



THE EVOLUTION OF ORTHOGNATHIC SURGERY: FROM HISTORICAL CHALLENGES TO MODERN INNOVATIONS

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ABSTRACT

Orthognathic surgery has undergone a profound transformation from early procedures aimed primarily at correcting mandibular deformities to a sophisticated multidisciplinary approach focused on functional, skeletal, and aesthetic rehabilitation. This review traces the major stages in the historical development of orthognathic surgery and examines the key surgical innovations that shaped contemporary clinical practice. Early mandibular procedures were characterized by limited bony contact, extraoral access, inadequate occlusal control, postoperative infection, and a high risk of relapse. Subsequent modifications progressively addressed these limitations through improved osteotomy design, preservation of neurovascular structures, orthodontic coordination, and enhanced stabilization. A major milestone was the development of the sagittal split osteotomy by Hugo Obwegeser and its subsequent modifications by Dal Pont, Hunsuck, and Epker, which established a more predictable and biologically conservative approach to mandibular repositioning. In parallel, advances in maxillary surgery, particularly complete Le Fort I mobilization and down-fracture, enabled controlled three-dimensional repositioning of the maxilla. Experimental studies further clarified the importance of vascular preservation for maxillary viability and bone healing. The development of genioplasty and bimaxillary surgery expanded the scope of skeletal and facial correction, while the introduction of rigid internal fixation



improved postoperative stability and reduced the need for prolonged intermaxillary fixation. Overall, the historical evolution of orthognathic surgery reflects a gradual transition from isolated skeletal resection toward biologically informed, functionally controlled, and aesthetically oriented reconstruction. The integration of surgical innovation, orthodontic planning, vascular preservation, bone healing principles, and rigid fixation established the foundation of modern orthognathic surgery.

Orthognathic surgery has evolved considerably from its early attempts to correct severe facial deformities to a sophisticated field of maxillofacial surgery aimed at restoring facial harmony, occlusal function and skeletal balance. The development of this discipline has been closely associated with advances in craniofacial anatomy, surgical techniques, anesthesia, fixation methods and orthodontic treatment. Early procedures were primarily focused on functional correction, whereas modern orthognathic surgery integrates functional, aesthetic, and skeletal considerations within a multidisciplinary approach. This review summarizes the major stages in the historical development of orthognathic surgery, highlighting key surgical innovations and their contribution to contemporary clinical practice.

The development of orthognathic surgery originated in the United States, with its early surgical approaches being primarily directed toward the correction of mandibular deformities. The first operation for the correction of malocclusion was Hullihen's procedure which was carried out in 1849.[1] Technically, this was a bilateral bicuspid region wedge ostectomy to “set back” the anterior mandibular dentoalveolar segment. (Figure 1a) Other examples of general surgeons of the 19th century who reported on different maxillofacial operations were: von Langenbeck, Cheever, Billroth, Dufourmentel and others.

Building upon these early contributions, St. Louis subsequently emerged as a pivotal center in the development of orthognathic surgery, where the orthodontist Edward Angle and the surgeon Vilray Blair made important contributions to the surgical correction of dentofacial deformities through their collaborative work.[3] The procedure involved a bilateral ostectomy of the mandibular body via an extraoral approach, with parallel cuts in the premolar regions and removal of the osteotomized blocks. Copper wire interosseous ligatures were used to secure the bony segments.[4] In 1898, operation was reported in the literature by Whipple. After several complications, an acceptable result was finally achieved. The result of this so-called 'St Louis operation', which was carried out in 1897.[3](Figure 1b)

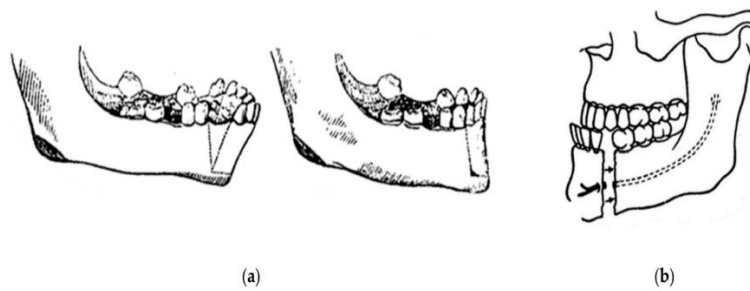


Figure 1. Pioneers of mandible surgery: a - the first operation (Hullihen's procedure) for the correction of malocclusion carried out in 1849; b - osteotomy of the mandibular body performed by Blair in 1897.[5]

Further advancing the principles of occlusal control in mandibular osteotomy, Rodrigues Ottolengui (1861–1937) challenged Angle's approach to splint use and proposed a single template splint to facilitate accurate postoperative occlusal positioning.[4] This concept was remarkably innovative for its time and anticipated the function of modern surgical wafer splints used in contemporary orthognathic surgery.

