



## Chronology of orthognathic surgery

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Orthognathic surgery has long been recognized as a major procedure in the field of oral and maxillofacial surgery (OMS) and is undoubtedly a technique widely applied clinically around the world.

From the early proposals of orthognathic surgery methods to the present application of artificial intelligence (AI), many innovative ideas have been suggested by OMS surgeons.

Nevertheless, the surgical techniques themselves have not significantly changed for decades, and apart from the wider adoption of procedures and reduction in expected complications, there have been no remarkable differences.

The most important aspect—accurately predicting post-operative facial profile changes—remains challenging, even with the introduction of AI. Despite cephalometric analyses and precise procedures, the variability of surgical planning between surgeons is undeniable.

Our efforts in the research field of orthognathic surgery can be summarized as follows:

### 1. Before 1990

- Reports on stability and complications of basic procedures such as Le Fort I and BSSO<sup>1</sup>
- Studies analyzing relapse (based on cephalograms)<sup>1</sup>
- Early discussions on the integration of orthodontics and orthognathics
- Complication reports (nerve injury, bleeding, etc.)

Early orthognathic surgery research focused on stabilizing surgical methods, collaborating with orthodontics in diagnosis and treatment, and recognizing complications. These

efforts played a major role in stabilizing modern orthognathic surgery and laid the foundation that remains widely accepted today.

### 2. 1990-2000

- Comparisons of rigid internal fixation (RIF) vs. wire fixation<sup>2</sup>
- Long-term stability and relapse prevention strategies<sup>2</sup>
- Studies applied to cleft lip and palate patients
- Transition from two-dimensional to three-dimensional computed tomography (2D to 3D CT)<sup>3</sup>

From the 1990s onward, research focused on producing more stable outcomes based on established surgical methods. The introduction of cone-beam CT allowed 3D analyses, which, although not replacing existing methods, provided more realistic and spatial information, giving both patients and surgeons greater confidence in diagnosis and outcomes.

### 3. 2000-2010

- Early 3D simulation software and computer-aided design/computer-aided manufacturing (CAD/CAM) splints<sup>3</sup>
- Increased research on airway and obstructive sleep apnea
- Studies on functional, aesthetic, and long-term outcomes
- Research on complications such as condylar resorption

The new millennium brought rapid progress across medicine and industry, and orthognathic surgery was no exception. 3D simulations were revisited for surgical convenience, while conventional splint fabrication was reevaluated. Complications were redefined through 3D analysis, leading to further understanding and improvements in relapse and complication rates.

### 4. 2010-2020

- Popularization of Virtual Surgical Planning and CAD/CAM<sup>4</sup>
- Expansion of the surgery-first approach protocol<sup>5</sup>
- Studies on quality of life, patient satisfaction, and psychosocial factors<sup>6</sup>
- Growth of research on customized plates and patient-specific implants

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The major change during this period was the advancement of 3D printers and simulation software. Patient-specific fixation devices were proposed, which, aside from economic considerations, further enhanced surgical convenience. However, differences in surgical outcomes compared to traditional methods were not significant.

#### 5. After 2020

- AI/machine learning-based analyses (cephalometrics, relapse prediction)<sup>7</sup>
- Dynamic 4D analyses and integration with motion capture
- Applications of custom titanium plates and 3D-printed grafts
- Big data and cloud-based platforms
- Expansion of multidisciplinary approaches

Recently, AI-based predictive programs have been actively studied, aiming to improve the predictability of surgery and better anticipate postoperative facial changes.

In many medical fields, rapid changes occur every 5-10 years with the introduction of technologies such as robotic surgery, navigation systems, advances in paramedic materials for complication prevention, new drug development, and consensus through regular conferences.

In contrast, orthognathic surgery has seen limited paradigm shifts despite decades of effort, with persistent reliance on traditional techniques, entrenched diagnostic methods, and stable relapse rates. While improved convenience and reduced complications are positive, they fall short of transformative change.

Through the chronology of orthognathic surgery, can we not envision new surgical methods or achieve precise predictions of postoperative facial outcomes?

As we move through the AI era, it is worth reflecting on the evolving role of oral and maxillofacial surgeons and placing our faith once more in the miracle of collective intelligence.

## Funding

No funding to declare.

## Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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**How to cite this article:** Kim YD. Chronology of orthognathic surgery. *J Korean Assoc Oral Maxillofac Surg* 2025;51:267-268. <https://doi.org/10.5125/jkaoms.2025.51.5.267>