Distraction Technique of Lower Jaw on Rabbit, Experimental Studies Research

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Abstract
In this piece of research, nine New Zealand Rabbits of one year of age weighted 3.5 kg were subjected to experimental study by distraction technique for elongation of the mandible. Distraction was achieved by using bilateral distract or designed for hand bone lengthening apparatus and adjusted by Tran’s fixation. Kirschinar wire of 1.5 mm passed through mandibular body, rhythmic distraction of both corticomized fragments at a rate of 1 mm/day at a rhythm of 0.5 mm twice daily preceded by latent period for 7 days and distraction period for 10 days, postoperatively systemic antibiotic of pen strep (penicillin streptomycin, 1 ml/10 kg IM) prescribed for 6 days. These segments were hold by external fixator for 6 weeks till consolidation phase completed and mandibular lengthening achieved of about 10 mm.

The result of this research mandibular lengthening 10 mm achieved in 3 Rabbits, pin side infection observed and controlled by idoformegauze in 2 Rabbits, dropping of lower jaw and open bite noticed in 2 and one Rabbit passed. No deviation of the mandible was noticed and all animal were able to open and close their mouth without any side effect on masticatory process.

This research was found quiet interesting and demonstrated the cytological changes associated with distraction technique with the formation of granulation tissue containing with mesenchymal stem cells derived from periosteum and bone marrow and growth factor during latent period which played an important role in bone formation during consolidation phase. And we believe its value to humans for managements of deformities of the mandible and facial skeleton.

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Introduction
Distraction is defined as the process of generating new bone by stretching distraction osteogenesis, traction on living tissue can stimulate and maintain regeneration and growth by inducing proliferation of precursor cells1. Human body has an enormous regenerative ability and distraction osteogenesis (DO) which takes the advantages of this regenerative ability to induce the regeneration and remodeling of bone, cartilage, nerve, muscle, blood vessels and the skin. Distraction is defined as the creation of neo-formed bone and adjacent soft tissues after gradual and controlled displacement of fragment bone and adjacent soft tissue after gradual and controlled displacement of bone fragment obtained by surgical osteotomy, by this technique we can increase bone volume by gradual traction of a fracture callus formed between osteotomized bony segments. Distraction is achieved through three main phases, first phase is the surgical phase, the second phase is latent period phase and the third phase is the consolidation phase. Distraction as a technique was advocated by genius Russian orthopedic surgeon, Illizarof2, (1988) for elongation of lower limbs of children and this technique was applied for elongation of the mandible in children by McCarthy3, (1995).

Distraction may be applied as callus distraction is a new surgical technique which makes it possible to create new bone by elongation of bone. It was originally designed by orthopedic surgeons Illizarof2 to extend long bones but has been proved...
useful for elongation of the mandible as well as other bones of the facial skeleton\(^3\). Some authors believe that by following cal-

Distraction osteogenesis (DO) is also called callus dis-

Original distraction was used to treat unequal lower limb length, but since 1980 McCarthy\(^3\) used this technique to treat cases like hemi facial microsomia and small chin or mi-

crognathism, others used it to treat craniofrontonasal dyspla-
sia, craniosynostosis as well as airway obstruction caused by
glossoptosis with micrognathism featured in Pierre Robin Syn-

drome\(^1\).

The surgical technique was divided into first osteotomy phase of the cortex as exterior surface only in the hard tissue or completely as surgical phase. The device fitted at this time, the second phase is the latest period which last seven days; in this stage no activation of the device which is mounted to the bone in each sides to allow early stage of healing and formation of mes-

Material and Methods

There are two phases required, the first phase is the choice of animal model and the second choice is the experi-

Choice of animal model

There are certain requirements for choosing the animal Rabbit as animal model; the animal should be chosen which al-

Experimental studies

The advantage of Rabbit as animal model chosen as a very good animal model, it is cost cheaper than other animal model like monkey, healthy animal and friendly, vegetarian and cleaner, does not transmit disease and we can keep few rabbits in one cage. The animal model were used in this research, these animals were used for distraction technique for elongation of the mandible and to study the boney structural changes that achieved by distraction through postmortem as macroscopically and histological changes of the distracted area. We used rabbit in this experiment as a good animal model because it is available, its coast cheap, clean and vegetarian and nice looking animal and its useful to apply surgical procedures designed for humans and we can keep many rabbits in one cage. Mandibular length-