Among the pioneers of early orthognathic surgery, Vilray Blair played a particularly influential role in establishing the principles of surgical correction of jaw deformities. He was among the first to systematically classify jaw deformities into five major categories: mandibular prognathism, mandibular retrognathism, mandibular and maxillary alveolar protrusion, and open bite. Blair also introduced several surgical approaches for the correction of these deformities, including ostectomy of the mandibular body, horizontal osteotomy of the mandibular ramus, and V-shaped osteotomy for the closure of anterior open bite.[3] Furthermore, his work emphasized the importance of interdisciplinary collaboration between orthodontists and surgeons, a concept he highlighted in his 1907 publication and which subsequently became a fundamental principle in the management of dentofacial deformities.

As efforts to improve the surgical correction of mandibular deformities progressed, persistent limitations in achieving predictable correction of mandibular prognathism prompted the development of alternative operative strategies. In 1897, Paul Berger of Lyon introduced bilateral condylectomy as a surgical approach to mandibular prognathism, with the condyles being resected through a preauricular incision.[6] The technique was subsequently adopted and further applied by other French surgeons, including Mathieu Jaboulay and Léon Bérard[4], thereby contributing to the expansion of surgical options for the correction of mandibular deformities. However, despite its technical innovation, bilateral condylectomy presented an important clinical limitation: the resulting mandibular position did not always provide satisfactory dental occlusion. Robert Henry Ivy (1881–1974) later emphasized this problem, drawing attention to the discrepancy between skeletal correction and functional occlusal outcome.[4] Nevertheless, the procedure remained in clinical use in France for several decades,



illustrating the gradual transition from purely anatomical correction toward greater consideration of functional outcomes in orthognathic surgery. Subsequent reports by Dufourmentel and Mouly in 1959 described favorable results with the technique[3], further demonstrating the evolving assessment and refinement of established surgical approaches.

Despite the increasing use of ramus osteotomy, the technique continued to present technical and clinical challenges, particularly with regard to adequate stabilization of the osteotomized segments and maintenance of the desired mandibular position. In 1931, Kostecka in Prague introduced a modification designed to simplify the procedure by performing the osteotomy as a “blind procedure” through a small stab incision using a Gigli saw.[7] The horizontal osteotomy of the ramus, as well as the condylar osteotomy were rather easy procedures, but the results were not satisfactory. Too much relapse and open bite problems occurred due to the small bony contact areas and the fragment dislocations which resulted from the pull of the inserted muscles.

It is important to note that earlier, the first documented condylar resection was performed by George Murray Humphry (1820–1896) in 1856 at Addenbrooke’s Hospital in Cambridge, treating a young woman with condylar hyperplasia. Through an extraoral approach, Humphry successfully corrected the associated facial asymmetry while improving occlusion and masticatory function.[4] This early experience demonstrated that surgical modification of the condyle could achieve both skeletal and functional correction, providing an important historical precedent for subsequent developments in mandibular and condylar surgery.

In addition to the problems of skeletal instability and postoperative relapse, the risk of infection and the difficulty of achieving a satisfactory occlusal relationship remained important concerns. In 1908, Max Ballin (1869–1934) proposed the extraction of teeth located at the planned osteotomy site several months before surgery as a means of reducing the risk of postoperative infection. Presented to the American Society of Orthodontists and subsequently published in Ottolengui’s journal, this proposal generated considerable discussion and reflected the growing recognition of the importance of preoperative dental preparation in surgical correction.[8]

During the following decade, several technical innovations sought to address the limitations of early mandibular osteotomies. In 1906, Anton Freiherr von Eiselsberg introduced a stepwise osteotomy designed to increase the area of bony contact between the osteotomized segments, a concept subsequently refined by Pichler and Trauner. In 1912, William M. Harsha further improved the technique of extraoral mandibular resection by emphasizing preservation of the neurovascular bundle, thereby reducing the risk of neurological complications. In 1917, Thomas G. Aller proposed an intraoral approach for removal of a bony wedge in the correction of mandibular deformities and emphasized the need for orthodontic involvement to establish optimal occlusion and improve treatment outcomes.[9] Collectively, these developments marked a gradual shift in orthognathic surgery from technically feasible skeletal repositioning toward a



more comprehensive approach incorporating infection prevention, preservation of anatomical structures, adequate bony contact, and coordinated orthodontic–surgical management.

