Chapter

# Prologue: Foundation and Progress of Craniofacial Surgery of Deformity and Malformation

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## 1. Introduction

Surgery of craniofacial malformation and deformity is a surgical subspecialty that deals with acquired and congenital deformity of the skull and facial skeleton, including the orbits, midface, and jaws.

The history of craniofacial surgery is not new but began with ancient humans drilling holes in the cranial vault (trephination).

In Europe, and especially in France, 40 out of 120 prehistoric skulls were found with drill holes in the skulls. This technique is currently practiced to reduce intracranial pressure and the evacuation of supradural hematoma from the middle meningeal arteries [1, 2].

Craniofacial anomalies have been known throughout history and both Hippocrates and Homer have touched upon the subject. Surgery was possible with the invention of general anesthesia in the mid-nineteenth century and was helped later with the discovery of penicillin by Sir Alexander Fleming of St. Mary's Hospital, Paddington, London, during the Second World War.

Surgeons like Sir Harold Gillies (UK), Hippolyte Morestin (France), and Jan F. Esser (Netherland) were pioneering the specialties of plastic surgery while dealing with war-injured soldiers [3].

In ancient times, reconstructive craniofacial procedures of the soft tissue were performed to reconstruct the nose or ears. Sushruta and other Indian doctors were practicing reconstruction of noses and ear lobes in 600 BC [2].

In India during Sushruta's time, it was common practice for criminals to have their noses amputated because the procedure was considered to be a symbol of reputation and respect. Groups of potters known as Koomas developed a technique of nasal reconstruction to help people with these problems [4].

In Iraq during the Iraqi/Iranian War (1980–1988), young soldiers who avoided front line duty were punished by the Saddam regime by cutting part of their ears or making a symbol on their forehead. This prevented doctors from repairing the created defect and deformity; it was a very depressing procedure for young people and many of them attempted suicide.

Gaspare Tagliacozzi of Bologna was a genius surgeon, and in 1597 was chosen to reconstruct a deformed nose. He did reconstruction of the nose by elevating the pedicle bicipital arm flap as tube pedicle and mobilizing the flap for reconstruction of the nose deformity. This technique required 14 days of immobilization of the arm to attach the face, followed by division and inset of the flap from the arm [5].

The author believes that this technique was the first to use the tube pedicle flap in reconstructive surgery.

Advancements in craniofacial and maxillofacial surgery have been more recently carried out by great surgeons like Paul Tessier, Hugo Obwegeser, Norman Rowe, and Joseph Converse.

Craniofacial surgery formally developed in 1967 after a meeting of well-known international surgeons with Paul Tessier because of pressure on him from French plastic surgeons. Tessier requested them to observe and follow up his cases and to recognize his work on craniofacial deformities at Foch hospital in Paris, where the meeting took place.

Norman Rowe and J.C. Mustardé from Britain, Joseph Converse from the United States, Hugo Obwegeser from Switzerland, and Zur Hausen from Germany were members of the group who spent 2 weeks in Foch hospital examining, observing and following up on 50 of Tessier's cases. Most cases were comprised of poor people from Italy. After 2 weeks Paul Tessier ask the invited committee am I entitled to practice this kind of subspecialties, all of them recognized him pioneered by a man who was recognized as the master of craniofacial surgery. This story was related to the author by Professor Hugo Obwegeser in 1981 during his first visit to Baghdad as my guest.

Paul Tessier made a revolutionary approach to the surgery of deformed skulls and orbital skeletons and was considered to be an expert in this field.

The outstanding pioneering work of Paul Tessier emerged as new specialties of craniofacial surgery. Hugo Obwegeser performed his first Le Fort I osteotomy of the maxilla and sagittal split osteotomy of the ascending ramus of the mandible for correction of the malformation of jaw relationship in 1960. He did this by advancing, pushing back, or rotating the lower jaw for correction of Class III and II skeletal jaw deformities and open bite. The lower jaw was mobilized by pushing backward and forward or rotating the lower jaw to correct the open bite, and a downward movement of the maxilla and application of bone graft in the gap were created by this procedure.

Paul Tessier spent a year training in Rocks down house in Britain with the great British surgeon Sir Harold Gillies. Sir Harold's nurse asked Sir Harold to correct her face, which was deformed because of Crouzon disease. He performed the first Le Fort III operation by advancing the face forward; however, 2 weeks later she relapsed and Sir Harold said he would never repeat the procedure.

Tessier was watching the operation; he learned the technique and studied the failure points of Sir Harold Gillies' procedure. Tessier discovered that by using a bone graft inserted in the gaps created by Gillies' osteotomy through Le Fort III operation it would make the skeleton more stable and free from relapse; these observations contributed to the success of Tessier's technique.

After the Second World War, Sir Harold Gillies expanded the field of congenital malformation. In 1949 he performed the first Le Fort III osteotomy based on facial injuries, which was discovered by French surgeon René Le Fort in 1901.

In the past there was a great deal of controversy regarding the complicated surgery of craniofacial deformities as advocated by Tessier; an operation time of up to 16–18 h and blindness were reported. Kenneth E. Salyer in the mid-1970s advocated less complicated surgery by advancing a frontal-orbital block in children and letting the brain and skull grow and operate without the pressure of cranial sutures [6].

One advantage of craniofacial surgery is the prenatal diagnosis of pre-pediatrics malformation by ultrasound, such as a cleft palate, Pierre Robin syndrome, and facial cleft and the possibilities of using intrauterine microsurgery [1].

The exciting progress in craniofacial surgery by using the bone grafting and distraction technique and advancement of radiological diagnostic tools such as ultrasound and three-dimensional CT scanning and MRI have advanced the design of instrumentation for this type of surgery.

