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What Is The Best Way To Predict Mandibular Auto-Rotation In Surgery First Approach Cases? A Scoping Review

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Abstract
Introduction: *Surgery First Approach is done to improve the facial profile in the first phase of the treatment and decrease the treatment duration. Though pronounced mandibular auto-rotation can be seen post-operatively, which is to be included in the treatment plan.*
Aim: *The aim of this scoping review is to know the best method for the predictability of mandibular auto-rotation in patients undergoing surgery first approach.*
Method: *Literature search was done using Google Scholar, PUBMED and Scopus databases. Articles published up to September 2025 were screened. Publications with no language limitations were included in the literary search.*
Results: *About 47 articles were obtained after removal of duplicates. These articles were then screened and full-length articles were assessed. 1 article was identified and included in the review.*
Conclusion: *It can be concluded that there is no proven single method that can be considered to be the best method for predicting the amount of auto-rotation mandible. Use of 3-D imaging is useful.*
Keywords: *Orthognathic surgery, autorotation, prediction, surgery first approach*

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I. Introduction

Growth rotation studies of mandible by Bjork and Skeiller[1] have told us about the tendency of for the mandible to rotate in counterclockwise and clockwise direction according to the centre of rotation. Mandible tends to rotate on its hinge axis.

Mandibular rotation also occurs after orthognathic procedures. Large numbers of relapses occur after surgery as a result. Both clockwise and counterclockwise rotation are possible. We refer to this as mandibular auto-rotation. Therefore, we must take this into account when making plans for the surgery.[2, 3, 4] However, it is difficult to forecast this precisely.

Presurgical orthodontic preparation was relatively uncommon among patients undergoing orthognathic surgery until the early 1960s. Prior to that period, surgical correction of skeletal discrepancies was typically performed without significant orthodontic intervention. However, as both clinicians and patients increasingly sought improved aesthetic outcomes and more precise occlusal relationships, the traditional approach shifted. Presurgical orthodontic decompensation—aimed at correcting dental compensations and aligning teeth into their ideal positions before surgery—became widely adopted. This strategy allowed surgeons to reposition the jaws more accurately, while orthodontists benefited from working with properly aligned dentition postoperatively.[5]

Despite the advantages, the conventional approach of orthodontic treatment both before and after orthognathic surgery carried several disadvantages. One major drawback was the extended overall treatment duration, which often spanned two to three years or more. Prolonged orthodontic therapy increased the risk of negative side effects, including dental caries due to challenges in maintaining oral hygiene, gingival recession associated with prolonged tooth movement, and root resorption caused by extended application of orthodontic forces. Moreover, as Kondo and Aoba later demonstrated, although advances in orthodontic techniques have expanded the ability to treat severe malocclusions using orthodontics alone, the fundamental skeletal discrepancies in many cases still remain unresolved without surgical intervention.[5]

These limitations prompted the development of an alternative treatment concept. In 1988, Behrman introduced the idea of performing orthognathic surgery before initiating orthodontic treatment. Shortly thereafter, in 1991, Brachvogel and colleagues formally proposed the concept of "surgery first and orthodontics second" as a means to eliminate many of the drawbacks associated with presurgical orthodontics. They observed that once the skeletal foundation was corrected surgically, the surrounding soft tissues—such as the lips, cheeks, and tongue—exerted improved functional forces on the dentition. This more normalized soft-tissue environment, they suggested, could help guide the teeth into more favorable positions following surgery, thereby facilitating more efficient orthodontic tooth movement and reducing overall treatment time.[5]

In contemporary practice, the surgery-first approach (SFA), also known as the surgery-first orthognathic approach (SFOA), has gained considerable popularity, particularly in orthodontic and surgical centers in Korea, Japan, and Taiwan. These regions have contributed significantly to refining the clinical protocols and expanding the evidence base supporting SFA. The approach is now recognized as a viable alternative to the conventional orthodontics-first sequence, offering advantages such as shorter total treatment time, immediate improvement in facial aesthetics, and enhanced patient satisfaction. As a result, the surgery-first approach continues to evolve as an important strategy in modern orthognathic treatment planning.[5]

