisation with Interdental wiring technique. However, it provided good stabilisation and immobilisation in 2 cases showing oblique (Fig. 15) and multiple fractures (Fig. 16) as well. During the post fracture rehabilitation period, the wires got loosened in 3 out of 6 animals leading to downward inclination of rostral fracture fragment (Fig. 17). Knots of wires were tightened again. In cases where the wire was tight enough to accomplish the immobilisation, the medial ends of wire did not touch the oral mucosa at fracture site whereas these wires touched the oral mucosa where the wire became loose (Fig. 18). The development of submandibular abscess took place in all the cases of this group. It was characterised by development of a pigeon egg size swelling (Fig. 19).

The gingival wounds of buccal mucosa at fracture site showed evidence of exudate or pus (Fig. 20) which became more marked when the submandibular abscess was pressed. The buccal wounds healed within one week following drainage and subsequent anti septic dressing.

The clinical and radiological union occurred from 8-10 weeks in these cases (Fig.21, 22 and 23). However, the formation of an anchoring callus started after two weeks of stabilisation of fractured fragments. The bridging callus was evidenced after 3 weeks, clinically and radiologically in all the animals.

The Interdental Wiring technique caused embedding wounds in form of long tunnels leading to trapping of oral ingesta around the embedded wires (Fig. 24). However, it did not interfere in the prehension and mastication.

## **Group-II**

In six animals of present study a modification of Interdental wiring technique was done. These cases had multiple or oblique fractures. Technique provided adequate immobilisation and prevented overriding of fractured fragments (Fig. 25, 26, 27). Additionally the movement at the fracture site was minimal. However, animals got adapted to the fiber cast application and it did not interfere in drinking, prehension and masticatory processes. A space between fiber cast at submandibular area allowed easy drainage of submandibular abscess (Fig. 28). These abscesses were treated as described in animals of group-I. These cases did not show loosening of wire; hence the knots did not require further tightening. Two cases of this group showed loosening of rostral pins

and these were removed (Fig. 29). However, the fiber cast remains in position. In 2 cases of present study, the fiber cast bite was observed after three weeks (Fig. 30). The clinical and radiological union in animals of this group occurred from 6-8 weeks (Fig. 31, 32, 33, 34, 35, and 36). However, in two cases of this group the rostral pin was migrated into oral cavity (Fig. 37, 39) and these were removed (Fig. 38, 40).

The gingival wounds other than at fracture site were inflicted at the proximal fracture fragment just below the incisoral arcade and alongside the course of central wires between the incisoral cup due to pressure trauma caused by interdental wiring. Such wounds though persisted till wires were removed but did not interfere with prehension and mastication. Following routine postoperative care, the gingival wounds healed in 7-10 days.

All animals of this group were able to prehense (Fig. 41) and drink water (Fig. 42) conveniently.

# Group-III

In animals of group-III, the Interdental wiring was used together with a fiber cast scaffold without transfixation. This group had 2 oblique fractures, one multiple fracture and three transverse fractures. This scaffold provided adequate support to the mandible and prevented its downward, lateral and medial movements (Fig. 43). The animals of this group did not require tightening of wires after initial application. This device was easy to apply and fiber cast was moulded as per the size of mandible on the particular clinical case showing mandibular fracture.

The submandibular abscesses were treated as described for animals of group-I. The rostral limit of scaffold was kept little below to the rostral border of lower lip. Animals of this group were able to drink water (Fig. 44) and prehense food (Fig. 45) without any problems. However, one owner reported interference in movements of lower lip and displaced the scaffold slightly posterior, in order to allow prehensive movements to the lower lip. The clinical and radiological union in animals of this group occurred from 8-10 weeks (Fig. 46).

The economics of diverse immobilization techniques is given in Table 2. The reduction and immobilisation of fracture was found in animals of group I where I.D.W. technique was used. It was found highly economical as the cost of technique incurred was mere Rs 200. The technique used in animals of group II proved costliest but was found best in terms of reduction and immobilisation of fracture. The cost incurred was Rs 4810. However, the technique used in animals of group III proved costlier than technique used in group I and 6 times economical to the technique used in animals of group II.

#### CT scan

The radiological anatomy of mandible was studied by CT scan (Fig. 47 to 51). The vertical and horizontal rami were distinctly visible in different scans. However, in fig. 47, the presence of molars and premolars was quite distinct (no. 5). The horizontal ramus was widest in this portion but gradually converged to make mandibular symphysis (Fig. 48). There was evidence of medullary cavity of horizontal ramus (Fig. 48) and mental canal (Fig. 47). The alveoli of tushes or first premolar were also visible in one scan (Fig. 49). There was evidence of long diastema, mental canal and presence of alveoli of tushes (Fig. 50) indicating the weakest point of mandibular fractures in camel. The presence of canine and incisors was also seen distinctly in one scan (Fig. 51).

#### Haemato-biochemical analysis

Different haematological parameters like haemoglobin, packed cell volume, total erythrocyte count, total leukocyte count and differential leukocyte count were performed and results were shown in Table 3.

In animals of present study, average mean value of haemoglobin was found to be  $9.19 \pm 0.24$  g%. The mean value of Hb in age group of < 4 years, 4-8 years and in males were within the normal range but in age group of 8-12 years, > 12 years and in females were lower than the lower limit of normal value. The average mean value of PCV was  $28.44 \pm 0.67\%$ . The mean value in all age groups and males were found within the normal range but female had lower than the lower limit of reference value. The average mean value of TLC was found  $18.56 \pm 0.25 \times 10^{3}$ /µl. The mean value of TLC in age group of < 4 years and 4-8 years were higher than the upper limit of reference value but in age group of 8-12 years, > 12 years and in both sexes these were within the normal range. The average mean value of TEC was found  $6.56 \pm 0.29 \times 10^{6}$ /µl. The mean value of TEC in age group of < 4 years and 4-8 years were lower than the lower limit of reference value. The average mean value in all four age groups and in males were lower than the lower limit of normal value. The average mean value of 1.2 years, > 12 years and in both sexes these were within the normal range but female had lower than the lower limit of reference value. The average mean value of  $2.2 \times 10^{3}$ /µl. The mean value of TEC in age group of 4.4 years and 4-8 years were within the normal range but in age group of 8-12 years, > 12 years and both sexes were lower than the lower limit of reference value. The average mean value of neutrophils was  $65.72 \pm 0.38\%$ . The mean value in all four age group of 4.4 years, 4-8 years and in males were lower than the lower limit of normal value. The average mean value of lymphocyte was  $27.56 \pm 0.31\%$ . The mean value of lymphocyte in age group of 4.4 years, 4-8 years and in males were lower than the lower limit of normal value but in age group of 4.4 years, 12 years and females were within the normal range. The average mean value of eosinophils was found within the norma

The average mean concentrations of Ca, P, Mg, ALP, ACP, LDH, G-6-PD, G-6-P, CPK, Glucose, Cholesterol, Protein, Vitamin- A and Vitamin- C were  $9.09 \pm 0.19 \mu \text{molL}^{-1}$ ,  $2.17 \pm 0.17 \mu \text{molL}^{-1}$ ,  $1.96 \pm 0.045 \mu \text{molL}^{-1}$ ,  $41.28 \pm 6.76 \text{ UL}^{-1}$ ,  $12.08 \pm 1.07 \text{ UL}^{-1}$ ,  $65.67 \pm 6.89 \text{ UL}^{-1}$ ,  $14.67 \pm 1.29 \text{ UL}^{-1}$ ,  $16.17 \pm 1.29 \text{ UL}^{-1}$ ,  $113.89 \pm 9.45 \text{ UL}^{-1}$ ,  $65.89 \pm 0.72 \text{ g/dl}$ ,  $311.11 \pm 38.68 \text{ g/dl}$ ,  $8.73 \pm 0.26 \text{ g/dl}$ ,  $1.59 \pm 0.10 \mu \text{molL}^{-1}$  and  $22.19 \pm 0.74 \mu \text{molL}^{-1}$ , respectively. The mean value of Ca in all age groups and both sexes differed non significantly. The mean value of P in age groups of 4-8 years, 8-12 years and in males were significantly higher but mean value in age groups of < 4 years, > 12 years and females were lower than the normal mean value. The average mean values and mean values of Mg, ALP, LDH, CPK and Cholesterol in all age groups and both sexes were higher than the normal mean value. The average mean values of ACP, G-6-PD, G-6-P, Glucose, Vitamin- A and Vitamin- C in all four age groups and both sexes were found remarkably lower than the normal mean value. The average mean value of proteins were slightly lower than the normal mean value and age groups of 8-12 years, > 12 years and both sexes had lower mean value but in age groups of < 4 years and 4-8 years had higher mean value than normal mean value (Table 4). **Retrospective study** 

An overview of 10 year's retrospective study revealed that there was a maximum occurrence of mandibular fracture in the year 2001 (13.14%) followed by year 2002 (12.2%), 2003 (11.2%), 2004 (10.8%), 2005 (9.86%), 2006 (9.86%), 2008 (8.92%), 2007 (8.45%), 2009 (8.45%) and 2010 (7.04%) (Fig. 13).

