The Effect of Sutural Distraction and Contraction On Growing Cranio-Maxillofacial Skeleton

An Experimental study

Thesis Submitted for final Fulfillment of the Requirements For Master Degree. In Oral and Maxillofacial Surgery

By

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Aim of the Study:

Evaluate the effect of coronal suture distraction and contraction on growing craniomaxillofacial skeleton.

Introduction

During the last decade there is a global agreement among surgeons that aggressive surgical procedures are full of risks and probably associated with sever complications and unsatisfactory results this turned researchers toward using less invasive and more biologically accepted procedures. Craniofacial surgery uses two basic maneuvers to alter the contour of facial skeleton: (1) osteotomy and rearrangement (2) augmentation or reduction. Management of Craniomaxillofacial deformities such as hemi-facial hypoplasia, hyper plasia, craniosynostosis syndromes, occular hyperlolerism and hypotelorism is complex multistep procedure involve complicated surgical techniques. In those cases it is challenging task to regain normal proportions among craniofacial skeleton. Current surgical techniques could provide satisfactory results in some patients, but in others the deformities are too sever to allow for complete normalization of craniofacial skeleton.

Early interceptive and prophylactic correction of craniofacial abnormalities is a fine reconstructive goal. It offers greater chance for complete correction of the deformity with decreased rate of relapse and complications. Better understanding of craniofacial growth in both normal and diseased models is essential to achieve this goal. Craniomaxillofacial deformities in most of the cases are gradual in nature with insidious onset where early detection permits efficient and conservative management.

Growing skeleton is so pliable and rapidly changing, these changes are controlled through growth primary and secondary growth centers. application of

external forces ether in the form of distraction and contraction across growth center will be associated with wide spread effect across the growing skeleton.

The response of growing bone to gradually applied forces depends on direction, magnitude, site and timing of applied forces. Any external force acting across growing bone and unfused sutures may profoundly alter the entire craniofacial skeleton where gradual forces could influence and modify morphology and dimensions of growing skeleton. In clinical orthopedics sutural expansion has already been established for median palatal suture to accelerate lateral growth of the maxilla. Acceleration of growth using traction forces across growing sutures, sutural distraction osteogenesis (SDO) is an accepted treatment modality.

On the other side gradual compressive forces externally applied to juvenile suture will restrict its growing capabilities without deformational changes in other planes of growth or Sutural fusion, (contraction ostemodeling).However, there is much controversy about the possibility to modify craniofacial growth through application of external forces across growing sutures, sutural manipulation. The probability to modify growth pattern of craniofacial skeleton through external manipulation of growing sutures necessates further investigation.

Material and Methods:

The present study included fifteen white New Zealand rabbits (Orictolagus cuniculus). The age of rabbits ranged between 25-30 days old at the beginning of the experiment. Their weights ranged between 450-650 gm. The rabbits were randomly assigned into three equal groups.

Group I: (control group)

It included five rabbits. Four micro-screws were surgically implanted across the coronal suture to assess the suture growth (drift check markers).

Group II: (distraction group)

It included five rabbits. Alveolar distractor was surgically implanted across the coronal suture in the left Sid to distract the growing suture. The rate of distraction was 0.6 mm (full clockwise turn) twice a week for three weeks. No corticotomies or osteotomies were performed.

Group III: (contraction group)

It included five rabbits. The same distractor was inserted across the coronal suture [with its plates separated to the maximum distance (15mm)].the distractor was used to induce contraction across the growing coronal suture in a rate of 0.3mm (half turn in counter clockwise) three times/week for three weeks.

Pre-operative preparation:

Preoperative evaluation of all animals was done to exclude respiratory pathology and stress handling. Animals were quarantined for a minimum of 72 hours and clinically evaluated before subjected to anesthesia. There was no need to fast the animal preoperatively.

Surgical technique:

The rabbits were anesthetized with intramuscular injection of ketamine hydrochloride 40 mg/kg* and midazolam 2.5 mg/kg**. The level of anesthesia was determined through monitoring of traditional reflexes. Those reflexes include palpebral, corneal, pedal withdrawal and ear pinna reflexes. Intra-operative monitoring has been achieved through cardiopulmonary parameters and body temperature. Respiratory rate was assessed by direct observation of chest wall and abdominal wall movement. The adequacy of ventilation was noticed through observation of mucous membrane color. The anesthetized animal was placed in ventral recumbency position. Scalps were shaved, fur were cleaned off and skins were scrubbed with povidine-iodine***.Local anesthetic solution (mepecaine HCL 2%, levonordephrin 1:20000) **** 0.6 ml was injected subcutaneously at the proposed surgical field to induce haemostasis.

