

Distraction Osteogenesis – a key technique in reconstructive surgery

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Dr. Ilizarov, father of distraction osteogenesis

Birth of a technique

Distraction osteogenesis – the creation of new bone between two segments by applying tension across the gap – was first described by the Italian surgeon Alessandro Codivilla in 1905, who reported lengthening of the femur by axial distraction forces [1].

The technique however remained undeveloped, until its fortuitous rediscovery by the Russian doctor Ilizarov, who was working in Siberia in the 1950s. In a remote area of the Soviet Union, without access to the equipment of the day, he was using primitive ring fixators to compress the two ends of fractures. By chance, a patient accidentally reversed the compression rods, causing distraction of the bone fragments [2].

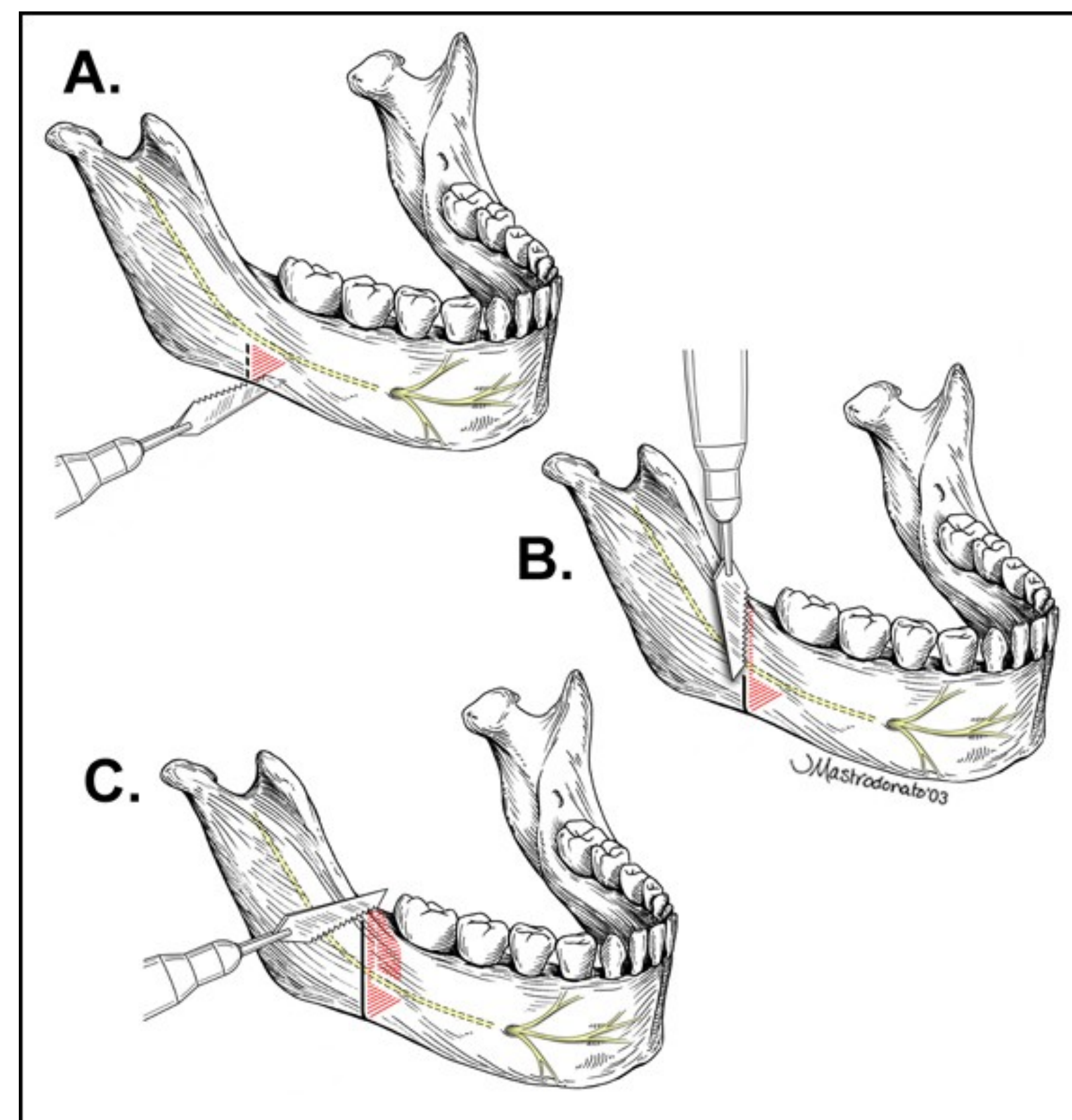
Ilizarov observed new bone formation, and further developed the technique, successfully treating the Soviet athlete Valery Brummel for an open fracture of the tibia [3]. The Ilizarov technique soon spread through the Warsaw Pact countries, but did not become established in the West until the 1980s. Finally, in 1992 McCarthy et al. first described the use of the technique in craniofacial surgery [4]. Since then, the technique has become an established part of craniofacial and reconstructive surgery.