Fig. 1. Clinical appearance of mandibular fracture showing typical downward hanging of rostral fracture fragment (1), lateral radiograph showing transverse fracture across the horizontal rami of mandible (2), drilling a tunnel across the gingiva between first two cheek teeth with a hand drill (3), reduction and immobilisation of fractured mandible by I.D.W. technique. The knots were trimmed by nose plier (4), irrigation of oral cavity after immobilization with I.D.W. technique (5), lateral radiograph showing reduced and immobilised fractured mandible with Interdental wiring (6) and reduced and immobilized fractured mandible by Interdental wiring in animals of group I (Centre)

Fig. 2. Fractured mandible posterior to the tushes (1), lateral radiograph showing fractured mandible (2), application of Intramedullary pin over horizontal ramus by en electric drill (3), position of transfixed four pins (4), transfixation and fiber cast application- finished appearance (5), lateral radiograph showing transfixed pins and perfect reduction and immobilisation (6) and technique of Interdental wiring with transfixation and fiber cast in animals of group-II (Centre).

Fig. 3. Fractured mandible (1), lateral radiograph showing fractured mandible (2), padding of lower jaw with cotton wool before fiber cast scaffold application (3), finishing of fiber cast scaffold (4), anchoring of fiber cast scaffold on lower jaw (5), lateral radiograph showing perfect reduction and immobilisation and technique of Interdental wiring with fiber cast scaffold in animals of group-III (Centre).

Fig. 4. Instruments used for I.D.W. in animals of group-I (1), with a specimen (2) and immobilised mandible (3).



Fig. 5. Instruments used for I.D.W. and transfixation with fiber cast in animals of group-II (1), with transfixation in a specimen (2) and immobilised mandible (3).

Fig. 6. Instruments used for I.D.W. and fiber cast scaffold in animals of group-III (1), with a specimen (2) and immobilised mandible (3).



Fig. 7. Disarticulated head (1), CT Scan of head of camel (2) and picture of CT Scan thus obtained (3).



Fig. 8. Graphical presentation of etiology of mandibular fracture at horizontal ramus in camel.

Fig. 9. Graphical presentation of sex of animals having mandibular fracture.



Fig. 10. Graphical presentation of age of animals with mandibular fracture.

Fig. 11. Graphical presentation of site of mandibular fracture at horizontal ramus in camels.



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Fig. 13. Graphical presentation of retrospective study of mandibular fracture in camels from 2001 to 2010.



Fig. 14. Lateral radiograph of mandibular fracture (transverse fracture) in a camel of group-I.

Fig. 15. Lateral radiograph of mandibular fracture (oblique fracture) in a camel of group-II.



Fig. 16. Lateral radiograph of mandibular fracture (multiple fracture) in a camel of group-II.

Fig. 17. Lateral radiograph of mandibular fracture in a camel, rostral fracture fragment had downward inclination due to loosening of wires.

Fig. 18. Loose wires touched the oral mucosa in camel (Red arrow) with I. D. W. application.



Fig. 19. Development of pigeon egg size (Red circle) submandibular abscess in a camel.

Fig. 20. Buccal wounds at fracture site (in compound fracture) in a camel.



Fig. 21. Lateral radiograph showed healing of mandibular fracture at 75 days of fracture in a camel.

Fig. 22. Lateral radiograph showed healing of mandibular fracture at 90 days of fracture in a camel.



Fig. 23. Lateral radiograph showed complete healing of mandibular fracture at 110 days (wires were removed) of fracture in a camel.

Fig. 24. Embedded wounds in form of long tunnels (Red arrow) by I.D.W. wires.



Fig. 25. Lateral radiograph showed adequate immobilisation of multiple mandibular fractures by I.D.W. and transfixation with fiber cast in a camel of group-II.

Fig. 26. Lateral radiograph showed adequate immobilisation of transverse mandibular fracture by I.D.W. and transfixation with fiber cast in a camel of group-II.

Fig. 27. Lateral radiograph showed adequate immobilisation of oblique mandibular fracture by I.D.W. and transfixation with fiber cast in a camel of group-II.

Fig. 28. Development of submandibular abscess (Red arrow) and space between fiber cast device in animal of group-II.

Fig. 29. Lateral radiograph showed loosened rostral fragment pins in a camel of group-II.



Fig. 30. Fiber cast wound (Red arrow) at caudal aspect of fiber cast in a camel.

Fig. 31. Lateral radiograph showed healing at 15 days in a camel of group-II.



Fig. 32. Lateral radiograph showed healing at 30 days in a camel of group-II.

Fig. 33. Lateral radiograph showed healing at 45 days and arrow show fiber cast in a camel of group-II.



Fig. 34. Lateral radiograph showed healing at 60 days in a camel of group-II.

Fig. 35. Lateral radiograph showed healing at 90 days in a camel of group-II.

Fig. 36. Lateral radiograph showed adequate immobilisation and healing at 30 days, arrow show fiber cast in a camel of group-II.



Fig. 37. Migration of rostral pin into oral cavity (Red circle).

Fig. 38. Migrated pin was removed (Red circle).



Fig. 39. Migration of rostral pin into oral cavity (Red circle) across the left horizontal ramus.

Fig. 40. Migrated pin was removed (Red circle).


Fig. 41. Camel prehensed food comfortably after immobilisation with transfixation with fiber cast device.

Fig. 42. Camel drinking water comfortably after transfixation with fiber cast device.



Fig. 43. Fiber cast scaffold application in animals of group-III.

Fig. 44. Camel drinking water comfortably after immobilisation with fiber cast scaffold device.



Fig. 45. Camel prehensed the food with fiber cast scaffold device comfortably.

Fig. 46. Lateral radiograph showed healing at 60 days in animals of group-III.



Fig. 47. CT scan of mandible of camel showing 1. Pre molar, 2, 3, 4. Cheek teeth, 5. Mental canal, 6. Vertical ramus, 7. Horizontal ramus and 8. Long diastema.

Fig. 48. CT scan of mandible of camel showing 1. Symphysis, 2. Tushes, 3. Canine teeth, 4. Incisors teeth and 5. Wide alveoli of tushes.

Fig. 49. CT scan of mandible of camel showing 1, 2. Wide alveoli of tushes, 3. Tushes.

Fig. 50. CT scan of mandible of camel showing 1. Tushes, 2. Wide alveoli across the tushes, 3. Canine teeth, 4. Incisors teeth.

Fig. 51. CT scan of mandible of camel showing 1. Medullary canal, 2. Tushes, 3. Symphysis of mandible and 4. Incisoral cup.



## DISCUSSION

The maximum incidence of mandibular fracture in animals of present study was seen during the month February which is a favourable month for breeding season. However, there was highest occurrence seen during the breeding season than non breeding season as the other etiological agents were also responsible for mandibular fracture and these were unrelated to the breeding season.

In the present study, mandibular fracture was recorded in 16 male and 2 female camels. Similar cases of mandibular fracture were recorded by Kumar *et al* (1977) in 6, Purohit *et al* (1984) in 5, Choudhary (2009) in 6, Lavania *et al* (1999) in 8 and Ram and Gahlot (2001) in 25 male camels. On the other hand, Kumar *et al* (1979) recorded fracture of mandible in one male and one female camel, 20 male and 5 female (Gahlot *et al*, 1984), 72 male and 6 female (Gahlot *et al*, 1989) and 51 male and 3 female camels.