Figure 1: Photograph, showing distraction device on both side of the mandible on Rabbit and osteotomy cut.
Postmortem examination

Post mortem examination of specimens from macroscopic point of view, the specimen showed an excellent union at the site of distracted zone with new bone formation. Specimens then immersed in buffered formalin of 10% with 4-N formic acid solution for decalcification for 10 days. (Figure 6)

Histological and microscopic examination

The histological examinations of distracted jaw were done after 6 weeks by longitudinal histological sections, were stained by Hematoxylin and Eosin (H&E). (Figure 7, Figure 8). The distracted zone showed mature bone trabeculae in fibro vascular stroma and heavy cells of mesenchymal stem cells with heavy fibroblasts formation oriented with the direction of tension-vector and also blood vessels oriented in the same direction. Newly formed trabeculae lined by chain of osteoblasts were noticed.
Discussion

Distraction is widely practiced by orthopedic surgeons for elongation of bones in children after Ilizarov\[2\] and also practiced in maxillofacial skeleton and the mandible since 2 decades, McCarthy\[3\] succeeded in elongation of the mandible in first arch dysplasia syndrome.

Ilizarov\[2\] first became interested in orthopedics and bone reconstruction because of many of his patients were soldiers returning from the front line battles of world war 2 and many of the patients suffered severe fractures and had to endure lengthy treatment; cast and skeletal traction being the only methods generally used. Ilizarov continued his research into improving the treatment of fractures and developed the idea of an external fixator ring with cross wires to improve the stability. Although the ilizarov device was met with scepticism, similar devices began to emerge Ilizarov & Rozbruch\[7\], (2007).

Ilizarov developed his on method\[7\] which was supported by biomechanics and basic science and he put the basic principle for treatment of fractures by preservation of blood supply, preservation of osteogenic tissue, complete anatomic reduction, and stable fixation with functional activity of the muscles and joints and early patient’s mobilization. Ilizarov discovered that other tissues such as blood vessels, nerve and skin were able to regenerate during gradual distraction and he made his (Low of Tension Stress) theory\[8\], which shows that under the effect of slow and gradual distraction, of bone and soft tissue would regenerate. The mechanism of ilizarov fixator is to stimulate bone growth by distraction osteogenesis and his idea, which is the pulling part of bone to stimulate new bone formation and growth\[8\].

The processes of generating new bone by stretching distraction osteogenesis, theoretically similar and applied to general principles, traction on living tissue and maintain regeneration and growth by inducing proliferation and differentiation of precursor cells. Previous literature did not mention the biological changes that occur in the gap created by osteotomy of the bone site desired during latent period which is the key factor in distraction process and formation of new bone.

Bone regeneration by distraction is highly complicated and organized process; through our research. We found the histological studies revealed and demonstrated by our experiment that bone regeneration based on pattern of membranous ossification preceded by formation of granulation tissue and mesenchymal stem cells derived from periosteum lining and bone marrow by influence of growth factor for formation of new bone, muscles and skin.

The previous biological changes occurred during latent period. The parameter of latent period, ideal distraction rate, rhythm and duration of consolidation phase as established by Ilizarov\[3\] are vital factors for success of distraction technique in tubular bones of extremities and other bones of facial skeleton. From our study research we concluded, distraction could be unlimited but two factors with great effect on distraction, first the periosteum with soft tissue damage or restriction of muscular function and the second factor is suboptimal bone formation with fibrous tissue formation induced by rapid distraction. Further factor may effect on distraction was infection and that controlled by systemic antibiotic and locally by application of iodoform gauze around pin insertion greatly affected and prevent spread of infection.

Our studies demonstrated that bone lengthens was applicable to the human mandible, the length of the mandible in Rabbits by distraction is achieved through applying an external fixator with constant external force proved as a” GOOD TECHNIQUE”.

Conflict of interest: The authors declare no conflict of interest.
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