It is seen that postoperative mandibular relapse is larger in the surgery-first approach.[6] Three major factors may contribute to postoperative instability in the surgery-first orthognathic approach (SFOA). The first factor is the unstable occlusion that often results immediately after surgery. Because patients do not undergo presurgical orthodontic alignment, the occlusal relationship at the time of surgery is frequently imperfect. This lack of stability can negatively affect postoperative skeletal positioning. Additionally, the compressive forces generated by the masseter muscle on the mandibular segments may promote relapse. In contrast, a stable occlusion distributes functional forces more evenly, helping maintain bone stability and reducing the risk of postoperative mandibular displacement.[7]

The second factor involves mandibular auto-rotation, which can occur after the removal of surgical splints or during postoperative orthodontic adjustments to correct occlusal interferences. As the mandible seeks a more comfortable or functional occlusal position, subtle or significant rotational changes may take place. These adjustments can alter the surgical correction that was initially achieved, leading to potential postoperative instability.[7]

The third factor is the extensive tooth movement required during postoperative orthodontics in SFOA. Orthognathic surgery activates the regionally accelerated phenomenon (RAP), a 3–4-month period marked by heightened osteoclastic activity and accelerated metabolic processes in the dentoalveolar region. While this phenomenon speeds up tooth movement, it may also create a temporary period of instability until the occlusion becomes fully coordinated.[7]

Together, these factors highlight the biological and biomechanical challenges associated with maintaining long-term stability in the surgery-first approach. Careful planning, precise surgical execution, and well-coordinated postoperative orthodontic management are essential to minimizing relapse and achieving successful outcomes.[7]

This involves detailed pre-operative planning using tools like computer-aided surgical simulation (CASS) to virtually model the surgery, determine the optimal jaw position, and predict the final outcome without a lengthy pre-surgical orthodontic phase.[8] Thus, predicting the mandibular auto-rotation is of utmost importance in Surgery First Approach (SFA). There are various methods for this prediction and planning of the surgery like; 3-D cone-beam computed tomography, multi-sliced computed tomography, with 3-D stereophotogrammetry.[9]

II. Aim And Objectives

The aim of this scoping review is to evaluate the best method for the prediction of mandibular auto-rotation in patients undergoing surgery first approach.

III. Method

A comprehensive literature search was conducted using three major scientific databases: Google Scholar, PubMed, and Scopus. These platforms were selected to ensure that both clinical and theoretical studies relevant to the topic were captured. The search encompassed all articles published up to September 2025, allowing inclusion of the most recent developments in orthognathic surgery and predictive modelling. To guide the retrieval of relevant data, specific search prompts were formulated, the primary one being: *"What predictive models can most reliably forecast the degree and direction of mandibular auto-rotation in orthognathic surgery first approach?"* Additional variations of this prompt were also used to broaden the scope of the search and ensure that no significant study was overlooked.

Clear inclusion criteria were established prior to screening. Eligible studies included those in which the central focus was mandibular auto-rotation, particularly within the context of orthognathic surgical planning. Only studies that attempted to predict or analyse the direction and magnitude of mandibular auto-rotation were considered. Various study designs such as randomized controlled trials (RCTs), cohort studies, and case-control studies were included to maintain methodological diversity. No language restrictions were applied to prevent exclusion of potentially valuable international research. Additionally, only studies published within the last 20 years, extending through September 2025, were incorporated.

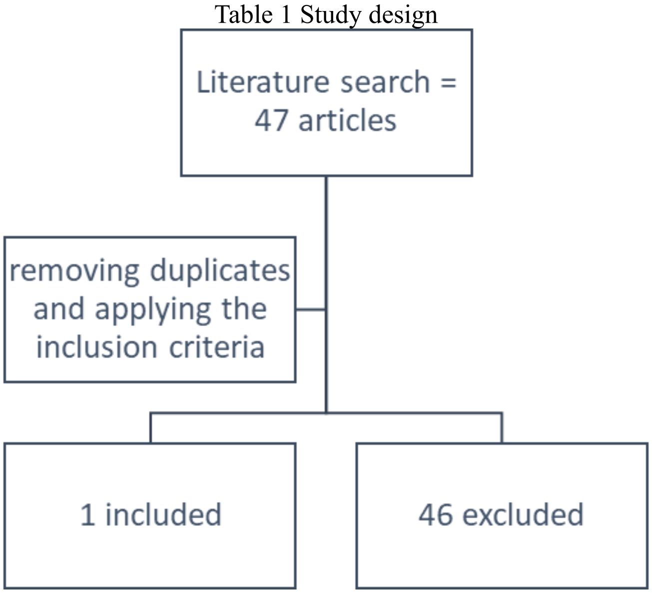
All titles retrieved from the database searches were systematically screened, and duplicates were removed. Abstracts were reviewed to assess relevance, and when necessary, full-text articles were obtained to extract further methodological or clinical details. This rigorous process ensured a thorough and unbiased selection of studies for analysis.