Kumar *et al* (1979) recorded age of camels at the time of fracture of mandible and it was 10 and 15 years in two camels. Gahlot *et al* (1984) noticed fracture of mandible in age group of 2-5 years (4 animals), 5-7 years (8 animals) and 7-10 years (8 animals). Ram (1997) noticed that the age of 54 camels at the time of fracture of mandible ranged from 3-12 years, Lavania *et al* (1999) recorded age of 18 camels which ranged from 8-12 years and Ram and Gahlot (2001) recorded age group of 5-15 years in 25 camels with mandibular fracture. In the present study, the age group recorded was less than 4 years (2 animals), 4-8 years (3 animals), 8-12 years (8 animals) and above 12 years (5 animals).

In the present study, fracture of mandible occurred due to infighting between two camels (7 animals), biting tree or fix objects (7 animals), forcible feeding (2 animals), electric shock (1 animal) and falling on ground (1 animal). Various authors were of the opinion that infighting was the main cause of fracture of mandible (Kumar *et al*, 1977; Singh and Nigam, 1982; Gahlot *et al*, 1989; Parsania *et al*, 1989; Ram, 1997; Lavania *et al*, 1999; Gahlot, 2000; Ram and Gahlot, 2001 and Gahlot *et al*, 2007). Fractures of mandible in camels have been reported due to blow of lathi (Gahlot *et al*, 1989; Ram, 1997; Ram and Gahlot, 2001 and Gahlot *et al*, 2007). Another cause of fracture of mandible was biting hard objects (Kumar *et al*, 1977 and Ram, 1997). Other etiological factors of mandibular fracture recorded were accidental falling of animal on ground or accidental trauma (Ram, 1997; Ram and Gahlot, 2001 and Gahlot *et al*, 2007).

All the 18 camels were found healthy and had suspended prehension and mastication because of mandibular fracture which make prehensile organs (lips) apart. Similarly, Gahlot *et al* (1989) observed suspended prehension and mastication due to mandibular fracture in camels. In the present study, 5 camels were furious and rest 13 camels were docile and cooperative in nature which enabled radiography. However, temperament of animal did not affect the success rate of techniques used.

The mandibular fracture was bilateral in nature in all the 18 camels. Similarly, bilateral mandibular fractures were also recorded in 6 camels by Kumar *et al* (1977), 25 camels (Gahlot *et al*, 1984), 78 camels (Gahlot *et al*, 1989), 42 camels (Ramadan and Abdin Bey, 1990), 51 camels (Ram, 1997) and 18 camels (Lavania *et al*, 1999), 25 camels (Ram and Gahlot, 2001) and 8 camels (Gahlot *et al*, 2007). Drooling of saliva in case of mandibular fractures in camels was also noticed by Kumar *et al* (1979), Ram (1997) and Gahlot (2000). Drooling of saliva was seen in all the cases of present study. Gingival wounds at the site of fracture of mandible were noticed by various authors (Kumar *et al*, 1977; Purohit *et al*, 1984; Ram, 1997 and Gahlot, 2000). In the present study, gingival wounds at the site of fracture were noticed in 15 camels and rest 3 camels had simple bilateral fractures these did not show gingival wounds. Blood clots and feed material were found in gingival wounds in 15 camels of present study.

The maximum occurrence of mandibular fracture was across the alveoli of tushes which suggest that this area is comparatively weak of horizontal rami. This is in agreement with the observations of Gahlot (2000); Gahlot *et al* (1994); Gahlot and Chauhan (1992); Ramadan (1994). The long interdental space, presence of alveoli of first premolar and presence of mental canal makes the area close to the alveoli of first premolar of horizontal rami weak, thus it is predisposed to the fractures. The stress forces overcome the breaking strength of horizontal rami at this place. These fractures were caused by not only the powerful muscular contraction but by also external trauma. The seat of fracture anterior and posterior to the tushes could be due to direct trauma to the particular area of horizontal rami.

The site of mandibular fracture in camels anterior to tushes (7), posterior (12) and across the alveoli (6) was reported by Gahlot *et al* (1984). Gahlot *et al* (1989) recorded the site of mandibular fracture anterior to tushes (14), posterior to tushes (14) and across the alveoli in 50 camels. In the present study, the site of fracture was anterior to tushes (3), posterior to tushes (4) and across the alveoli (11) were recorded.

Gahlot *et al* (1984) recorded 1 simple and 24 compound cases of mandibular fracture in camels. Gahlot *et al* (1989) observed 8 cases of simple and 70 cases of compound mandibular fractures in camels. Gahlot *et al* (2007) also recorded simple (3) and compound (8) cases of mandibular fracture in camels. In the present study simple fractures (3) and compound fractures (15) were recorded

In the present study, the line of mandibular fracture at horizontal rami was transverse (10), oblique (5) and multiple (3). Similarly Gahlot *et al* (1984) observed 23 cases of transverse and 2 cases of oblique fractures of mandible in camels. Gahlot *et al* (1989) recorded transverse (51), oblique (25) and multiple (2) cases of fracture of mandible in camels. Ram (1997) observed transverse (29), oblique (22) and multiple (3) cases of fracture of mandible in camels. Ram and Gahlot (2001) recorded 8 cases of compound fracture and type was transverse (5), oblique (2) and multiple (1) in camels.

In the present study animals were restrained in sitting position and sedated with Xylazine hydrochloride. After sedation the head was rested over wooden table. The procedure of restraint adopted in present study facilitated all three techniques i.e. I.D.W; I.D.W. and transfixation with fiber cast and I.D.W. and a fiber cast scaffold for repair of mandibular fracture. Similarly animals were restrained in sitting position for repair of mandibular fracture in camels by Gahlot *et al* (1989), Lavania *et al* (1999) and Ram and Gahlot (2001). On the contrary, camels were restrained in lateral recumbency for repair of mandibular fracture by Gahlot *et al* (1984), Purohit *et al* (1984) and Parsania *et al* (1989).

In the present study, the sedation achieved by using Xylazine was sufficient enough to perform I.D.W. I.D.W. and transfixation with fiber cast and IDW and a fiber cast scaffold for repair of mandibular fracture in camels as the animal did not show any pain during repair of fracture. Similarly camels were sedated by using Xylazine for repair of mandibular fracture (Ram, 1997; Lavania *et al,* 1999; Ram and Gahlot, 2001 and Gahlot *et al,* 2007).

The gingival wounds and buccal mucosa's wire gall wounds occurred due to bite of either wire or knots of Interdental wiring technique in animals of present study. However, occurrence of such wounds was reported previously also (Ram, 1997 and Gahlot and Chouhan, 1994).

The occurrence of submandibular abscess was a sequel to the percolation of saliva and ingesta into these wounds through the buccal wounds leading to a potent contamination or infection. This process led to development of submandibular abscess. However, the healing of buccal wounds was quick following drainage of submandibular abscess. The early healing of gingival wounds is mainly because of rich blood supply of buccal mucosa. Frank (1981) also reported fast healing of buccal wounds following injuries caused by bits in horses owing to good blood supply of oral mucosa.

The migration of pin in one animal of present study could have been a result of over drilling of intra medullary pin crossing both the cortices of horizontal ramus while drilling. The loosening of pin as seen in two cases of present study of group–II was due to presence of local infection at the site of embedding of pin in rostral fractured fragments.

Even though the fiber cast was applied after a careful padding with cotton wool, sometimes it was displaced and leds to bite wounds on the skin due to friction. However, such wounds did not lead to a serious complication.

The Interdental wiring technique together with application of a fiber cast even though proved costlier than I.D.W. technique alone but provided adequate immobilisation of fractured fragments even in multiple and oblique fractures where I.D.W. alone led to overriding and shortening of jaw (Gahlot *et al*, 1989 and Gahlot, 2000). This technique, therefore, has become a boon to the fractures which cannot be managed by I.D.W. alone. The I.D.W. technique has been used successfully in transverse mandibular fractures (Gahlot *et al*, 1994 and 1989). However, in animals of present study also this technique proved efficacious in transverse mandibular fractures. Few cases of present study required tightening of wires at knots after one week of application of I.D.W. This could be due to straightening of minor dents of wire and elasticity of wire. However, in animals of group-II where transfixation and fiber cast were together with I.D.W; the tightening of wires was not required.