Efforts to improve mandibular osteotomies continued between 1920 and 1940. Several surgeons in Austria and Germany, including Perthes (1922), Pichler (1928), Wassmund (1935), and Hofer (1936), introduced new osteotomy designs for the correction of mandibular deformities.[4] Perthes in 1922, following Schlossmann's suggestion, tried a type of sagittal splitting of the ramus using an extraoral approach with an oblique transverse osteotomy.[5] During this period, particular attention was given to maintaining bone contact, preventing infection, controlling muscular forces, and achieving adequate fixation. These factors were increasingly recognized as essential for stable bone healing and long-term correction.

Further a variety of techniques were carried out by pioneering surgeons to address concerns regarding the maintenance of contact between the fragments to achieve bony union; soft tissue coverage to limit infection; opposing muscle pull to limit relapse; and adequate fixation. In 1928, von Eiselberg proposed a step osteotomy of the mandibular body. In the same year, Gadd described a stepped procedure for correcting mandibular asymmetry, while Limberg introduced an L-shaped sliding osteotomy of the mandibular body to improve bone-to-bone contact after mandibular advancement.[2] These techniques reflected a growing understanding that the design of the osteotomy directly influenced skeletal stability. This principle was further developed by Kazanjian. In 1936, he performed step osteotomies anterior to the mental foramen with extension into the mandibular body, allowing greater approximation of the fragments during advancement.[2] Earlier, in 1931, Kazanjian had presented an extraoral body osteotomy using a Gigli saw and surgical bur, combined with postoperative immobilization using an intraoral orthodontic appliance.[4] Thus, surgical correction was becoming increasingly integrated with orthodontic control.

Technical development also continued during the 1930s. Between 1932 and 1940, Matthew Henry Cryer developed an electrically operated surgical engine and proposed a semicircular osteotomy for vertical mandibular rotation.[4] However, the technique frequently resulted in posterior open bite and was therefore not widely adopted. This experience demonstrated that technical innovation alone was insufficient when the resulting skeletal movement was not functionally stable.

A further step toward less invasive surgery was made in 1942, when Schuchardt described the first intra-oral approach for mandibular ramus osteotomy. Then in 1945 Moose described what may have been the first fully intraoral technique for horizontal ramus osteotomy in the treatment of mandibular prognathism. In 1950, G. V. Barrow and Reed O. Dingman further emphasized precision in mandibular surgery by using dental models, splints, and templates to determine the amount and shape of bone to be removed. Dingman also described a two-stage procedure that separated the intraoral and extraoral components, thereby improving control of the segments and reducing the risk of infection.[2]

The importance of bone healing was also increasingly recognized. In the 1950s, Ben Fickling and Gordon Fordyce proposed the use of cancellous bone from the iliac crest or resected mandibular bone to promote bony union.[9] Although these approaches improved healing, concerns regarding graft-related complications remained. Progress had been interrupted by World War II, when maxillofacial surgeons

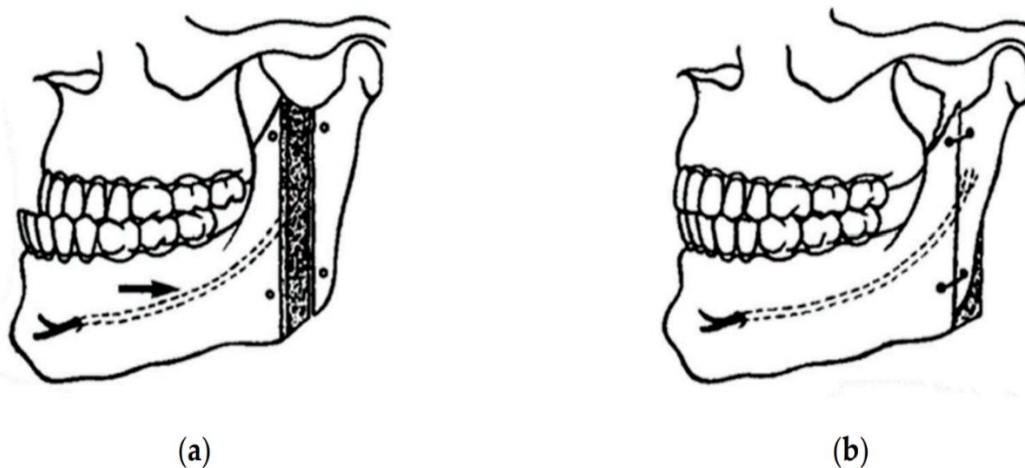


Figure 2. Caldwell and Letterman technique for the correction of mandibular prognathism with emphasis on neurovascular preservation: a - black arrow indicates the attempted preservation of the inferior alveolar nerve. b - bone repositioning and wire fixation.[5]

primarily focused on facial trauma and reconstruction. By the early 1950s, however, orthognathic surgery began to emerge as a distinct surgical field.[3]

