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Systematic Review

Comparison of Surgery First Versus Orthodontics First Approaches in Management of Skeletal Class III Malocclusion: A Systematic Review

Fatemeh Samieizadeh[1], Ladan Eslamian[2*], Mohammad Farahani[3]

[1] Orthodontist, Fellow of Orthosurgery, School of Dentistry, Department of Orthodontics, Shahid Beheshti University of Medical Sciences, Tehran, Iran.

[2] Professor of Orthodontics, School of Dentistry, Department of Orthodontics and Center of Dentofacial Deformity, Shahid Beheshti University of Medical Sciences, Tehran, Iran.

[3] Assistant Professor, School of Dentistry, Department of Orthodontics, Shahid Beheshti University of Medical Sciences, Tehran, Iran.

*** Corresponding Author**: Ladan Eslamian, School of Dentistry, Department of Orthodontics and Center of Dentofacial Deformity, Shahid Beheshti University of Medical Sciences, Tehran, Iran, Tel: +982122403010, Email: l-eslamian@dent.sbmu.ac.ir

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Abstract

Introduction: This study aimed to review the articles comparing orthodontic first (OFA) and surgery first approaches (SFA) orthognathic approaches from various aspects in patients with class III skeletal malocclusion.

Methods: Electronic databases were systematically searched, including PubMed, Scopus, and Web of Science. We included experimental cohort and retrospective studies that compared the orthodontics first (conventional method) and surgery first approaches in the management of patients with skeletal class III malocclusion from various aspects.

Results: A total of 294 records were found through database searching; after removing duplicates, 131 papers were assessed. Finally, 17 studies were included. The included studies evaluated a vast spectrum of outcome measures ranging from quality of life and duration of treatment to cephalometric measures. The amount of surgical movement, post-surgical change, and the relapse rate were the most prevalent assessed outcome measure in 10 out of 17 included studies, followed by total treatment time, which was evaluated in 8 studies. Other less common outcome measures were temporomandibular joint (TMJ) disorders and the oral health-related quality of life (OQLQ) questionnaire.

Conclusion: Two OFA and SFA orthognathic surgery approaches were not significant different in terms of the final amounts of surgical change in the mandible and maxilla. Also, these two approaches can remarkably improve the quality of life with no intergroup differences. There is no united consensus on the effects of OF and SF approaches on the outcomes of patients with class III skeletal malocclusions.

Keywords: Surgery first Approach; Orthognathic surgery; Skeletal stability; Systematic review; Class III malocclusion.

Introduction

As a recognized approach to orthognathic surgery, pre-operative orthodontics followed by surgical operation and post-operative orthodontics, which is known as the “orthodontics first approach” (OFA), has been considered the conventional approach until recently [1]. The issue of long surgical timing was raised in 1959, pointing to the necessity of proceeding with surgery before orthodontic treatment, known as the “surgery-first approach” (SFA), to decrease the total treatment time needed for correcting orthognathic deformities [2, 3].

SFA bypasses the primary orthodontic treatment, makes an efficient reposition of the mandible and maxilla by surgery, and finally shortens the duration of the orthodontic treatment phase [4]. In addition, earlier improvement of swallowing and facial aesthetics as well as similar skeletal stability in comparison to OFA, are among other strong points of SFA [5]. It is worth mentioning that these benefits have not been fully

approved, and also the effects of these two surgical approaches on the other aspects of treatment, including quality of life and cost-effectiveness, have remained controversial.

According to the increasing popularity of the surgical methods, especially SFA, and the lack of comprehensive evidence on the superiority of this method over OFA, we aimed to systematically review the original articles comparing these two orthognathic approaches from various aspects in the treatment of patients with class III skeletal malocclusion.

Methods

Data Resources and Search Strategy

On August 8th, 2021, electronic databases were systematically searched, including PubMed, Scopus, and Web of Science, using combinations of the appropriate keywords such as conventional, three stages, Orthognathic, Orthodontics first, surgery first, class III and malocclusion. All selected articles were written in English and no time limit was applied to the search. Besides, the reference lists of all included studies were screened to identify any missing papers.

Eligibility Criteria

Inclusion criteria were experimental cohort and retrospective studies that compared the two orthodontics (conventional method) first surgery approaches in the management of patients with skeletal class III malocclusion in various aspects. Systematic reviews, case reports, letters to the editor, conference proceedings, and non-English articles were not included.