The fiber cast scaffold applied in animals of group-III prevented latero-medial and downward movements of mandible, thus loosening of wire did not occur. The technique proved costlier to I.D.W. due to additional cost of fiber cast bandage but proved slightly cheaper than the techniques used in animals of group-II which incurred an additional cost of intra- medullary pins.

However, clinical and radiological union took place in 6-8 weeks in animals of group–II followed by 8-10 weeks in animal of group-III and 8-12 weeks in animal of group-I. This points to the fact that transfixation together with fiber cast provided most adequate immobilization among all the groups used in the present study. The wires got loosened only in animals of group-I where only I.D.W. technique was used. The transverse and oblique fractures were managed more efficiently with the technique used in animals of group-II. This technique provided an additional merit of preventing, overriding and movement of fractured fragments, although the cast and skeletal trauma are the additional demerits. This technique also required an electric drill machine for insertion of pins into the horizontal rami whereas the other two techniques did not cause skeletal trauma and were easy to apply. The complication of bites and wire gall wounds due to wires of I.D.W. technique were common in all the groups. The technique used in animals of group-III proved a superior option to the I.D.W. technique as used in animals of group-I and inferior option to the transfixation together with I.D.W. technique as used in animals of group-II.

CT scan has proven to be the most valuable of these four modalities (Ultrasound, nuclear scintigraphy, magnetic resonance imaging and computed tomography) to identify maxillofacial pathology providing accurate images cross sectional and multiplanar views. Both soft and hard tissue algorithms with or without contrast provide ample information. Three- dimensional reconstructions are particularly useful for maxillary and mandibular fracture repair.

The CT Scan of specimen mandible of present study proved highly useful in detailing out the anatomy of horizontal ramus of mandible which helped understanding the weakest portion of mandible close or across the alveoli of tushes. The junction of mental canal, medullary cavity of horizontal ramus and alveoli of tushes was clearly visible. This helped finding the explanation of fracture of mandibles in camels from the commonest site.

An overview of 10 years retrospective study revealed that there was a maximum occurrence of mandibular fracture in the year 2001 (13.14%). The cases reported in clinics in the retrospective study showed a decline in these cases from 13.14% (2001) to 7.04% (2010). This was possibly due to decrease in camel population, awareness in farmers and nearby treatment facilities availability.

The lower values of Hb and PCV in camels more than 8 years of present study could be due to a poor physical health of these animals. The higher value of TLC in animals more than 4 years and 4-8 years range indicated their good immune system. The lower TEC and neutrophils values in animals of 8 years and more could be due to poor physical health. Similarly the lower lymphocytes levels in animals of age group more than 4 years, 4-8 years and in males could not be explained.

The higher P level in animals of age group 4-8 years and particularly males indicates a higher Ca: P ratio in these animals. However, Al-Mujalli (2012) reported that macro minerals concentrations in the blood were significantly lower in camels with jaw fracture (2.85±0.29 mmol/L, 0.92±0.17 mmol/L and 0.13±0.07 mmol/L for calcium, magnesium and inorganic phosphate, respectively) compared to respective values in healthy camels. The higher levels of Mg, ALP, LDH, CPK and Cholesterol in all age and sex groups indicate normal liver and pancreatic functions. However, the highly lower values of ACP, G- 6-PD, G-6-P, Glucose Vitamin- A and Vitamin- C could be due to poor physiological state of these animals. In animals of present study, the mean value of proteins was gradually declined as the age advanced. Similarly Kataria *et al* (1991) recorded a decline in mean protein value as the age was advanced in camels. The mean value of protein was higher in males than females in animals of present study. Similarly Kataria *et al* (1991) reported higher mean protein value in males than females.

## SUMMARY

The present study was conducted on 18 camels which were diagnosed mandibular fractures at Surgery Clinics of TVCC of College of Veterinary and Animal Science, RAJUVAS, Bikaner, during January 2012 to December 2012. These animals were divided in 3 groups, comprising 6 animals in each group. Group I was considered as control group- animals of this group were treated by interdental wiring technique (I.D.W. technique). Group II animals were treated by I.D.W. and transfixation of pins with fiber cast technique. Group III animals of this group were treated by I.D.W. and a Scaffold of fiber cast bandage technique.

The maximum incidence of mandibular fracture in animals of present study was seen during the month February which is a favourable month of breeding season. However, there was highest occurrence seen during the breeding season than non breeding season as the other etiological agents were also responsible for mandibular fractures and these were unrelated to the breeding season. In the present study, mandibular fracture was recorded in 16 male and 2 female camels, the age group recorded was less than 4 years (2 animals), 4-8 years (3 animals), 8-12 years (8 animals) and above 12 years (5 animals).

In the present study, fracture of mandible occurred due to infighting between camels (7 animals), biting tree or fix objects (7 animals), forcible feeding (2 animals), electric shock (1 animal) and falling on ground (1 animal).

All the 18 camels were found healthy and had suspended prehension and mastication because of mandibular fracture which make prehensile organs (lips) apart. In the present study, 5 camels were furious and rest 13 camels were docile and cooperative in nature which enabled radiography. However, temperament of animal did not affect the success rate of techniques used.

The mandibular fracture was bilateral in nature in all the 18 camels. Drooling of saliva was seen in all the cases, gingival wounds at the site of fracture were noticed in 15 camels and rest 3 camels had simple bilateral fractures these did not show gingival wounds. Blood clots and feed material were found in gingival wounds in 15 camels of present study.

In the present study, the site of fracture was anterior to tushes (3), posterior to tushes (4) and across the alveoli (11), simple fractures (3) and compound fractures (15), line of mandibular fracture at horizontal rami was transverse (10), oblique (5) and multiple (3) were recorded.

In the present study animals were restrained in sitting position and sedated with Xylazine hydrochloride. After sedation the head was rested over wooden table. The procedure of restraint adopted in present study facilitated all three techniques i.e. I.D.W; I.D.W. and transfixation with fiber cast and I.D.W. and a Fiber cast scaffold for repair of mandibular fracture, the sedation achieved by using Xylazine was sufficient enough to perform I.D.W; I.D.W. and transfixation with fiber cast and IDW and a fiber cast scaffold for repair of mandibular fracture in camels as the animal did not show any pain during repair of fracture.

The gingival wounds and buccal mucosa wire gall wounds occurred due to bite of either wire or knots of Interdental wiring technique in animals of present study. The occurrence of submandibular abscess was a sequel to the percolation of saliva and ingesta into these wounds through the buccal wounds leading to a potent contamination or infection. This process led to development of submandibular abscess. However, the healing of buccal wounds was quick following drainage of submandibular abscess.

The migration of pin in one animal of present study could have been a result of over drilling of intra medullary pin crossing both the cortices of horizontal ramus while drilling. The loosening of pin as seen in two cases of present study of group–II was due to presence of local infection at the site of embedding of pin in rostral fractured fragments.

Even though the fiber cast was applied after a careful padding with cotton wool, sometimes it was displaced and leads to bite wounds on the skin due to friction. However, such wounds did not lead to a serious complication.

The Interdental wiring technique together with application of a fiber cast even though proved costlier than I.D.W. technique alone but provided adequate immobilisation of fractured fragments even in multiple and oblique fractures where I.D.W. alone led to overriding and shortening of jaw. In animals of present study also, this technique proved efficacious in transverse mandibular fractures. Few cases of present study required tightening of wires at knots after one week of application of I.D.W. This could be due to straightening of minor dents of wire and elasticity of wire. However, the animals of group-II where transfixation and fiber cast were together with I.D.W; the tightening of wires was not required.

The fiber cast scaffold applied in animals of group-III prevented latero-medial and downward movements of mandible, thus loosening of wire did not occur. The technique proved costlier to I.D.W. due to additional cost of fiber cast bandage but proved slightly cheaper than the techniques used in animals of group-II which incurred an additional cost of intra- medullary pins.