This transition was particularly important in Central Europe. Vienna and Graz became major centers of orthognathic surgery, with Pichler and his successor Trauner playing central roles. Trauner advocated the inverted L osteotomy of the ramus for the correction of mandibular prognathism.[4](Figure 3) He also trained Heinz Köle and Hugo Obwegeser, whose later work significantly influenced the development of modern orthognathic surgery.[3] At the same time, Martin Wassmund established the German school and developed the anterior maxillary osteotomy. His pupil Karl Schuchhardt subsequently described posterior maxillary osteotomy and an oblique sagittal osteotomy of the mandibular ramus.[2]

Several new mandibular techniques appeared during this period. Kazanjian suggested a horizontal oblique osteotomy in 1951.[10] In 1954, Caldwell and Letterman introduced a vertical ramus osteotomy with decortication and perforation of the fragments, in an attempt to preserve the inferior alveolar neurovascular bundle and procedure followed by direct wire fixation.(Figure 2) The technique provided overlapping bone surfaces and therefore improved the potential for healing.[6]

The most important advance, however, came from Hugo Obwegeser. In 1952, Dr. Obwegeser retrospectively reviewed a consecutive series (n = 36) of Dr. Trauner's mandibular osteotomies that had been treated with the Blair-Kostecka approach.[11] Obwegeser found a 50%

incidence of significant complications. At his teacher's request to look for a better way to solve the mandibular deformity problem, Dr. Obwegeser made a personal decision about two aspects. Obwegeser sought an approach that would provide broad bony contact while allowing controlled mandibular repositioning.[2] First, he felt that the extraoral (cutaneous) approach left an unpredictable quality of scar and added a risk of injury to the inferior alveolar (sensory) nerve and the facial (motor) nerve, so he chose to find an intraoral approach. Second, he believed that the available techniques produced inadequate bone-to-bone contact to ensure stable bony healing. A new approach would have to provide broad contacting bone surfaces, even after anterior mandibular repositioning from micrognathia.

On February 17, 1953, Obwegeser performed the first sagittal split osteotomy of the mandibular ramus unilaterally via an intraoral approach.[3](Figure 4) Interested in collaborating, Trauner suggested they operate together: On one side, his reverse L-shaped osteotomy with the combined extraoral-intraoral approach, and on the other, Obwegeser's sagittal split of the ramus performed transorally. The case involved a 27-year-old edentulous woman with a protruding mandible. Acrylic splints were placed on the jaws for postoperative intermaxillary fixation. The procedure was carried out with the patient in a half-sitting position and under local anesthesia, with Trauner and

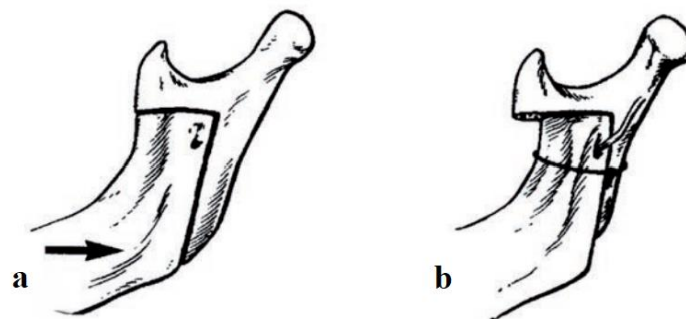


Figure 3. Inverted L osteotomy of the ramus for the correction of mandibular prognathism by Trauner: a- initial osteotomy of the mandibular ramus with planned posterior repositioning of the distal segment. b – completed inverted L osteotomy, allowing mandibular setback while preserving the proximal condylar segment. [4]

Obwegeser as the primary surgeons and H. Köle assisting. Trauner completed his part of the surgery first. Obwegeser then instructed the patient to open her mouth wide and made a mucosal incision along the left ascending ramus. Using a Stichsäge (keyhole) saw, he cut through the cortical plates. First, he cut the lateral cortical plate from the inner to the outer angle of the jaw and then the medial cortical plate above the lingula, extending back to the posterior border. He connected these cuts along the anterior border of the ramus with a fissure bur. However, when he attempted to split the ramus with an osteotome, it unexpectedly shattered instead of splitting. The mandible was repositioned with splints, and the patient was kept in intermaxillary wire

fixation for the postoperative period.[4] Although the mandibular ramus fractured unpredictably during the initial procedure, the concept proved successful and became the basis for further modifications. His approach was developed in response to important limitations of earlier techniques, particularly extraoral scarring, the risk of facial and inferior alveolar nerve injury, and inadequate bone contact. Obwegeser mentions two important modifications to the sagittal splitting of the ramus of the mandible that later came about. The first modification was in “the placement of the lateral corticotomy to increase the surface area of the bony contact for improved union and to accommodate a wider range of advancement of the distal mandible.” The change was from a horizontal orientation of the lateral corticotomy of the ramus to a vertical orientation of the lateral corticotomy of the mandibular body.[11]