Synthes © Craniofacial distraction devices [5].

The challenge of orofacial repair

Defects in the craniofacial region can arise for a number of reasons: either through trauma, congenital abnormality or cancer. Repair of such defects is particularly challenging: whereas the long bones have simple cylindrical shapes, the bones of the maxillofacial region require a complex three-dimensional repair, in order to maintain craniofacial shape and contour [6].



Operative technique: Osteotomy of the Mandible. A reciprocating saw is used to osteotomise inferior (A), lateral (B) and superior (C) portions of the mandible [7].

Operative procedure

An osteotomy of the bone is made, maintaining the periosteum (and vascular supply to the bone) [8]. Particularly important in the mandibular region is that the mandibular nerve, artery and mental foramen and nerve are spared.

The bone then forms a provisional callus by mixed endochondral-intramembranous ossification, as part of the normal repair response. This is known as the latency period, following which, distraction (stretching) of the callus is carried out. The distraction device can either be fixed internally or externally. The daily rate of distraction (e.g. 1mm/day) is divided up into 4 daily rhythms (0.25mm). Under the stretching forces, the bone is remodelled along the distraction vector to form regenerative bone, by a well organised intramembranous response [2]. A final procedure is carried out to remove the distraction device.

Benefits, problems and future trends

Craniofacial defects have been repaired in the past by bone graft techniques. The cosmetic result is compromised by the degree of overlap of the grafts, and the contours these create in the overlying soft tissues. The benefit of distraction osteogenesis is that not only the bones are gently elongated, but so are the soft tissue attachments, resulting in a superior outcome [8]. Other benefits are that the surgery is less traumatic, and results in less blood loss. Because the periosteum is maintained, there is a constant blood supply with no intra-cranial dead space, lowering the risk of intra-cranial infection [9]. The pain is reported to be no greater than that caused by orthodontic treatment [10]. Morbidity and costs are also lower than with grafts, flaps and allosteric implants [6].

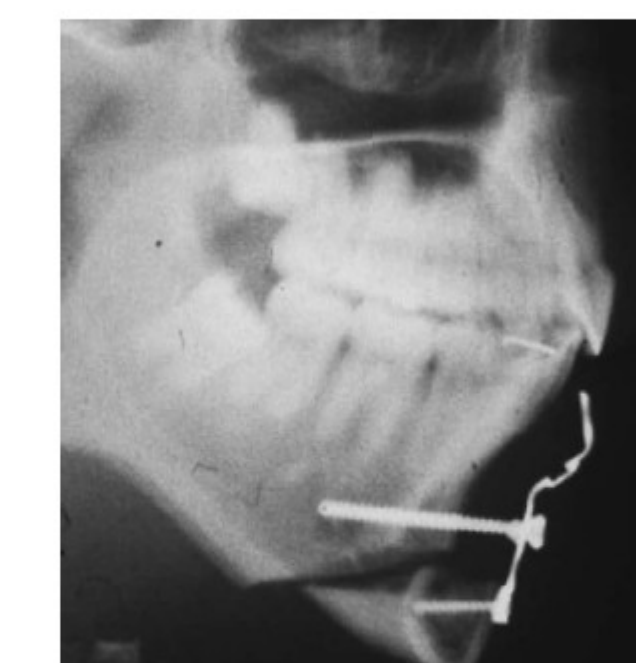
Characterisation of distraction vectors, optimum distraction rates and duration, experimentation with continuous distraction devices, as well as deeper understanding of the cell biology, gene expression and response of the bone tissue to physical and electromagnetic forces will lead to greater understanding and improvements of the technique.

In conclusion:

Distraction osteogenesis is a relatively new technique which has allowed the repair of craniofacial defects without the use of grafts or implants, and is fast becoming an established technique in reconstructive surgery.

References

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A good cosmetic result is achieved in a 20 yr old male with micrognathia. An osteotomy of the jaw was performed. In a 30 minute operation performed under local anaesthesia, a distraction device was placed (central image). The jaw was advanced by 10 mm in 15 days. Image of patient was produced with permission in [8].