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*Ketamar, Amoun Pharmaceuticals Co, SAE.

**Dormicum, F.Hoffmann-La Roache Ltd, Basel.Switzerland.

***Povidone-Iodine U.S.P 10% W/V Amoun Pharmaceutical Industries Co. Cairo, Egypt.

****Mepecaine L, ALEXANDRIA Co. Pharmaceuticals. EGYPT.

Coronal scalp incision was used to expose the calveria The flap extended 1cm posterior to the lateral canthus in anterior curvilinear fashion to reach the contra lateral side (Figure 1). A snap was done using a sharp scissor while rising up the scalp with an Addison forceps, then the sharp scissor was used again to cut the scalp along the predetermined and marked incision line. Exposing the underlying pericranium, a T-shaped incision was done using #15 blade to sharply incise the pericranium in order to provide one frontal flap and two opposing parietal flaps (Figure 2). Then, a mucoperiosteal elevator was used to carefully raise the pericranium without tearing it and exposing both coronal and sagittal sutures. The exposed coronal suture was examined using binocular loupes (4.5x Zeiss) to ensure complete patency and exclude any premature suture closure (Figure 3).

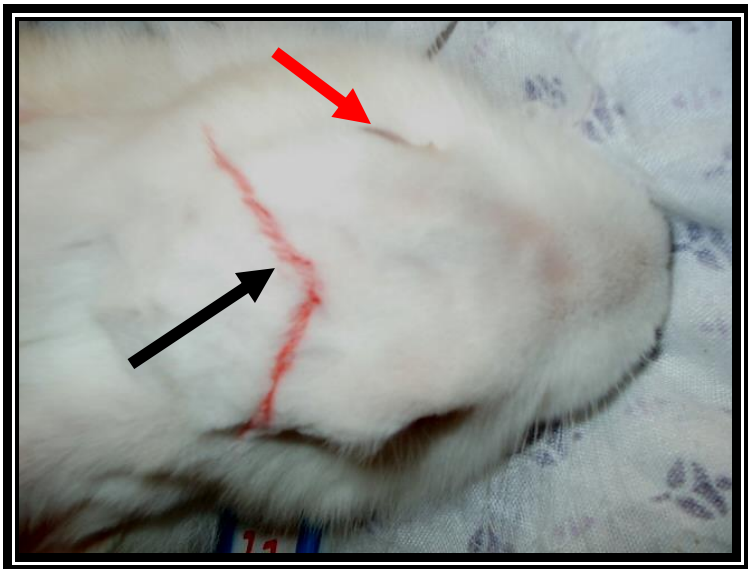

Figure (1): Marked Coronal scalp incision extending 1cm posterior to the lateral canthus (red arrow) in anterior curvilinear fashion to the other side (black arrow).

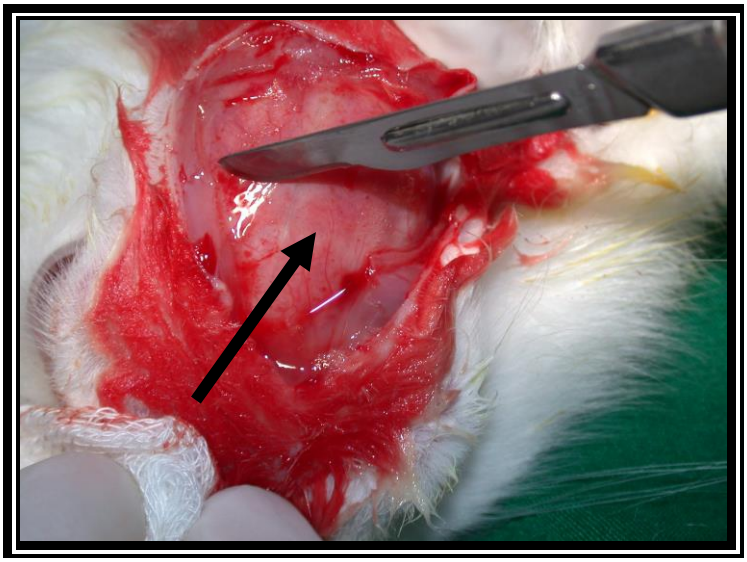

Figure (2): Blad No.15 used to incise the pericranium in a T-shaped incision exposing coronal suture (Black arrow).