Study selection, quality assessment and data extraction

Two authors (L.S. and F.S.) independently reviewed all identified papers through database searching and screening on different levels, including title, abstract, and full text. The screening process was based on the PRISMA guideline to report systematic reviews [6]. Disagreements between the authors were resolved by a neutral discussion. Data including the first author's name, country, publication year, sample size, mean age, gender, outcomes measures, and final results were extracted from full texts.

Results

Study Screening

Two hundred and ninety-four records were found through database searching and after removing duplicates, 131 papers were investigated. We excluded 99 articles by title screening, and seven by abstract screening. Finally, together with the updated search, 17 papers were included in this study (Fig. 1).

Characteristics of the Included Studies

The included studies were cohort, experimental, and retrospective studies published since 2010. The characteristics of the studies on the differences between two surgeries first and orthodontic first orthognathic surgery methods in patients with skeletal class III malocclusion have been shown in Table 1.

Outcome Evaluation

The included studies have evaluated a variety of outcome measures ranging from quality of life and duration of treatment to cephalometric measures. The amount of surgical movement, post-surgical change, and the relapse rate was the most prevalent assessed outcome measure being evaluated in 10 out of 17 included studies [7-16], followed by total treatment time, which was considered in eight studies [7, 12-14, 17-19]. Other outcome measures were temporomandibular joint (TMJ) disorders and the oral health-related quality of life (OQLQ) questionnaire. Only two studies had a sample size larger than 150 [9, 18] and the remaining had a sample size ranging from 26 to 62. In three studies [7, 8, 18], male patients were more than female ones, and three studies [9, 10, 15] had not reported the gender distribution. The mean age of the patients ranged from 19.4 to 35.63 years old.