Paul Tessier in 1976 classified facial clefts as neither based on theory nor on embryological definition but on an observation made during clinical examination and operative dissection. These clefts were distributed both around the orbit and eyelids and around the lips and maxilla, and certain clefts are common to these two regions; the cleft of soft tissue and bony clefts do not always exactly coincide [6].

Cooperation is required between the orthodontist and the craniomaxillofacial surgeon during different phases of treatment. The treatment plan starts with the orthodontist who aligns the teeth followed by surgical correction after proper planning, which may be followed by orthodontic treatment for final alignment of the teeth and occlusion.

The distraction technique was advocated by a genius Russian orthopedic surgeon Ilizarof [7] for the elongation of short limbs in children and this technique was later applied to the lower jaw with first arch deformity by McCarthy et al. [8].

Distraction is defined as the process of generating new bone by stretching distraction osteogenesis, traction on living stimulate, and maintaining regeneration and growth by inducing a proliferation of precursor cells. This is defined as neoformed bone and adjacent soft tissue after gradual and controlled displacement of fragment bone and adjacent tissue after gradual and controlled displacement of bone fragment obtained by surgical osteotomy [9].

The distraction technique passes through three phases: the surgical phase, the latent period phase, and the consolidation phase. The most critical phase is the latent period phase. An experimental study was conducted on rabbits to understand the cellular changes associated with the distraction technique. This was achieved by using a bilateral distractor. The hand bone lengthening apparatus was adjusted with 1.5-mm Kirschner wire and was passed through both mandibular bodies. Rhythmic distraction of both corpectomies of the bone using an osteotome was carried out at a rate of 1 mm/day at a rhythm of 0.5 mm twice daily, preceded by a latent period of 7 days. The period for distraction lasted 10 days and an immediate postoperative antibiotic of 1 mL/10-kg IM penicillin streptomycin was prescribed once daily. The segments were held by an external fixator for 6 weeks until consolidation was completed. Bone regeneration was evaluated radiologically for periods of 2 weeks, 4 weeks, and 6 weeks. At the end of the experiment a length of 10 mm was achieved.

Histological examination of the distracted jaw showed mature bone trabeculae in the fibrovascular zone and mesenchymal stem cells with heavy fibroblasts oriented with distraction tension, with blood vessels oriented in the same direction. These changes occurred due to the effect of platelet growth factor (PGF), which was released from platelets from bone marrow of osteotomized bone. Newly formed trabeculae lined by a chain of osteoblasts was also noticed.

Bone regeneration by distraction osteogenesis is a highly complicated and organized process. In the above experiment bone regeneration was observed during distraction based on the pattern of a membranous type of bone proceeded by formation of granulation tissue and release of PGF and mesenchymal stem cells from the bone marrow of osteotomized bone segments and from the overlying periosteum [9].

Bone grafting plays another important role in the successful technique of craniofacial surgery and is considered an important factor in advanced craniofacial surgery by inserting a bone graft in the site of osteotomy to prevent relapse. This might be used in orbital reconstruction and skull defects.

Bone grafting is an interesting topic practiced by craniomaxillofacial surgeons. It is a surgical technique used to fix a problem by using transplanted bone to repair and build or replace missing bone, for example lost pieces of bone caused by a road traffic accident or in post-traumatic missile war injuries or after tumor surgery, by filling the gap of osteotomized bone in craniomaxillofacial surgery and orthopedic surgery. The most common type of bone graft practiced by the author is an autogenous cortico-cancellous type or a cancellous type of bone, with the donor area being the iliac crest [10].

Bone grafting is possible because bone tissue can regenerate completely once the space is provided for it to grow as natural bone.

Bone grafting is a complicated technique requiring highly experienced surgeons with high skill and knowledge of the pathology of bone grafting. The greatest advances in bone grafting occurred during the last four or five decades.

The mechanism of bone grafting was not fully understood by most surgeons and cases of failed procedures were reported. Recently experimental studies on rabbits were conducted by reconstructing the mandible by bone graft from the iliac crest of rabbit after excision of a piece of bone from the mandible. The aim was to study and understand the cellular changes that occur between the free bone graft and the recipient stump of bone of the mandible. Cellular changes were tested in three stages of bone formation after 2 weeks, 4 weeks, and 8 weeks.

It was observed that the cytological changes of bone grafting showed the formation of granulation tissue with mesenchymal stem cells derived from bone marrow of boney segments of the mandible and from the periosteum and covering muscle with release of PGF with large numbers of fibroblasts and tiny small blood vessels. Osteoblast was noticed with chondrocyte and osteoid tissue [11, 12].

It was concluded from experimental studies and research on distraction and bone grafting that cellular changes that occur in bone grafting and distraction with these different surgical techniques are the same, with the presence and release of PGF and mesenchymal stem cells. The only differences are the distraction caused by expansion stress of the periosteum and muscles and the bone graft by rigid fixation, and decortication of both graft and stump of the bones [12].

Another revolutionary work was carried out by David Poswillo in 1974, [13]. He presented his experimental studies on *Macaca irus* monkeys by reconstructing the temporomandibular joint (TMJ) by costal-chondral graft to the damaged TMJ to restore growth of the destroyed condyle. In 1986, Raja Kummoona [14] performed his technique for the reconstruction of the TMJ by using his chondral-osseous graft instead of the costal-osseous graft and supported his work by experimental studies on rabbits. He concluded that graft can grow, repair, and remodel the TMJ due to the presence of mesenchymal stem cells in the graft. This technique has an endogenous mechanism for growth. Kummoona's technique was designed for the reconstruction of first arch syndrome and damaged condyle in ankylosis and hypoplastic condyle for restoring midface growth and length.

It is hoped that this introduction presents the author's views on the history and advancements made in craniofacial surgery during the last five decades.

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