Improvements and modifications to this surgical procedure have always been

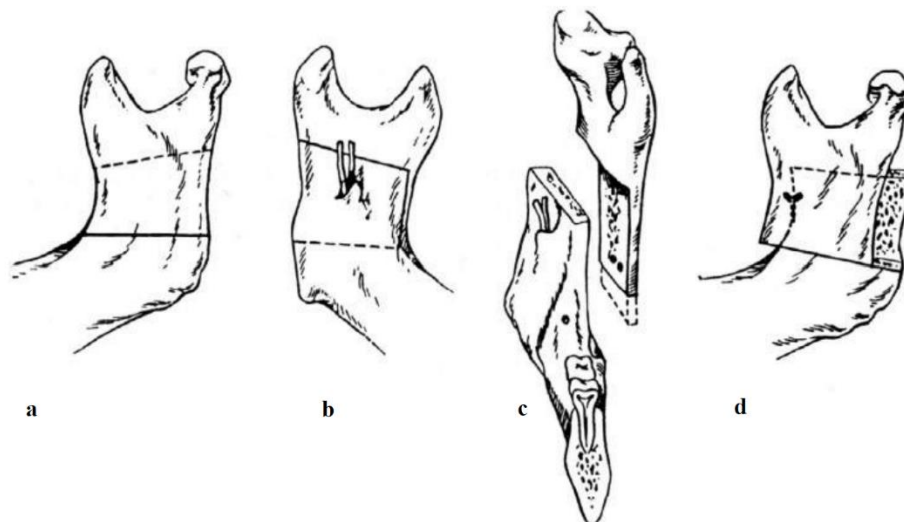


Figure 4. The sagittal split as described by Obwegeser: a – buccal and b – lingual view of mandibular ramus demonstrating the planned osteotomy lines. c – separation of the proximal and distal segments along the sagittal plane is demonstrated. d – the completed sagittal split is shown, producing two broad bony surfaces that can be repositioned for mandibular advancement or setback. [2]

aimed at reducing relapse, improving healing and reducing complications. Contributions have been made by Dal Pont, Hunsuck in 1968, and Epker in 1977.[5] In 1957, Dal Pont improved the technique by changing the lateral corticotomy from a horizontal orientation in the ramus to a vertical orientation in the mandibular body.[11] This modification increased the area of bone contact and improved the possibilities for mandibular advancement. (Figure 5)

In 1960, Caldwell described vertical osteotomies of the ramus with interpositional iliac bone graft for the correction of micrognathia. A C-osteotomy of the ramus was later described by Caldwell and colleagues, in 1968.[2] Although these osteotomies with interpositional grafting

are occasionally used for the management of mandibular retrognathism, the Obwegeser sagittal split ramus osteotomy is generally preferred.

Obwegeser continued to refine his sagittal split technique with minor modifications. Later, further adjustments were proposed by American military oral surgeon Ervin Eugene Hunsuck in 1968.[4] He recommended performing an incomplete horizontal osteotomy on the medial side of the ramus, stopping behind the lingula instead of extending to the posterior border of the ramus. This method used vertical cleavage lines within the mandible to accomplish the split, thereby reducing the likelihood of unintentionally transecting posterior vessels and decreasing hemorrhagic risk.[9]

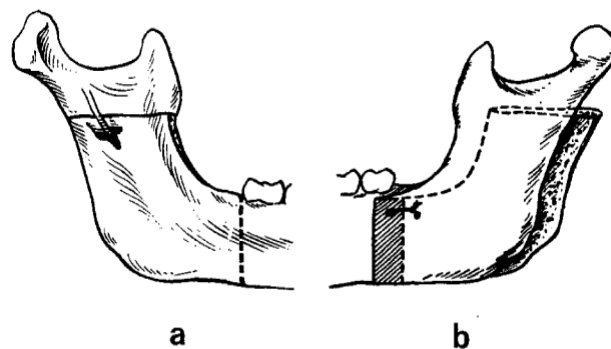


Figure 5. Modification of the sagittal splitting of the mandible by Dal Pont in 1958: a - the bone cut on the lingual and b – on the buccal side. [5]

