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Comparison of the Cost Effectiveness of Orthognathic Surgery Treatment Between Orthodontic-first and Surgery-first Approaches in the Surgical Phase in Thammasat University Hospital

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Abstract

Objectives: This retrospective cohort study aims to evaluate the costs and advantages of the surgical phase of the surgery-first approach (SFA) versus the orthodontic-first approach (OFA).

Methods: Orthognathic surgery has been described as having two concepts: an orthodontic-first approach and a surgery-first approach. However, there was no consensus on which group has the best cost effectiveness in the surgical treatment phase. In total, 70 patients were treated; half of the patients were treated via the SFA, and another half were treated via the OFA. The information collected included operation cost, operation time, total hospital cost, and length of hospitalization. Effectiveness was determined by quality of life, which was measured with the Orthognathic Quality of Life Questionnaire Thai Version (OQLQ) before and then 6 months after treatment. The cost effectiveness was assessed with an incremental cost effectiveness ratio (ICER) and an incremental time effectiveness ratio (ITER).

Results: The results indicated the intervention cost and time of SFA were slightly higher but more effective than those of OFA. However, the operation cost (p=0.375), operation time (p=0.556), total hospital cost (p=0.363), and length of hospitalization (p=0.643) and OQLQ scores (p=0.344) of both groups were not significantly different.

Conclusions: The intervention cost and time of SFA were slightly higher but more effective than those of OFA. Depending on the result of this study, SFA treatment planning was a good choice for orthognathic treatment.

Keywords: cost effectiveness, orthodontic-first approach (OFA), orthognathic quality of life questionnaire (OQLQ), quality of life, surgery-first approach (SFA)

Introduction

Dentofacial deformities have created both physiological and psychological problems in those where they are present. The treatment of choice to correct dentofacial deformities is orthognathic surgery.[1] Orthognathic surgery approach has been described as bifurcating into two, competing, concepts: an orthodontic-first approach and a surgery-first approach. The orthodontic-first approach (OFA) is used to correct the worsened occlusion and prepare the appropriate occlusion before orthognathic surgery. This is time-consuming. The risks of this are that teeth and periodontal tissue may be damaged by the amount of time spent. The consequences could include gingival recession and root resorption. Moreover, the presurgical phase can deteriorate the facial profile and oral function. A surgery-first approach (SFA) is performed without a presurgical phase and then followed by regular orthodontic treatment. This is time-saving. One benefit is that it can allow an early response to patient needs. SFA is an alternative treatment plan for orthognathic surgery, the purpose of which is to shorten the overall orthodontic treatment period. Another benefit of this technique is the regional accelerated phenomenon (RAP), which can improve postsurgical orthodontic tooth movement.[2]

A health economic evaluation is performed to analyze the health and health care treatment. This is a set of analytical techniques to compare and decide on which treatment is the best, usually performed in a health care center. Ultimately, health economics is about maximizing social benefits obtained from limited resources.[3] Cost effectiveness analysis is one of the methods of health economic evaluation to compare alternative medical interventions with their cost and outcomes (effectiveness). It is the ratio of the difference in cost to the difference outcomes between the two interventions. Therefore, the cost effectiveness ratio can be interpreted as the additional cost per unit of health benefit gained from one medical intervention to another.[4]

The cost effectiveness ratio is that of the cost (C) to the effectiveness (E) of the medical intervention. The costs of intervention can be expressed in monetary units, such as Thai baht or duration of treatment, while the effectiveness of intervention is expressed by the benefits from the intervention. These benefits include the number of deaths avoided, the survival year, or the quality of life of patients. For example, the C/E ratio can be expressed as dollars/life saved or Thai baht/quality of life gained.[4]

Orthognathic surgery can improve the quality of life (QOL).[5] QOL can be referred to both as the effectiveness in the cost effectiveness ratio (one of the tools to measure the satisfaction of the patient is by questionnaire) and as the quality of life of patients. The most popular questionnaire to evaluate quality of life is "the 22-item Orthognathic Quality of Life Questionnaire (OQLQ)", which concerns both physical and psychological impacts.[6,7]