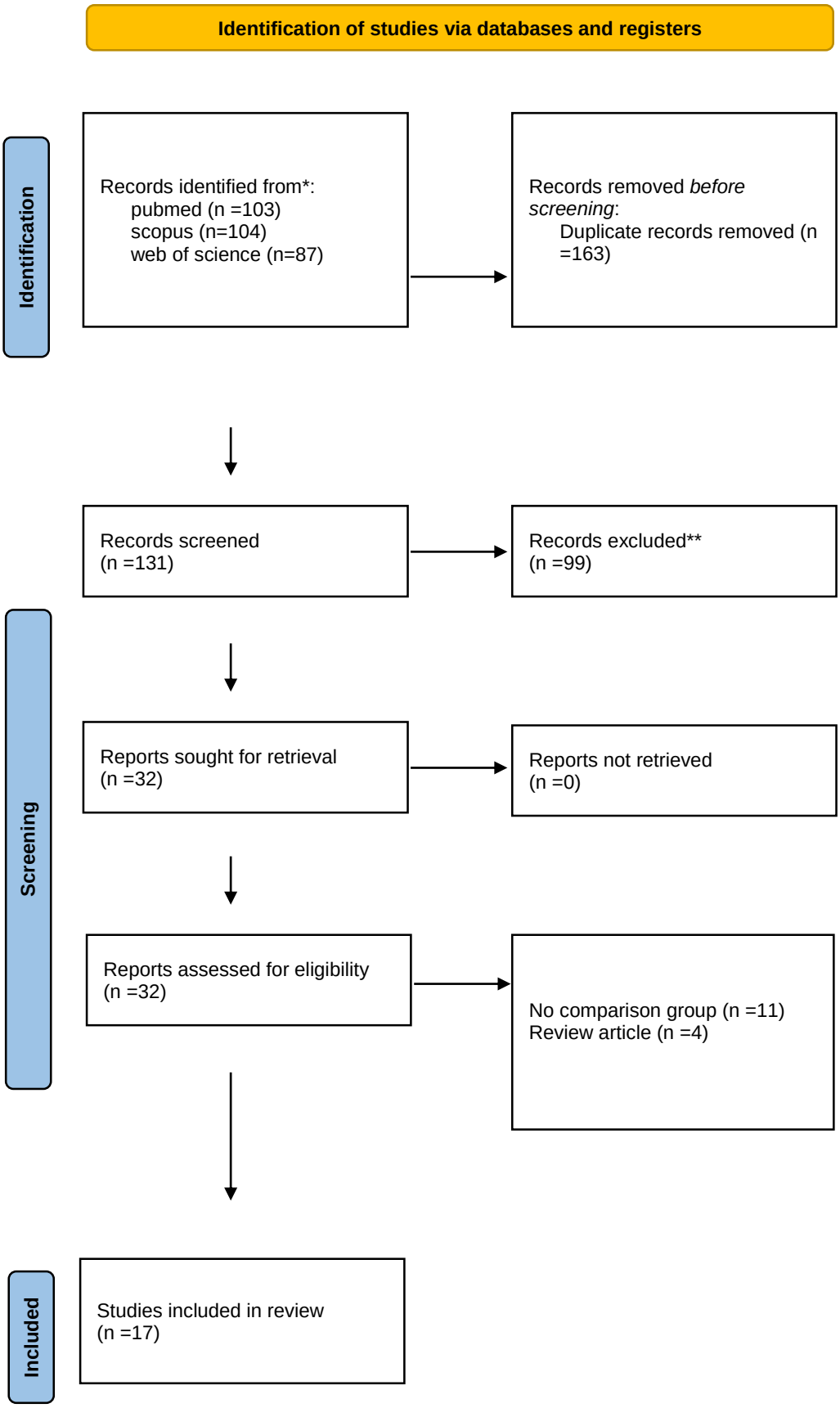

Figure 1: Flowchart of the included studies

Table 1. Characteristics of the Included Studies

First Author	Year	Study design	Sample size (N)	Mean age (years)	Orthodontic first (N)	Surgery first (N)	Outcome measures	Results
Park Y.W. (2)	2021	Retrospective	15 Male 13 Female	22.2 ± 3.17 OF 19.4 ± 1.41 SF	20	8	Total treatment time **Three-dimensional changes in the maxilla and mandible:** Surgical change Post-surgical change Long-term change	SF<OF OF~SF OF~SF OF~SF
J. Hu (3)	2021	Cohort	24 Male 30 Female	23.8 in SF 21.9 in OF	26	28	Length of total treatment Operating time Length of hospital stay Total treatment cost OQLQ	OF>SF SF>OF OF~SF OF~SF OF~SF
Zhai Y. (4)	2020	Cohort	100 Male 82 Female	23.3±3.8 in OF 21.3±3.3 in SF	116	66	TMJ clicking TMJ pain Total treatment time	OF~SF OF~SF SF<OF
Jung S. (5)	2020	Cohort	22 Male 16 Female	20.1±2.6 in OF 20.3±2.4 in SF	18	20	**Three-dimensional changes in the maxilla and mandible:** before surgery to 2 days after surgery **Three-dimensional changes in condyle:** before surgery (T0) to 2 days (T1) 1 year after surgery (T2) **Angular changes in the proximal segment:** before surgery (T0) to 2 days (T1) 1 year after surgery (T2)	 OF~SF OF~SF OF~SF OF~SF OF~SF
He X. (6)	2019	Cohort	18 Male 26 Female	21.2 in OF 23.1 in SF	24	20	Condylar Bodily Shift Condylar surface remodeling Condylar rotation Euclidean distance Point to point average distance	SF>OF OF~SF OF~SF OF~SF SF>OF
Yamauchi K. (7)	2018	Retrospective	13 Male 34 Female	27.2 in OF 25.3 in SF	24	23	Range of mouth opening TMJ clicking TMJ pain TMJ tenderness	OF~SF OF~SF OF~SF OF~SF
Brucoli M. (8)	2018	Experimental	10 Male 23 Female	25.04 ± 5.58 in OF 35.63 ± 13.45 in SF	25	8	TCI SF-36 RSA PIDAQ BDI-II RSES OHIP-14	OF~SF OF~SF OF~SF OF~SF OF~SF OF~SF SF>OF
Jeong WS (9)	2017	Retrospective	155	23.1 OF 23.3 SF	51	104	Relapse rate Maxillary anteroposterior and vertical stability Mandibular stability Occlusal plane Maxillomandibular alignment	OF~SF OF~SF OF~SF OF~SF OF~SF
Pelo S. (10)	2017	Retrospective	10 Male 20 Female	30.2 ± 4.3	15	15	OHIP OQLQ	OF~SF OF~SF
Huang S. (11)	2016	Prospective	25 Male 25 Female	25.2 ± 4.2 OF 24.2 ± 5.8 SF	25	25	Treatment time Individual Satisfaction Quality of life	OF>SF SF>OF OF~SF
Akamatsu T. (12)	2015	Retrospective	-	-	24	14	Surgical movement of the mandible **Mandibular relapse and angular changes**	OF~SF OF~SF SF>OF