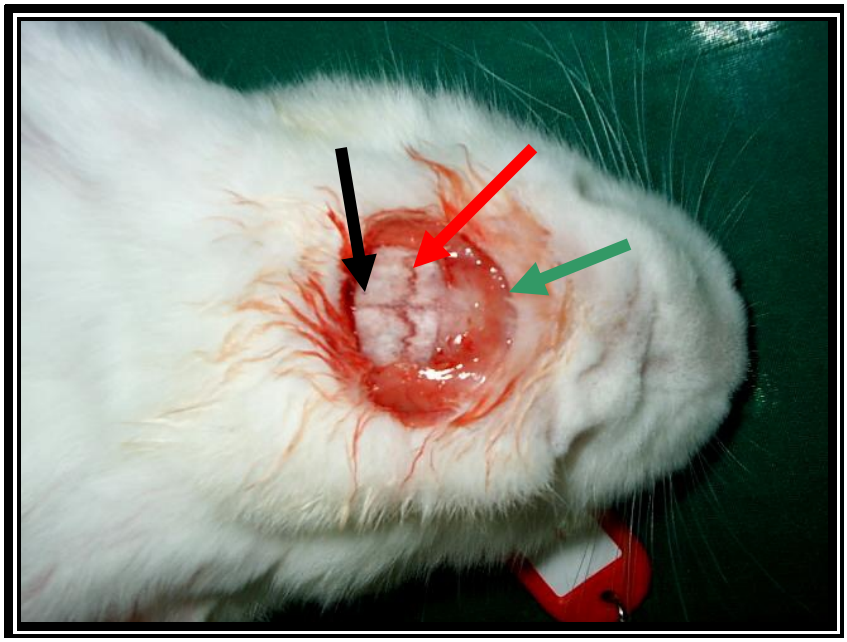

Figure (3) Exposure of the coronal and sagittal sutures. (Green arrow) pericranial flap, (Red arrow) immature coronal suture, (Black arrow) sagittal suture.

Control group:

Four stainless steel micro screws *(1.1mm diameter x3mm length) were inserted across the coronal suture (Figure 4).The osteotomy was performed with 0.9 mm diameter drill at low speed under copious irrigation with refrigerated saline .The distance between screws were measured and recorded intra-operatively utilizing veriner caliper. The distance between the screws were measured and recorded intra-operatively utilizing veriner caliper in order to act as reference for post sacrifice measurement and comparison (Figure 5).

*Martin Company. Germany

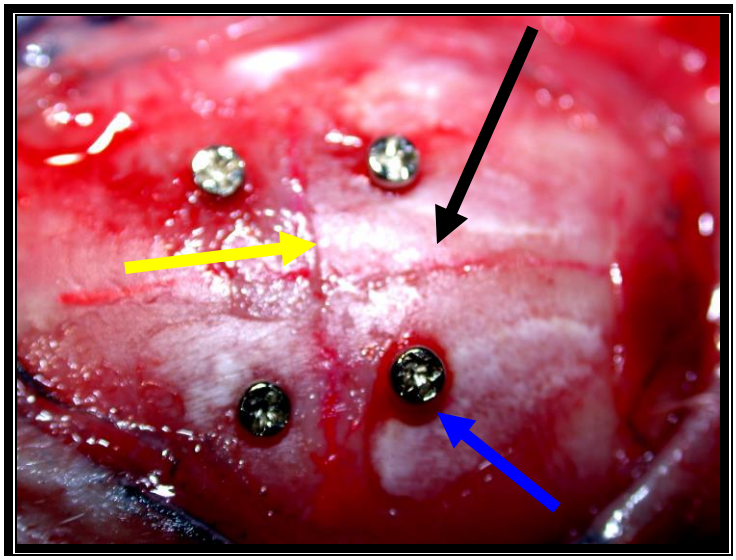

Figure (4): Four micro-screws inserted, drift markers. (Yellow arrow) coronal suture. (Black arrow) sagittal suture. (Blue arrow) bicortical micro-screw.

Figure (5): Distance between screws measured using Vernier caliper.