Although previous studies have shown that the SFA's elimination/shortening of the presurgical phase, coupled with the postoperative accelerated orthodontic tooth movement by RAP, creates shorter treatment times than OFA, some studies have shown that the SFA group's operating time and costs were slightly higher than those of the OFA group.[7,8] However, there is only one research study about the difference in cost effectiveness between SFA and OFA.[8] Furthermore, there is no consensus on which group has the best cost effectiveness in the surgical treatment phase. Moreover, it has not been studied in Thailand before. The aim of this study is to evaluate the cost effectiveness in patients with dentofacial deformities and treatment with orthognathic treatment in the surgical treatment phase, comparing OFA and SFA.

Materials and Methods

This retrospective cohort study recruited 70 patients (SFA=35, OFA=35) who had dentofacial deformities. Sample size is calculated by G*Power 3.1.9.7 software using data from a similar previous study.[8] Power was conducted at 95%. Patients who underwent orthognathic surgery, double jaw surgery without genioplasty, by one surgeon at the Department of Oral and Maxillofacial Surgery, Thammasat University Hospital, a single center. The ethic has been approved by the Human Research Ethic Committee of Thammasat University (Science), Pathum Thani, Thailand, Project Code 141/2565. The date of approval is April 28, 2023.

The inclusion criteria included patients aged between 18-60 years old, which have dentofacial deformity and scheduled for orthognathic surgery, underwent bimaxillary orthognathic surgery including Le Fort I (1 piece) osteotomy for maxilla and bilateral sagittal split osteotomy (BSSO) for mandible. The patients underwent orthognathic surgery at Thammasat University Hospital from 2018 to 2022. The exclusion criteria were patients

with congenital disease or syndrome with maxillofacial deformity such as cleft lip and palate, a mental disease. Patients who had maxillofacial transformation caused by an injury or cancer, temporomandibular joint dysfunction, previous orthognathic surgery, systemic disorders that affect the patient's quality of life.

To determine the two groups were balanced, patient characteristics were compared between groups, including age and quality of life scores. The primary outcome variables are cost, time, and quality of life. The cost effectiveness of the SFA and OFA treatments is the secondary outcome variable.

The cost effectiveness analysis was divided into two parts: including the incremental cost effectiveness ratio (ICER), and the incremental time effectiveness ratio (ITER). The ICER is the ratio of the different costs (C) between SFA and OFA to the different effectiveness (E) of SFA and OFA. Similarly, the ITER is the ratio of the different time spent on treatment between SFA and OFA to the different effectiveness of SFA and OFA.[8] In this study, the costs (C) measured are only direct cost, including intraoperation costs (material costs, billed minutes) and total cost of hospitalization (intraoperation costs and pharmacy/hospital costs). All expenditures are expressed in monetary units (Thai baht).

The time of treatment in this study is composed of operation time (minutes), and length of hospitalization (days). The effectiveness is defined in terms of the change in QOL and will be used to calculate the ICER and ITER. The OQLQ score was assessed before treatment (T_0) and 6 months after orthognathic surgery (T_6). OQLQ data at T_0 and T_6 was available.

The ICER and ITER equations are shown below.[4,9]

$$ICER_{mean} = \frac{mean(C_1)–mean(C_2)}{mean(E_1)–mean(E_2)}$$

C1 = Cost of treatment in SFA in the surgical phase
C2 = Cost of treatment in OFA in the surgical phase
E1 = Effectiveness of SFA (the different OQLQ score between T_0 and T_6 of SFA)
E2 = Effectiveness of OFA (the different OQLQ score between T_0 and T_6 of OFA)

$$ITER_{mean} = \frac{mean(T_1)–mean(T_2)}{mean(E_1)–mean(E_2)}$$

T1 = Time of treatment in SFA in the surgical phase
T2 = Time of treatment in OFA in the surgical phase
E1 = Effectiveness of SFA (the different OQLQ score between T_0 and T_6 of SFA)
E2 = Effectiveness of OFA (the different OQLQ score between T_0 and T_6 of OFA)

The mean of ICER during the surgical phase was reported in terms of the ICER of intraoperation cost and the ICER of total cost of hospitalization. The mean of ITER during the surgical phase was reported in terms of ITER of operation time and ITER of length of hospitalization.