Clinical and radiological union took place in 6-8 weeks in animals of group-II followed by 8-10 weeks in animal of group-III and 8-12 weeks in animal of group-I. This points to the fact that transfixation together with fiber cast provided most adequate immobilisation among all the groups used in the present study. The wires got loosened only in animals of group-I where only I.D.W. technique was used. The transverse and oblique fractures were managed more efficiently with the technique used in animals of group-II. This technique provided an additional merit of preventing, overriding and movement of fractured fragments, although the cast and skeletal trauma are the additional demerits. This technique also required an electric drill machine for insertion of pins into the horizontal rami whereas the other two techniques did not cause skeletal trauma and were easy to apply. The complication of bites and wire gall wounds due to wires of I.D.W. technique were common in all the groups. The technique used in animals of group-III proved a superior option to the I.D.W. technique as used in animals of group-I and inferior option to the transfixation together with I.D.W. technique as used in animals of group-II.

The CT Scan of specimen mandible of present study proved highly useful in detailing out the anatomy of horizontal ramus of mandible which helped understanding the weakest portion of mandible close or across the alveoli of tushes. This helped finding the explanation of fracture of mandibles in camels from the commonest site.

The lower values of Hb, PCV, TEC and neutrophils in camels more than 8 years of present study could be due to a poor physical health of these animals. The higher value of TLC in animals more than 4 years and 4-8 years range indicate their good immune system. Similarly the lower lymphocytes levels in animals of age group more than 4 years, 4-8 years and in males could not be explained.

The higher P level in animals of age group 4-8 years and particularly males indicated a higher Ca: P ratio in these animals. The higher levels of Mg, ALP, LDH, CPK and Cholesterol in all age and sex groups indicated normal liver and pancreatic functions. However, the highly lower values of ACP, G- 6-PD, G-6-P, Glucose Vitamin- A and Vitamin- C could be due to poor physiological state of these animals. In animals of present study, the mean value of proteins was gradually declined as the age advanced.

## CONCLUSION

- 1. Three immobilization techniques were attempted in clinical cases of bilateral mandibular fractures of camel.
- 2. The techniques were used in 18 animals out of which I.D.W. technique, I.D.W. and transfixation with fiber cast technique and I.D.W. and a fiber cast scaffold were used in 6 animals each, as group-I,II,III, respectively.
- 3. In animals of present study, the mandibular fractures of horizontal ramus were transverse (10), oblique (05) and multiple (03).
- 4. The clinical and radiological union occurred at an earliest in animals of group -II (6-8 weeks), followed by group-III (8-10 weeks) and group-I (8-12 weeks).
- 5. The sub mandibular abscess was formed in all animals of present study which was mainly due to compound fractures and subsequent oral infection.
- 6. The transfixation technique with fiber cast used in animals of group-II was costliest of all.
- 7. The transfixation technique required additional orthopedic tools such as an electric drill machine, Intra medullary pins and pin cutter and as an aseptic procedure.
- 8. The I.D.W. was found suitable for transverse fractures and other stechniques proved efficacious for transverse, oblique and multiple fractures as well.
- 9. The CT Scan of specimen mandible highly useful in detailing out the anatomy of horizontal ramus of mandible which helped understanding the weakest portion of mandible close or across the alveoli of tushes.

10. Haemato-biochemical parameters indicate poor physiological state and normal liver and pancreatic functions in all age and sex groups.



## LITERATURE CITED

Ahmed A F (2011). Mandibular Fracture in Single-humped Camels. Veterinary Surgery 40(7): 903-907.

Ahmed A F and Al-Sobayil F A (2012). Fractures in young single-humped camels (Camelus dromedarius). Turk. J. Vet. Anim. Sci. 36(1): 1-8.

Ahsan S, Hussain M M, Khan I A and El Yousuf R J (2004). Effect of age on some serum constituents of camels in United Arab Emirates. Indian Journal of Animal Sciences 74(3): 278-280.

Al-Busadah K A (2003). Some aspects of calcium and magnesium metabolism in camel calves. Journal of Camel Practice and Research 10(2): 111-114.

Al-Dughaym A M, Ramadan R O, Mohamed G E, Fadlelmula A and Abdin Bey M R (2003). Post-traumatic buccal infection and osteomyelitis associated with mandibular fractures in the dromedary camel. Journal of Camel Practice and Research 10(1): 57-60.

Al-Mujalli A M (2012). Relationship between mineral status and jaw fractures in dromedary camels (Camelus dromedarius). Bulg. J. Vet. Med. 15(2): 110–114.

Al-Sultan S I (2003a). Studies of some normal biochemical parameters of majaheem breed of camel (*Camelus dromedarius*) in Saudi Arabia. Journal of Animal and Veterinary Advances 2(12): 646-647.

Al-Sultan S I (2003b). Studies of some normal biochemical parameters of Majaheem breed of camel (Camelus dromedarius) in Saudi Arabia. Journal of Camel Practice and Research 10(1): 79-80.

Ammann K (1970). Repair of mandibular fracture in large animal by the use of plaster bridge. Schweizer arch. Tierheik 112: 109-112.

Armstead W W (1947). Unusual management of mandibular fracture in a dog. Journal of American Veterinary Medical Association 11:103-104.

Bahgat H (2007). Computed Tomography and Cross Sectional Anatomy of the Metacarpus and Digits of the Small Ruminants. Benha Vet. Med.J. 18: 63-84.

Barri M E S, Al-Busadah K A and Homeida A M (2005). Comparative calcium and magnesium status in adult and young camel (*Camelus dromedaries*). Scientific Journal of King Faisal University Basic and Applied Sciences 6(2): 151-158.

Beckenhauser W H (1956). Fractured mandibular symphysis in cow. Journal of American Veterinary Medical Association 126:104-105.

Belsito and Fischer (2001). External skeletal fixation in the management of equine mandibular fractures: 16 cases (1988-1998). Equine Veterinary Journal 33(2): 176-183.

Bengoumi M, Faye B, El-Kasmi K and De La Farge F (1997). Clinical enzymology in the dromedary camel (*Camelus dromedaries*). Part 2: Effect of season, age, sex, castration and pregnancy on serum AST, ALT, GGT, AP and LDH activities. Journal of Camel Practice and Research 4(1): 25-29.

Bienert A and Stadler P (2006). Computed tomographic examination of the locomotor apparatus of horses a review. Pferdeheilk 22: 218–226.

Bourne G H (1958). The Biochemistry and Physiology of bone. Academic Press, New York. Pp 190-195.

Chambers J N (1981). Principles of management of mandibular fracture in dog and cat. Journal of Veterinary Orthopaedics 2(2): 26-36.

Chaudhary S R (2009). Studies on mandibular fracture in camels. Indian Journal of Veterinary Surgery 30(2): 140.

Chouhan D S (1972). Clinical studies of mandibular fracture in camel with mode of action of serum alkaline phosphatase. M. V. Sc. Thesis, University of Udaipur, Udaipur.

Colahan P T and Pascoe J R (1983). Stabilisation of equine and bovine mandibular and maxillary fractures using an acrylic splint. Journal of American Veterinary Medical Association 182(10):1117-1119.

David T Z, Clifford M H, James D H, Elizabeth S, James M J and James R H III (1992). Surgical Repair of a Fractured Mandible in an Adult Camel (*Camelus dromedarius*). Journal of Zoo and Wildlife Medicine 23(3): 364-368.

FAOSTAT (2011). Vision 2030. National Research Centre on Camel. Indian Council of Agricultural Research. http://nrccamel.res.in/ downloads /NRCC-Vision-2030.

Fleisch H and Newman W F (1961). Mechanism of calcification, role of collagen polyphosphate and phosphatase. Am. J. Physio. 200(6): 1296-1300.

Frank E R. Fractures and dislocations, In Veterinary Surgery (1981), 7<sup>th</sup> Edn. Pp. 109-111.

Gabel A A (1969). A method of surgical repair of fractured mandible in the horse. Journal of American Veterinary Medical Association 155:1831-1834.

Gahlot A K (2007). Camels of Rajasthan-a journey from Ganga Risala to Rajasthan canal and beyond. Camel Conf-Book, International Camel Conference. Feb. 16–17, College of Veterinary and Animal Science, Bikaner.

Gahlot N and Bhatia J S (1989). Observations on serum phosphatases in camels. Indian Journal of Animal Health. December 1989: 103-105.

Gahlot T K, Khatri S K, Chauhan D S, Choudhary R J and Purohit R K (1984). Repair of transverse mandibular fractures by silver wiring in camels. Indian Journal of Veterinary Surgery 5:74-76.