IV. Results

After the removal of duplicate records, approximately 47 unique articles remained for preliminary evaluation. These articles underwent an initial screening based on their titles and abstracts to determine their relevance to the research question. Studies that appeared potentially suitable were subsequently retrieved in full-text form for a more detailed assessment. During this stage, each article was carefully examined to determine whether it met all predefined inclusion criteria related to study design, focus on mandibular auto-rotation, and predictive modeling within an orthognathic surgery context.

Following this thorough evaluation process, only one study was ultimately found to fulfill all the inclusion criteria and was therefore incorporated into the final review. The details of the study selection process and the characteristics of the included study are summarized in Table 1.

Table 1 Study design



V. Discussion

Frost (1993) provided a clear description of the regional acceleratory phenomena. Following an osteotomy, the healing process is aided by bone remodeling surrounding the healing tissue.[10] Two bone indicators, alkaline phosphatase (ALP) and C-terminal telopeptide of type I collagen (ICTP), have been investigated in 22 SFA patients. The latter is a consequence of osteoclastic bone degradation, whereas the former is linked to osteoblastic activity. According to the findings of this study, orthognathic surgery causes increased osteoclastic activity and metabolic alterations in the dentoalveolus for three to four months.[11]

Following orthognathic surgery, a brief spike in bone remodeling and turnover activities is shown by the postoperative transient elevation in ICTP and ALP.

In addition to the aforementioned benefit, the following are some possible issues with SFA:
• The most difficult task with SFA is predicting the final occlusion because of numerous dental interferences.
• Predicting and taking into account the mandibular auto-rotation and postoperative recurrence
• When performing surgery-first, cases requiring extractions are particularly challenging to plan;
• Any minor surgical error can compromise the final occlusion;
• The planning process takes a lot of time compared to the total treatment time;
• The patient is at greater risk due to the increasing number and complexity of osteotomy procedures.

Predictive models for mandibular auto-rotation in orthognathic surgery have shown varying degrees of reliability. Deep learning models using convolutional neural networks have demonstrated high accuracy in predicting treatment modality for surgery-first approach (SFA) versus orthodontics-first approach[8]. However, traditional cephalometric variables have limited predictive impact on mandibular growth patterns1[12,13]. In SFA, postoperative mandibular positional changes can be predicted based on vertical dimension changes, with mandibular advancement cases showing larger relapse than setback cases[6]. Model surgery predictions have shown some inaccuracies, particularly in maxillary advancement and impaction, as well as mandibular setback, although differences were not statistically significant[14]. Factors contributing to prediction errors include face bow recording inaccuracies, intermediate wafer issues, and mandibular auto-rotation in supine or anesthetized patients. Overall, while progress has been made, further refinement of predictive models is needed to improve accuracy in forecasting mandibular auto-rotation.

In the study by Han[15], they compared postoperative positional changes in the mandible after isolated mandibular surgery (IMS) and bimaxillary surgery (BMS) using a surgery-first approach (SFA). They designed a and implemented a retrospective cohort study. They divide the cases into two groups based on the extent of the surgery in IMS and BMS.

The study conducted a detailed assessment of mandibular positional changes by analyzing a series of lateral cephalograms taken at three key time points. The first set of cephalograms was obtained approximately one month before surgery (T0), providing a baseline for skeletal and dental relationships. The second set (T1) was captured one week after the surgical procedure, representing the immediate postoperative skeletal position before significant orthodontic adjustments or biological remodeling could occur. The final set of cephalograms (T2) was taken immediately after the removal of fixed orthodontic appliances, marking the completion of postoperative orthodontic treatment. On average, the T2 recordings were obtained 16.6 ± 8.7 months after surgery, offering sufficient time to evaluate both short-term stabilization and longer-term adaptive changes in mandibular position.