In 1977 Bell and Schendel published a seminal paper on the biological underpinnings of the bilateral sagittal split osteotomy (BSSO).[12] That work addressed several biological causes of postoperative complications and established a framework for subsequent technical refinements. It underscored that clinical success of a surgical technique should be grounded in, or at least informed by, laboratory research. The Bell and Schendel analysis set out fundamental principles that influenced Epker's 1977 contribution.[12] Drawing on advancing knowledge of muscle and temporomandibular joint function, Epker proposed a biologically informed modification. He rejected extensive masseteric reflection—used by some to prevent relapse—in favor of a two-wire stabilization technique with proximal wires placed low and distal wires placed high, thereby limiting condylar sag and the consequent relapse.[12] Epker also elaborated on the Dal Pont osteotomy by detailing the buccal corticotomy and stressing the necessity of a complete osteotomy through the inferior mandibular cortex to avoid unfavorable splits.[2]

In 1976, Spiessl introduced an osteotomy variant that involved removing the lingual cortical plate covering the oblique ridge in the retromolar region.[12] This resection improved visualization of the retromolar lingual mandible, facilitating distinction between cancellous and cortical bone. Spiessl additionally conducted preliminary anatomical investigations into variations in the mandibular nerve's relationship to the lateral mandibular cortex. He advocated the use of thin oscillating saws for precise osteotomies rather than thicker burs, thereby

conserving bone and minimizing the intersegmental gap.[2] Only minimal gaps were considered acceptable for stable compression osteosynthesis.

During the 1980s Bell and Steinhäuser and Rudzki-Janson published two-volume treatises delineating foundational principles of osteotomy techniques in orthognathic surgery. Nevertheless, injury to the inferior alveolar nerve remained a persistent concern.[12] In 1986, employing contemporary computed tomography, Rajchel re-evaluated the optimal position of the anterior buccal osteotomy. He was the first to report systematically on the mediolateral course of the mandibular nerve and recommended locating the buccal vertical corticotomy in the first-molar region to

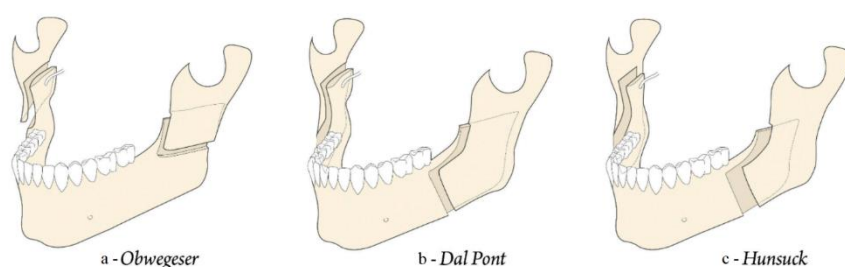


Figure 6. Development of modern jaw surgery for facial discrepancies: a – sagittal split osteotomy of the mandibular ramus by Obwegeser. b – Dal Pont modification(longer lateral cur and increased bony contact). c – Hunsuck modification(shorter medial cut intended to reduce nerve and soft-tissue injury). [5]

protect the inferior alveolar nerve.[12] Rajchel characterized this area as a bony prominence—an extension of the lateral oblique line—which anatomically corresponds to the region distal to the second molar where the neurovascular bundle most frequently lies in direct apposition to the buccal cortex. In some cases the neurovascular bundle and canal are situated within the buccal cortical plate, thereby substantially increasing the risk of inferior alveolar nerve injury.

Wolford advocated advancing the vertical osteotomy anteriorly into the first-to-second molar region to decrease the risk of direct injury to the inferior alveolar nerve. He was also the first to endorse early mandibular mobilization permitted by rigid osteosynthetic fixation.[12] Radiographic analyses of lingual-split configurations demonstrated that, with the conventional approach, the split commonly propagated through the lingual cortical plate. When a high lingual split occurred, placement of the third inferior screw below the alveolar canal was precluded because of insufficient lingual cortical bone for fixation. To address this, Wolford and Davis, in 1990, proposed an inferior-border split technique. Using a purpose-designed saw to transect the inferior border produced a low lingual split and enabled adequate bone stock for inferior screw placement.[11] An additional benefit of this modification was a reduced incidence of the



inferior alveolar nerve residing in the proximal segment, thereby lowering the nerve's susceptibility to traction injury, poor visualization, and separation from the canal.

While mandibular surgery was developing, correction of the chin was also changing. Until the late 1950s, correction of retrogenia was mainly performed using onlay bone or cartilage grafts and alloplastic implants.[4] Although these methods could improve chin projection, bone graft resorption and complications associated with alloplastic materials limited their long-term reliability.