Gahlot T K, Chawla S K and Krishnamurthy D (1988). Mandibular fracture repair of horizontal and vertical rami in a bullock. Indian Veterinary Journal 65: 1023-1024.

Gahlot T K, Choudhary R J, Chauhan D S, Chawla S K and Krishnmurthy D (1989). Clinical evaluation of interdental wiring technique for mandibular fracture repair in camels. Indian Veterinary Journal 66 (3):251-254.

Gahlot T K (1990). Mandibular fracture repair in camels. Camel Newsletter 7(12): 66.

Gahlot T K (1991). Mandibular fracture repair in camel (Camelus dromedarius). Proceedings of the International Conference on Camel Production and Improvement, 10-13 December 1990, Tobruk, Libya. 255-257. 113-115.

Gahlot T K and Chauhan D S (1992). Camel Surgery. I<sup>st</sup> Edition. Gyan Prakashan Mandir, Gauri Niwas, 265, Pawanpuri, Bikaner, India Pp 54-63.

Gahlot T K and Chouhan D S (1994). Fractures in dromedary (Camelus dromedarius)- a retrospective study. Journal of Camel Practice and Research 1:9-16.

Gahlot T K, Garg R, Bishnoi P, Mathur A and Singh G (1994). Removal of maxillary canines in cases of fractured mandible of camels (*Camelus dromedarius*). Journal of Camel Practice and Research 1(2):69-70.

Gahlot T K (2000). Selected Topics on Camelids. The Camelid Publishers, Bikaner, India. pp 1 – 614.

Gahlot T K (2005). "The camel's lower jaw is unique." Down To Earth : Jan. 15.

- Gahlot T K, Dudi P R, Sharma C K, Bishnoi P and Purohit S (2007). Surgeries of head and neck region of dromedary camel in India. Proceedings of the International Camel Conference"Recent trends in Camelids research and Future strategies for saving Camels", Rajasthan, India, 16-17 February 2007. 171-175
- Gahlot T K (2010). Peculiar Anatomical Features of Dromedary vis-à-vis Surgical Procedures. Second Scientific Congress of the African Association of Veterinary Anatomists, March 20-21 2010, Cairo.
- Garner H E and Thurman J C (1968) Repair of bilateral fracture of the maxilla, premaxilla and mandible in a horse. Journal of American Veterinary Medical Association 152:1402-1406.

George E M (1948). Phosphatase activity in blood serum, bone and soft tissue following fracture in cat. Arch. Surg . 57:

Goncalves Fetreira A J, Herculano carvalho M, Melanica JP, Farias JP and Gomes L (2001). Corpus callosum: microsurgical anatomy and MRI. Surgical Radiology & Anatomy 23:409–414.

Henninger R W, Bread W L, Schneider R K, Bramlage L R and Burkhardt H A (1999). Fractures of rostral portion of the mandible and maxilla in horses: 89 cases. (1979-1997). Journal of American Veterinary Medical Association 214(11):1648-1652.

Hort I (1968). Mandibular fracture repair in 25 years old Arab horse. British Veterinary Journal 124:140-142.

Jain N C (1986). Schalm's Veterinary Haematology, 4<sup>th</sup> Ed., Lea and Febiger, Philadelphia.

Johnston H W and Farquharsan J (1939). Fixation of mandibular fracture in the dog and cat by transfixation pinning. Journal of American Veterinary Medical Association 94:647.

Jones E D (1951). Effect of local alkaline phosphatase in experimentally prodused fracture in rabbits. American Journal of Surgery 81: 417-418.

Kataria N and Bhatia J S (1991). Activity of some enzymes in the serum of dromedary camels. Research in Veterinary Science 51: 174-176.

Kataria N, Sareen M, Kataria A K, Bhatia J S and Ghosal A K (1991). Some observations on total serum proteins in camel. Indian Veterinary Medicine Journal 15 (March): 38-43.

Kazer-hotz B S, Sartoretti Schefer S and Weis R (1994). Computed tomography and magnetic imaging of the normal equine carpus. Veterinary Radiology & Ultrasound 6:457-461.

Keile C A and Neileric (1965). Samson Wright's Applied Physiology. XI Ed. The English language Book Society and Oxford University Press, London.

Komnenou A, Karayannopoulou M, Polizopoulou Z S, Constantinidis T C and Dessiris A (2005). Correlation of serum alkaline phosphatase activity with the healing process of long bone fractures in dogs. Veterinary Clinical Pathology 34(1): 35-38.

Kumar R, Gill P S, Singh R, Setia M S and Rattan P J S (1992). Plasma electrolyte changes during fracture healing in dogs. Indian Veterinary Journal 69: 476-477.

Kumar V, Singh G and Datt S C (1979). Treatment of unilateral fracture of mandible by bone plating in camel. Indian Veterinary Journal 56 (1):58-59.

Kumar V, Singh G, Manohar M and Nigam J M (1977). Bilateral fracture of mandible in camel. Indian Veterinary Journal 56 (6):477-478.

- Kumar V, Varshney A C, Singh M, Sharma S K and Nigam J M (1997). Haemato- biochemical changes during fracture repair with hydroxyapatite-fibrillar collagen implants in calves. Indian Journal Veterinary Surgery 18(1): 47-56.-
- Kuria S G, Gachuiri C K, Wahome R G and Wanyoike M M (2006). Mineral profile in the plasma of free ranging camels (Camelus dromedarius) in Kenya. Indian Journal of Animal Sciences 76(12): 1068-1070.

Lavania J P (1998). Proceedings of the third annual meeting for animal production under arid conditions, Vol. 1: 174-179 © 1998 United Arab Emirates University.

Lavania J P, Shukla R K and Kayum A (1999). A field oriented immobilisation technique for mandibular fracture in camel- A clinical study. Journal of Camel Practice and Research 6(1):121-129.

Lawson D D (1957). Fixation of mandibular fracture in the dog and cat by transfixation pinning. Veterinary Record 69: 1029-1031.

Leese A S (1927). A Treatise on the One Humped Camel in Health and Disease : Stamford, Haynes and Son.

Leonard E P (1964). Orthopaedic Surgery of dog and cat. W B Saunders Company. Philadelphia and London.

Lewis D D, Oakes M G, Kerwin S C and Hedlund C S (1991). Maxillary mandibular wiring for the management of caudal mandibular fractures in two cats. Journal of Small Animal Practice 32(2): 253-257.

Lischer C J, Fluri E and Auer J A (1997a). Stabilisation of a mandibular fracture in a cow by means of a pinless external fixator. Veterinary Record 140(9): 226-229.

Lischer C J, Fluri E, Kaser Hotz B, Bettschart Wolfensberger R and Auer J A (1997b). Pinless external fixation of mandible fractures in cattle. Veterinary Surgery 26(1): 14-19.

Lorch I T (1949). Alkaline phosphatase and the mechanisum of calcification. J. Bone and Joint Surg. 12(20): 94-95.

Lundvall R L (1963). Equine Medicine and Surgery edited by J F Boneet al. American veterinary Publication Inc, Santa Barbara, Clif: 698.

Marino A A, Cullar J M, Reichmanis M and Becker R O (1979). Fracture healing in rats exposed to extremely low electric current. Clinical orthopedic. Rel, Res, 145: 239-244.

- Martens A, Steenhaut M, Boel K, Gasthuys F, Vlaminck L, Desmet P and Moor A de (1999). Conservative and surgical treatment of mandibular and maxillary fractures in 54 horses. Vlaams Diergeneeskundig Tijdschrift 68(1): 16-21.
- Mitchell D M (1939). Role of alkaline phosphatase in bone healing. J. Bone and Joint Surg. 12(2): 67-68.
- Mohamed H E (2004). A note on vitamin A, C and E status in healthy and infected camel calves. Journal of Camel Practice and Research 11(1): 63-64.
- Mohammed A K, Sackey A K B, Tekdek L B and Gefu J O (2007). Serum biochemical values of healthy adult one humped camel (*Camelus dromedarius*) introduced into a sub-humid climate in Shika-Zaria, Nigeria. Journal of Animal and Veterinary Advances 6(5): 597-600.

Monin T (1977). Tension band of equine mandibular fracture. Journal of Equine Medicine and Surgery 1(10): 325-329.