A comprehensive analytical protocol was applied to these cephalograms, focusing particularly on the counter-clockwise auto-rotation of the mandible. This movement was quantified and compared with the predicted values derived from preoperative measurements. The study aimed to evaluate the accuracy of predictive assessments by analyzing how closely real postoperative mandibular movements aligned with geometric forecasts. To strengthen the reliability of the comparisons, a robust statistical methodology was employed.

Demographic variables between the two groups were first assessed using either an independent t-test or Fisher's exact test, depending on the nature of the data. These tests ensured that any observed differences in mandibular rotation or postoperative adaptation were not confounded by baseline disparities between groups. For evaluating statistical differences in individual cephalometric variables between the two groups, an independent t-test was again utilized. To assess temporal changes within each group, repeated-measures analysis of variance (ANOVA) with Bonferroni correction was used, which allowed the researchers to analyze changes across multiple time points while controlling for Type I error. A paired t-test was then performed to compare specific variables measured at different time points within each group. Finally, Pearson correlation coefficients were calculated to determine the relationship between surgical skeletal changes and subsequent postoperative movements. The level of statistical significance was set at $p < 0.05$, aligning with common standards in clinical research.

The results indicated measurable counter-clockwise rotation of the mandible in both groups. In the IMS group, the forward movement associated with counter-clockwise rotation was recorded as 1.2 mm at point B, 1.4 mm at pogonion, and 1.5 mm at menton. In contrast, the BMS group exhibited slightly greater movements, with 1.7 mm at point B, 1.9 mm at pogonion, and 2.2 mm at menton. Despite these numerical differences, statistical analysis revealed no significant differences between the groups. Both groups demonstrated meaningful time-course changes in mandibular position, indicating that postoperative mandibular adaptation occurs consistently, regardless of the magnitude of surgical movement involved in a surgery-first approach (SFA).

From these findings, the study concluded that the mandible undergoes significant rotation after surgery, particularly in the counter-clockwise direction, contributing to forward postoperative mandibular movement during orthodontic treatment. The researchers applied a geometric approach in combination with preoperative vertical dimension (VD) changes to predict the extent of postoperative forward movement produced by mandibular counter-clockwise rotation. The retrospective comparison using immediate postoperative cephalograms demonstrated that the predicted values closely matched the actual postoperative changes. This lack of significant discrepancy suggests that the geometric prediction method has practical value.

Overall, the study highlights that this predictive approach may be beneficial during the treatment planning phase of the surgery-first approach. Since the immediate postoperative mandibular position can be accurately identified after establishing the final surgical objective, clinicians may use this method to anticipate postoperative mandibular behavior and plan more effectively for orthodontic finishing.

Limitation

A key limitation of this review is the lack of comparative research available on the topic. Despite conducting an extensive literature search, only a single study met all the predetermined inclusion criteria, which restricts the ability to draw strong or generalizable conclusions. To identify the most effective method for predicting the degree of mandibular auto-rotation—and ultimately to minimize postoperative relapse and improve long-term stability—there is a clear need for additional high-quality randomized controlled trials (RCTs).

Furthermore, the only study included in this review relied solely on lateral cephalograms for its assessments. While useful, two-dimensional imaging inherently limits the accuracy and comprehensiveness with which complex mandibular movements can be evaluated. Future investigations incorporating advanced three-dimensional imaging technologies, such as cone-beam computed tomography (CBCT) and stereophotogrammetry, may offer more precise insights into the biomechanics of mandibular auto-rotation. These modern diagnostic tools provide enhanced spatial detail and may significantly improve predictive modeling. Therefore, further research utilizing these advanced modalities is strongly recommended to deepen understanding and strengthen clinical prediction methods.

VI. Conclusion

Based on the available evidence, it can be concluded that there is currently no single, universally accepted method that can reliably and consistently predict the precise amount of mandibular auto-rotation. Although several approaches have been proposed in the literature, none have demonstrated clear superiority across different clinical scenarios or patient populations. Among the tools evaluated, three-dimensional imaging techniques show promising potential, as they allow for more accurate visualization and simulation of skeletal and soft-tissue changes. However, even with these advancements, prediction remains complex and influenced by numerous anatomical and biomechanical variables.

Therefore, there is a significant need for further high-quality research in this area. Additional well-designed studies, particularly those using standardized methodologies and larger sample sizes, are necessary to develop more reliable predictive models and improve clinical decision-making in orthognathic surgery.

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