							Mean horizontal movement Mean vertical relapse Degree of completion of the occlusion	OF~SF
Park H.M. (13)	2015	Retrospective	18 Male 20 Female	23.9±7 in OF 22.5±3.6 in SF	19	19	**Total treatment time** **Post-operative orthodontic treatment time** **Cephalometric changes:** Surgical change Post-surgical change Total change **Post-surgical relapse** **>30% relapse rate**	OF>SF OF~SF OF~SF OF~SF OF~SF SF>OF SF>OF
Park J.K. (14)	2015	Retrospective	5 Male 21 Female	25±3.25 in OF 26.27±4.45 in SF	15	11	Comparison of the amounts of surgical movement of the maxilla and mandible OQLQ	OF~SF OF~SF
Min B.K. (15)	2014	experimental	18 Male 21 Female	21.16 ± 2.77 OF 23.86 ± 5.63 SF	26	18	Amounts of Surgical Movement Treatment Duration Correlation Between Pre- and Postoperative Pre-operative orthodontic treatment Postoperative orthodontic treatment	OF~SF OF>SF OF>SF OF~SF
Kim C.S. (16)	2014	retrospective cohort	28 male 33 female	21.6 ± 3.5 OF 23.0± 6.3 SF	38	23	total orthodontic treatment time **relapse rate** vertical height Horizontal and vertical skeletal mandibular movements by surgery interincisal angle after surgery pattern of vertical relapse **postsurgical change** overjet, overbite, and interincisal angle decrease relapse greater than 3 mm relapse less than 1.5 mm	OF>SF SF>OF OF~SF OF>SF OF~SF SF>OF SF>OF OF>SF
Park H.M. (17)	2014	retrospective	24 male 36 female	22.46± 4.4	36	24	Surgical movement Mandibular advancement Maxillary superior impaction mandibular setback superior movement of the mandible Inclination at T3	 SF<OF SF>OF OF~SF SF>OF OF~SF
Wang Y.C. (18)	2010	retrospective	-	22.3 ± 3.8 OF 23.3 ± 4.2 SF	18	18	Transverse dimension of: Maxillary canine Presurgical change Postsurgical change Maxillary molar Mandibular molar Presurgical change Postsurgical change	 OF>SF OF~SF SF>OF SF>OF

Discussion

After the final full-text assessment, 17 studies were fully compatible with our screening criteria. Despite finding valuable efforts and articles for comparing the effects of surgery-first (SFA) and orthodontic first (OFA) orthognathic surgery approaches on patients with class III skeletal malocclusion, we could not perform a meta-analysis due to the variety of exercise methods and their duration as well as remarkable differences in study populations, both in gender distribution and type of surgery. In addition, variable factors were assessed throughout these studies ranging from surgical movements, skeletal stability, and relapse rate to quality of life and less frequent TMJ disorders. According to the criteria of the present study, all the studies which had compared the effects of two SFA and OFA approaches on patients with class III skeletal malocclusion were assessed.

Surgical movement, post-surgical change, stability and relapse rate

Jung S. et al. evaluated the three-dimensional changes in the mandible and maxilla at three-time points; before surgery, two days after surgery and one year after surgery [8]. It was reported that there are no significant differences between the two surgery first and orthodontic first approaches regarding maxilla and mandible surgical changes as well as angular movement in any of these time points. In addition, there was no significant difference between the two groups in the coronal plane and anteroposterior direction of the condyle one year after the surgery. These findings are in agreement with the Park YW et al. study, in which they concluded that there are no significant differences between the two SFA and OFA groups in terms of the surgical, post-surgical, and long-term result changes [7]. In a similar study, Min BK. et al. reported that there were no significant differences between the OFA and SFA groups for amounts of surgical movements [12]. Also, there were no significant differences in post-surgical and total surgical changes between the two groups in Wang YC et al. study [15].

He X. et al. compared condylar physical shift, Euclidean distance, and condylar rotation in two surgeries first and orthodontic first groups. They concluded that the amount of the condylar physical transition was significantly more prominent in the SFA group in comparison with the OFA group. However, they reported no statistically significant differences between the two groups for Euclidean distance, condylar rotational change, and remodeling patterns [20].

Jeong W.S. et al. compared the anteroposterior skeletal long-term stability in patients with class III malocclusion as two SFA and OFA groups [9]. They reported no significant differences between the two groups regarding maxillary anteroposterior and vertical stability. They also concluded that SFA provides more satisfying results by directing the dental movement in the opposite direction of the natural dental adaptation process. Overall, they deduced that there is no remarkable difference between the two approaches in anteroposterior skeletal stability.