The first recorded surgical advancement of a deficient chin was performed by Otto Hofer in 1942.[4] A more important development followed in 1957, when Obwegeser introduced the term "genioplasty" and described an intraoral approach for chin advancement. Trauner and Obwegeser used the anterior labial sulcus for access and circummandibular wires for stabilization.[11] Later modifications by Converse and Wood-Smith in 1964 allowed simultaneous correction of chin projection, height, and asymmetry. In 1965, Otto Neuner introduced an intraoral advancement technique, while Obwegeser described a triple-step advancement in 1970.[4]

The development of maxillary surgery followed a similar path. the history of this procedure got deeply intertwined with advancements in the management of facial trauma, beginning with René Le Fort's pioneering work on midface fracture patterns, which later formed the basis for elective osteotomies developed by visionaries like Wassermund, Trauner, Paul Tessier, Hugo Obwegeser, and William Bell, to name a few.

The nomenclature for the Le Fort fractures and corresponding osteotomies owes its origin to René Le Fort's 1901 experiments on cadaveric skulls, which identified natural planes of maxillary and facial fractures and led to the identification of consistent fracture patterns in the maxilla and midface. These fractures, classified as Le Fort I, II, and III, revolutionized orthognathic surgery.[13] Surgeons soon began using these naturally occurring fracture planes to guide surgical interventions, allowing for the controlled mobilization of the maxilla in therapeutic procedures such as osteotomies.[4]

Early maxillary surgery was limited by incomplete mobilization and insufficient understanding of vascular supply. Cohn-Stock began performing anterior maxillary osteotomies in 1921, while Wassmund described a one-stage procedure in 1935.[3] Wassmund had also performed a total maxillary osteotomy in a patient with an open bite in 1927 using orthopedic traction instead of intraoperative mobilization[14] In 1934, Georg Axhausen described a Le Fort I osteotomy with additional vertical osteotomy for correction of a malunited maxillary fracture.[4] Further progress came from Schuchardt in 1942. He described a two-stage Le Fort I osteotomy with pterygomaxillary separation and external traction for maxillary advancement.[14] Moore and Ward later recommended horizontal transection of the pterygoid plates in 1949.[4] However, postoperative relapse remained a significant problem, particularly because maxillary mobilization was often incomplete and fixation was limited. In 1954, Gillies



and Rowe described a maxillary osteotomy in a cleft patient, which included maxillary advancement and the use of autogenous bone grafts.[9] However, they also had to set back the mandible, resulting in a “flattened” profile, indicating that the desired maxillary advancement was not fully achieved. Gillies and Rowe later presented additional cases involving cleft patients.[9] Most of the techniques described involved partial mobilization of the maxilla, followed by the application of some form of external orthopedic force to reposition it. However, these methods were associated with significant relapse rates.

Pioneering surgeons described and continued to attempt maxilla osteotomies (anterior segmental, posterior segmental, and total maxillary) to improve the occlusion in individuals with dentofacial deformities. Unfortunately, circulation requirements of the maxillary segments were poorly understood, mobilization was often incomplete, and available fixation options were limited. These problems severely hampered the results that were possible for the patient with a jaw deformity. It was not until Hugo H. Obwegeser described the total horizontal Le Fort I osteotomy in 1968, with complete down-fracture through a circumvestibular incision followed by full mobilization that the maxillary deformity could be universally addressed in all three planes.[14](Figure 7) Obwegeser introduced interposed bone grafts between the pterygoid plates and maxillary tuberosities, significantly enhancing stability and reducing relapse rates.[2] Long-term follow-up studies, such as those by de Hailer, corroborated the effectiveness of Obwegeser’s refinements, establishing the Le Fort I osteotomy as a foundational technique in maxillofacial surgery.[4]

The biological basis of maxillary surgery was subsequently clarified by William H. Bell.[4] From the late 1960s, his experimental studies demonstrated that the maxilla could be segmented and repositioned without compromising long-term vascularity when an adequate soft-tissue pedicle was preserved. Microangiographic and histological studies confirmed the importance of maintaining vascular supply to the osteotomized segments.[2] Bell also demonstrated that adequate vascularity allowed bone union within approximately six weeks.[4] These findings provided important biological support for complete maxillary osteotomy and down-fracture.