Nair N R, Tiwari S K and Nair S (1988). Repair of bilateral mandibular fracture with wiring in cross bred heifer. Indian Journal Veterinary Surgery 9(1): 51-53.

Nelson A W, Curley B M and Kainer R A (1971). Mandibular symphysiotomy to provide adequate exposure for intra oral surgery in the horse. Journal of American Veterinary Medical Association 159 (8): 1025-1031.

Ottesen N and Moel L (1998). An introduction to computed tomography (CT) in the dog. Eur. J.Compan. Anim. Pract. 8: 29-36.

Parsania R R, jani B M, Barvalia D R, Tank P H and Kelawala N H (1989). Repair of bilateral mandibular fracture in a camel. Gujvet. 17 (1): 21-22.

Purohit R K and Chouhan D S (1985). Mandibular fracture and its repair by transfixation technique in young calves. Indian Veterinary Journal 40:56-58.

Purohit R K, Dudi P R, Choudhary R J, Chouhan D S and Sharma C K (1984). Amputation of anterior fracture fragment of irrepairable mandibular fracture in camel. (A report of 5 cases). Indian Veterinary Journal 61: 989-991.

Raji A R, Sardari K and Mirmahmood P (2009). Magnetic resonance imaging of the normal bovine digit. Vet. Res. Commun. 33:515-520.

Ram H (1997). Clinical and Radiological Evaluation of Immobilization Techniques for Repair of Mandibular Fracture in Camels. M. V. Sc. Thesis, Rajasthan Agricultural University, Bikaner

Ram H and Gahlot T K (2001). Gross and radiological evaluation of RBR IDW technique for repair of mandibular fracture in camels (*Camelus dromedarius*). Journal of Camel Practice and Research 8(2): 199-202.

Ramadan R O (1990). Jaw fracture in camels. Camel Newsletter 7(12): 68.

Ramadan R O (1994). Surgery and radiology of dromedary camel. I<sup>st</sup> Edition, printed at AI- Jawad printing press, Kingdom of Saudi Arabia Pp 227-234.

Ramadan R O and Abdin Bey M R (1990). Mandibular fractures in camels. Camel Newsletter 7(12): 67.

Ramakumar V and Singh Gajraj (1979). Treatment of unilateral fracture of mandible by bone plating in camel. Indian Veterinary Journal 56(1): 58-59.

Ramakumar V, Prasad B, Singh J and Kohli R N (1981). Cross- pinning for repair of bilateral mandibular fracture in a bullock. Modern Veterinary Practice 62 (2): 317-318.

Rashed M N (2002). Trace elements in camel tissues from a semi arid region. Environmentalist 22(2): 111-118.

Rathor S S and Singh R (1963). Repair of mandibular fracture in camel. Indian Veterinary Journal 40:56-58.

Reif U, Lischer C J, Steiner A, Fluckiger M A and Auer J A (2000). Long- term results of bovine mandibular fractures involving the molar teeth. Vet. Surg. 29: 335-340.

Rickards D A (1977). Repair of a fracture of the mandibular symphysis in a dog. Canine Practice 4 (3): 28-29.

Robison R (1923). The possible significance of hexosephosphoric esters in ossification. Biochem. J. 17: 286-293.

Romdhane S B, Romdane M N, Feki M, Sanhagi H, Kaabachi N and M'Bazaa A (2003). Blood biochemistry parameters in dromedary (*Camelus dromedarius*). Revue de Medecine Veterinaire 154(11): 695-702.

Shahid R and Kausar R (2005). Comparative gross anatomical studies of the skull of one-humped camel (Camelus dromedarius). Pakistan Veterinary Journal 25(4): 205-206.

Siddiqui M I, Anwar S and Telfah M N (2012a). Management of atypical mandibular fractures by cerclage and standard interdental wiring technique in the dromedary camel- a report of four cases. Journal of Camel Practice and Research 19(2): 177-181.

Siddiqui M I, Telfah M N, Rashid J and Taleb S A (2012b). Modified Interdental Wiring Technique for Mandibular Fractures in Camels: A Clinical Study J. Vet. Anim. Sci. Vol. 2: 57-60. Siffert R S (1951). The role of alkaline phosphatase in osteogenesis. J. Exp. Med. 93: 415-416.

Singh A P and Nigam J M (1982). Radiography of some disorders of head and neck of camel. Indian Veterinary Journal 159: 153-155.

Singh A P, Singh G and Singh J. Fracture; In Ruminant Surgery. Tyagi R P S and Singh J (1993). I<sup>st</sup> Editon. pp 369-371.

Snedecor G W and Cochran W G (1994). "Statistical methods" 8<sup>th</sup> edition.

Struck H, Daben, Hermaandez, Richer H J and Benfer J (1970). Clinical and chemical finding in serum from dogs treated for experimental fracture. Excerpta Med. Biochem. 24:10.

Wallace C E (1971). Repair by open reduction of fractured mandible in a stallion. Indian Veterinary Journal 47: 57-60.

Wilson D G, Trent A M and Crawford W H (1990). A surgical approach to the ramus of the mandible in cattle and horses. Veterinary Surgery 19(3) 191-195.

Wollanke B, Gerhards H and Cronau M (2006). Diagnosis and therapy of periorbital diseases in horses. Indication for computed tomography (CT) or magnetic resonance tomography (MRT). Pferdeheilkunde 22(4): 431-438.

Yadav S B and Bissa U K (1998). Factors affecting some blood constituents in camels - A review. Proceedings of the third annual meeting for animal production under arid conditions. United Arab Emirates University. 2: 32-48.

Zabady M K and Al-Mujalli A M (2011). Mandibular fractures and its influence on haematological and some biochemical parameters in dromedary camels. Journal of Camel Practice and Research 18 (2) 331-335.

Table: 1. Type of fractures recorded in animals of present study.

S.No.	Group	Transverse fracture		C	Dblique	Ν	Total	
		Simple	Compound	Simple	Compound	Simple	Compound	-
1.	I	1	3	-	1	-	1	6
2.	II	-	3	1	1	-	1	6
3.		-	3	-	2	1	-	6
Total		10		5		3		18
%		(55.55%)		(27.77%)		(1	100%	











Table: 2. Economics of diverse immobilization techniques.

S.No	Name of Technique	Reduction &	Clinical and	Cost of technique	Suitability for fract	
		Immobilization of	Radiological			
		fracture	union occur			
1	I.D.W.	Good	8-12 weeks	200/-	Transverse	
2	I.D.W. and Transfixation	Best	6-8 weeks	4810/-	Transverse, Obliqu Multiple	
3	I.D.W. and Scaffold	Better	8-10 weeks	800/-	Transverse, Obliqu Multiple	