In another study by Akamatsu T. et al., they retrospectively compared two SFA and OFA groups in terms of mandibular stability [10]. They reported no significant differences between the two groups for the amount of horizontal movement of the mandible. They concluded that mean vertical relapse was significantly higher in the SFA group; however, there was no statistically significant difference between the two approaches for degree of completion of the occlusion.

Park HM et al. compared the cephalometric variables at each stage between OFA and SFA groups. They concluded no significant differences between the two groups for cephalometric variables and surgical movements in all phases of the study. Comparing the amount of post-surgical relapse of the maxilla and mandible, the authors found that the SFA group had a significantly higher number of cases with relapse. They reported that the number of cases with a relapse of more than 30% was higher in the SFA group.

Regarding the amount of surgical movement, only Park HM. et al. had a slightly different and detailed conclusion [14]. They reported that the SFA group had less advancement and more superior impaction of the maxilla in comparison with the OFA group. They also concluded that the SFA group showed a remarkably higher superior movement of the mandible; however, the amount of mandibular setback was not different between the two groups.

Total treatment and operating time

Hu J. et al., in a cohort study, compared two surgeries first and orthodontic first approaches in terms of treatment time, quality of life, and cost [17]. They concluded that there are no significant differences

between the two groups in the length of hospital stay, quality of life (OQLQ), and total treatment cost. However, patients in the surgery first group had a significantly longer operating time and lower length of the entire treatment, which is in line with the Zhai et al. study [18].

Park H.M. et al. also compared the duration of various treatment phases in two OFA and SFA groups [11]. They reported that the period of pre-operative orthodontic treatment and the mean total treatment time was significantly higher in OFA group patients. This is also in line with Park YW et al. and Min BK. et al. studies [7, 12]. However, there was no significant difference between the two groups for the mean post-operative duration of treatment, which is also in agreement with Min BK. et al. study [12].

Quality of life

Brucoli M. et al. compared the effects of SFA and OFA on psychosocial well-being and quality of life in patients with class III malocclusion. They concluded that SFA group patients showed a significantly better score for the short-form health survey (SF-36) in comparison with OFA group patients. In addition, they reported fewer depressive symptoms in the SFA group using the Beck depression inventory (BDI-II) [21].

Pelo et al. evaluated the quality of life using two Orthognathic Quality of Life Questionnaire (OQLQ) and the Oral Health Impact Profile (OHIP) questionnaires in patients with class III malocclusion who underwent orthognathic surgery using SFA and OFA [22]. Although both groups showed significant improvements in quality of life after the surgery, there was no significant difference between the two groups in terms of changes in quality of life.

Huang S. et al. administered two Dental Impact on Daily Living and OHIP questionnaires to two groups of class III malocclusion who were treated by SFA or OFA [19]. They evaluated patients in 1, 6, 12, and 18-month intervals after the intervention and reported that the quality of life was significantly improved in both groups. However, the amount of change was not remarkably different between the two SFA and OFA groups. They also reported that the OFA group had a deteriorated quality of life before the orthognathic surgery, while patients in SFA had a constantly improving quality of life [19]. These findings are identical to the Park JK. et al. study [16].

Other measures

(TMJ, maxilla-mandibular alignment [9],)

TMJ clicking and pain were assessed in Zhai Y. et al. study, which concluded that there is no significant difference between the two surgery first and orthodontic first approaches in reducing these factors during a six-month follow-up; however, both methods had notably improved TMJ clicking and pain within the groups [18]. In a similar effort, Yamauchi K. et al. reported that there are no significant differences between two SF and OF approaches regarding TMJ clicking, pain, and tenderness in a 12-month follow-up. Also, they evaluated a range of mouth openings which was not different between the two groups after the intervention [23].

Conclusion

Based on all the included studies, it was concluded that the two OF and SF orthognathic surgery approaches are not different in terms of the final amounts of surgical change in the mandible and maxilla. Also, these two approaches can remarkably improve the quality of life with no intergroup differences. Moreover, there are no united agreements on the effects of two OF and SF approaches on the outcomes of the patients with class III skeletal malocclusions that it is highly attributable to variations in population and design of studies as well as evaluated outcome measures. Researchers should focus on more specific and united types of outcome measures. Also, more studies with larger sample sizes are needed.

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Conflict of Interest Disclosures

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Authors' Contributions

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Ethical Statement

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