At the same time, another important progress in orthognathic surgery was 'two-jaw surgery' which represents the simultaneous mobilization of the total maxilla and mandible. Krole had already introduced bimaxillary alveolar surgery in 1959.[2] Krole

described the combined simultaneous maxillary and mandibular anterior segmental (alveolar) osteotomies for the correction of bimaxillary protrusion and other forms of

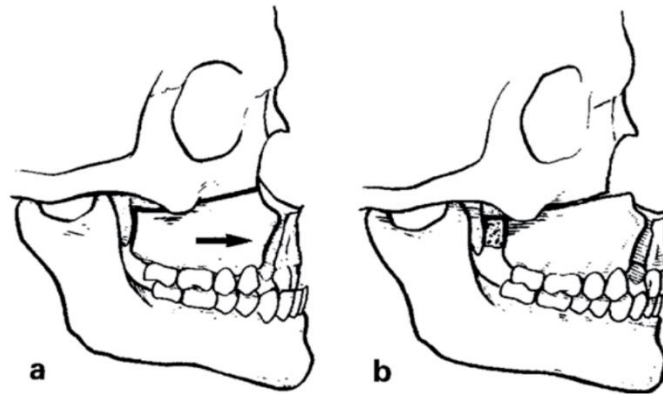


Figure 7. Total maxillary advancement by a Le Fort I osteotomy in a cleft palate patient as published by Obwegeser: a – Le Fort I osteotomy line. b – Maxilla has been moved forward into its new position. [4]

open bite, deep bite, and posterior crossbite. He also pioneered the “corticotomy of maxillary and mandibular bones to facilitate the orthodontic movement of either a single tooth or group of teeth.”[14] In 1970, Obwegeser reported his experience with total maxillary and mandibular osteotomies.(Figure 7)The combination of both procedures improved skeletal stability and allowed greater correction of facial proportions.[3] Thus, orthognathic surgery increasingly moved from isolated jaw correction toward three-dimensional reconstruction of the facial skeleton.

The final major stage in this historical development was the introduction of rigid fixation. Early bone plating had originated in maxillofacial trauma, with Soerensen reportedly using a small gold plate to stabilize a mandibular fracture in 1917. However, practical development of modern fixation systems began much later. At the end of the 1960s, the AO group developed smaller plates and screws for mandibular osteosynthesis.[3]

These principles were subsequently introduced into orthognathic surgery. In 1974, Bernd Spiessl described compression screw fixation for sagittal split osteotomy.[3] Hans Luhr later developed improved miniplates, while Michelet, Festal, Champy, Lodde, and Steinhauser contributed further to the development of maxillofacial plating systems.[4] Although the value of compression fixation was debated, rigid fixation gradually became an important component of orthognathic surgery.

The clinical advantages were substantial. Plates and screws provided faster and more reliable stabilization of osteotomized segments and reduced the need for prolonged intermaxillary fixation. They also improved postoperative airway access and facilitated oral hygiene.[3] Consequently, rigid fixation significantly expanded the range of procedures that could be performed safely and predictably.

Overall, the history of orthognathic surgery reflects a gradual shift from simple skeletal resection toward biologically informed and functionally controlled reconstruction. Early



techniques focused primarily on correcting mandibular deformity, whereas later developments emphasized bone contact, vascular preservation, occlusal control, skeletal stability, and facial aesthetics. The integration of orthodontics, advances in osteotomy design, improved understanding of bone healing, and rigid fixation ultimately established the multidisciplinary principles that characterize contemporary orthognathic surgery.

The historical development of orthognathic surgery and its integration with orthodontics reflects the foundational contributions of early surgeons and orthodontists. These pioneers, through sustained dedication, innovation, and overcoming numerous challenges, established the core techniques and protocols that underpin contemporary practice. Future advances in orthognathic surgery are likely to be driven primarily by technological progress. In particular, the adoption of virtual surgical planning has already reshaped clinical workflows. Digital methodologies improve the precision of osteotomies and facilitate highly individualized treatment strategies that were previously unattainable. Robotic assistance represents another promising direction. Whether employed directly in the operating field or via teleoperated systems, robotic technologies have the potential to enhance surgical accuracy, reduce human error, optimize outcomes, and shorten recovery intervals. Moreover, remote robotic interventions could expand access to specialized care in underserved regions, thereby broadening the global reach of advanced orthognathic treatments.

Despite these technological innovations, the essential principles of orthognathic surgery and the collaborative relationship between surgeons and orthodontists remain constant. The interdisciplinary partnership—exemplified by the field's early practitioners—continues to be fundamental. As new techniques and technologies are integrated into practice, it is imperative to build upon the robust legacy established by predecessors while responsibly extending the scope of possible interventions. Ultimately, the ongoing evolution of orthognathic surgery promises to enhance patient outcomes and increase the number of individuals who can benefit from transformative treatment.

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