S. No.	Parameters	Age groups				Male	Female	Overall	Normal
		Upto 4	4-8 years	8-12 years	Above 12			Mean±SE4t	values
		years			Teals				
1	Haemoglobin	9 9 <sup>6</sup> +0 00	10 61 <sup>b</sup> +0 31	8 56 <sup>a</sup> +0 21	8 53 <sup>a</sup> +0 32	$9.28^{a} + 0.26$	8 30 <sup>a</sup> +0 38	9 19+0 24	9-45 a%
1.	(Hb) gm/dl	3.3 10.00	10.01 ±0.31	0.00 ±0.21	0.00 10.02	9.20 10.20	0.03 ±0.00	5.1310.24	9-40 g /0
0	Packed Cell	31 <sup>b</sup> ±2.0	32 <sup>°</sup> ±0.58	27.75 <sup>ª</sup> ±0.65	26.4 <sup>a</sup> ±1.21	29.06 <sup>b</sup> ±0.59	23.5 <sup>ª</sup> ±0.5	28.44±0.67	25-35 %
2.	Volume (PCV) %								
3.	Total Leukocyte	19.5 <sup>bc</sup> ±0.5	20 <sup>°</sup> ±0.58	18.5 <sup>ab</sup> ±0.19	17.4 <sup>a</sup> ±0.59	18.68 <sup>b</sup> ±0.27	17.5 <sup>°</sup> ±1.5	18.56±0.28	10-19 ×10 <sup>3</sup> /µl
	Count (TLC) %								
	Total Erythrocyte	7 <sup>a</sup> ±1.00	8.33 <sup>b</sup> ±0.33	6.25 <sup>°</sup> ±0.25	5.8 <sup>ª</sup> ±0.58	6.68 <sup>a</sup> ±0.31	5.5 <sup>ª</sup> ±0.5	6.56±0.29	7-13 ×10 <sup>6</sup> /µl
4.	Count (TEC) %								
5.	Neutrophils %	67 <sup>a</sup> ±0.00	67.33 <sup>a</sup> ±0.33	65.25 <sup>a</sup> ±0.45	65 <sup>°</sup> ±0.89	65.93 <sup>a</sup> ±0.39	64 <sup>a</sup> ±0.00	65.72±0.38	65-75 %
6.	Lymphocytes %	26.5 <sup>ª</sup> ±0.5	26 <sup>a</sup> ±0.58	28 <sup>b</sup> ±0.33	28.2 <sup>b</sup> ±0.66	27.37 <sup>a</sup> ±0.33	29 <sup>b</sup> ±0.00	27.56±0.31	28-38 %
7.	Eosinophils %	2.5 <sup>a</sup> ±0.5	3 <sup>a</sup> ±0.58	3.25 <sup>a</sup> ±0.25	3.6 <sup>a</sup> ±0.51	3.18 <sup>a</sup> ±0.23	3.5 <sup>a</sup> ±0.5	3.22±0.21	3-6 %
8.	Monocytes %	3.5 <sup>a</sup> ±1.5	3.33 <sup>a</sup> ±0.33	2.75 <sup>a</sup> ±0.31	2.8 <sup>a</sup> ±0.58	3 <sup>a</sup> ±0.27	2.5 <sup>a</sup> ±0.5	2.94±0.25	4-5 %
9.	Basophils %	0.5 <sup>a</sup> ±0.5	0.33 <sup>a</sup> ±0.33	0.75 <sup>a</sup> ±0.16	0.4 <sup>a</sup> ±0.24	0.5 <sup>ª</sup> ±0.13	1 <sup>a</sup> ±0.00	0.56±0.12	1-2 %

Table: 3. Haematological parameters of camels with mandibular fracture.

a= non significantly differed, b= significantly differed



Table: 4. Biochemical parameters of blood serum of camels with mandibular fracture.									
S.No.	Name of parameter	Age groups				Male	Female	Over all	Normal
		Upto 4	4-8 years	8-12 years	Above 12			Mean±SE	values
		years			years				
1	Calcium (Ca) µmolL <sup>-1</sup>	8.53 <sup>a</sup> ±0.13	9.43 <sup>a</sup> ±0.60	8.94 <sup>a</sup> ±0.34	9.39 <sup>a</sup> ±0.18	9.07 <sup>a</sup> ±0.21	9.24 <sup>a</sup> ±0.18	9.09±0.19	9.11±0.09
2	Phosphorus (P) µmolL <sup>-1</sup>	2 <sup>a</sup> ±0.00	2.83 <sup>b</sup> ±0.17	2.37 <sup>ab</sup> ±0.28	1.5 <sup>a</sup> ±0.16	2.28 <sup>b</sup> ±0.17	1.25 <sup>a</sup> ±0.25	2.17±0.17	2.10±0.002
3	Magnesium (Mg) µmolL <sup>-1</sup>	1.86 <sup>a</sup> ±0.05	2.06 <sup>a</sup> ±0.06	1.89 <sup>ª</sup> ±0.053	2.052 <sup>a</sup> ±0.13	1.98 <sup>ª</sup> ±0.045	1.76 <sup>ª</sup> ±0.045	1.96±0.045	1.39±0.02
4	Alkaline phosphatase (ALP) UL <sup>-1</sup>	27.5 <sup>a</sup> ±0.00	36.67 <sup>a</sup> ±9.17	48.12 <sup>a</sup> ±14.47	38.61 <sup>a</sup> ±6.69	43.00 <sup>a</sup> ±7.51	27.5 <sup>ª</sup> ±0.00	41.28±6.76	4.5±0.03
5	Acid phosphatase (ACP) UL <sup>-1</sup>	11.25 <sup>°</sup> ±3.75	10 <sup>a</sup> ±2.5	13.12 <sup>a</sup> ±1.22	12 <sup>a</sup> ±3.0	12.19 <sup>a</sup> ±1.16	11.25 <sup>a</sup> ±3.75	12.08±1.07	280.00±0.90
6	Lactate dehydrogenase (LDH) UL <sup>-1</sup>	49.25 <sup>a</sup> ±0.00	65.67 <sup>a</sup> ±16.42	73.87 <sup>a</sup> ±13.16	59.1 <sup>ª</sup> ±9.85	64.64 <sup>a</sup> ±7.41	73.87 <sup>a</sup> ±24.62	65.67±6.89	7.23±0.09
7	Glucose-6- Phospho-								
	dehydrogenase (G-6- PD) UL <sup>-1</sup>	17.5 <sup>ª</sup> ±2.5	13.33 <sup>ª</sup> ±4.41	14.37 <sup>a</sup> ±1.99	13 <sup>ª</sup> ±2.55	13.75 <sup>ª</sup> ±1.41	17.5 <sup>ª</sup> ±2.5	14.67±1.29	27.21±0.43
8	Glucose-6-								
	Phosphatase (G- 6-P) UL <sup>-1</sup>	19.5 <sup>ª</sup> ±2.5	15.33 <sup>ª</sup> ±4.41	16.37 <sup>a</sup> ±1.99	15 <sup>ª</sup> ±2.55	15.75 <sup>a</sup> ±1.41	19.5 <sup>ª</sup> ±2.5	16.17±1.29	48.25±0.31
9	Creatinine Phosphate	92 6 <sup>a</sup> 0 00	82 6 <sup>a</sup> 0 00	100 / <sup>a</sup> , 1/ 66	122 76 <sup>a</sup> , 20 49	112 45 <sup>a</sup> 0 00	105 1 <sup>a</sup> , 11 0	112 90 0 45	7 19 0 21
	Kinase (CPK) UL <sup>-1</sup>	03.0 ±0.00	03.0 ±0.00	120.4 ±14.00	133.70 ±20.40	112.45 ±9.90	125.4 ±41.0	113.09±9.45	7.10±0.21
10	Glucose g/dl	4.83 <sup>a</sup> ±0.67	8.32 <sup>a</sup> ±1.44	7.06 <sup>a</sup> ±1.11	6.5 <sup>a</sup> ±1.75	6.64 <sup>a</sup> ±0.79	8.66 <sup>a</sup> ±1.06	6.86±0.72	479.0±7.33
11	Cholesterol g/dl	350 <sup>a</sup> ±250	266.67 <sup>a</sup> ±33.3	275 <sup>ª</sup> ±52.61	380 <sup>a</sup> ±80	312.5 <sup>a</sup> ±43.66	300 <sup>a</sup> ±0.00	311.11±38.68	10.00±0.03
12	Proteins g/dl	9.7 <sup>a</sup> ±0.5	9.33 <sup>a</sup> ±0.52	8.8 <sup>a</sup> ±0.44	7.88 <sup>a</sup> ±0.26	8.88 <sup>a</sup> ±0.27	7.55 <sup>a</sup> ±0.05	8.733±0.26	9.23±0.06
13	Vitamin- A µmolL <sup>-1</sup>	1.3 <sup>a</sup> ±0.02	2.02 <sup>a</sup> ±0.34	1.57 <sup>a</sup> ±0.16	1.46 <sup>a</sup> ±0.11	1.62 <sup>a</sup> ±0.11	1.35 <sup>a</sup> ±0.03	1.59±0.10	2.09±0.008
14	Vitamin- C µmolL <sup>-1</sup>	21.88 <sup>a</sup> ±2.14	20.65 <sup>a</sup> ±1.34	23.01 <sup>a</sup> ±1.46	21.76 <sup>a</sup> ±0.81	21.97 <sup>a</sup> ±0.82	23.9 <sup>a</sup> ±0.00	22.19±0.74	24.00±0.01

a= non significantly differed, b= significantly differed















Fig. 47







Fig. 44







Fig. 42



<u>riy. 43</u>





Fig. 40







Fig. 38











Fig. 36





Fig. 34



**FIG. 33** 




Fig. 32







Fig. 30







Fig. 28







Fig. 26







Fig. 24







Fig. 22









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Fig. 18







Fig. 16







Fig. 14













