To interpret the data, if the intervention costs were higher and have less effectiveness than the comparator, the intervention was said to be 'dominated', but if the intervention costs were lower and had more effectiveness than the comparator, the intervention was said to be 'dominant'. However, the most common scenario was that a new strategy improves clinical results at increased cost, it was called "trade-off". In trade-off scenarios, the decision-making depends on willingness to pay.[4]

The 22-item Orthognathic Quality of Life Questionnaire (OQLQ)

The OQLQ questionnaire (Thai version) has 22 items that were graded on a four-point scale, with 1 meaning "it bothers you a little" and 4 meaning "it bothers you a lot," and 2 and 3 meaning "it bothers you somewhere in the middle." NA= "indicates that the statement does not apply to you or bothers you". The overall OQLQ scores ranged from 0 to 88. A lower number suggested a better quality of life, while a higher score indicated a worse quality of life. The 22 questions were divided into four groups: awareness of dentofacial esthetics (items 8, 9, 12, 13 scoring 0-16); facial esthetics (items 1, 7, 10, 14 scoring 0-20); oral function (items 2-6 scoring 0-20); and social aspects of dentofacial deformity (items 15-22 scoring 0-32).[6,10] The OQLQ scores were collected at the time of presurgical treatment (T_0) and at 6 months after the surgical treatment (T_6).[6,11]

Statistical analysis

All variables were described as the mean with standard deviation (SD) to compare the different time, cost and OQLQ scores of treatments between SFA and OFA groups. The data were analyzed statistically with Mann-Whitney U test, with *p*-value less than 0.05 considered significant.

To compare the difference in OQLQ scores between before and after treatment of each group, the data were analyzed statistically with an independent *t*-test, with *p*-value less than 0.05 considered significant. All data analysis were conducted by using the IBM SPSS Statistics 22 software.

To compare the cost effectiveness of the two groups: SFA and OFA groups was used ICER and ITER to analyze.

Results

Descriptive statistics

The review of medical records and patient screening was described in Table 1. There were 70 patients (24 men and 46 women); half of the patients were treated via the OFA and another half were treating via the SFA. The patients in these two groups were similar in respect to age (mean 26.29 years in the OFA group, mean 24.77 years in the SFA group) and OQLQ score at baseline (p=0.46). The type of deformity was 7 patients of skeletal II and 28 patients of skeletal III in both groups of SFA and OFA. The two groups were significantly balanced with no differences in terms of ages, OQLQ scores at baseline, or number of samples of deformity type.

Table 1: The demographic data were compared using Pearson's chi-squared test for gender, the independent *t*-test for age, and average OQLQ score before surgery (T_0). The type of deformity is also exhibited in the table

	OFA	SFA	Total	*p*-value
Gender (n,%)				
Male Female	17 (48.6%) 18 (51.4%)	7 (20%) 28 (80%)	24 46	0.012 (Pearson's chi-squared test)
Age (years)				
Mean ±SD	26.29±5.839	24.77±4.959	25.53±5.431	0.246 (Independent *t*-test)
Type of deformity				
Skeletal II (n, %) Skeletal III (n, %)	7 (20%) 28 (80%)	7 (20%) 28 (80%)	14 (20%) 56 (80%)	
Average OQLQ score before surgery (T_0)				
Mean±SD	51.83±2.87	49.34±3.04		0.463 (Mann-Whitney U test)

OQLQ=orthognathic quality of life questionnaire; OFA, orthodontic-first approach; SFA=surgery-first approach
n, number of samples; SD, standard deviation.
The significance level was less than 0.05.

Table 2: Comparisons of cost and time between surgery-first approach (SFA) and orthodontic first approach (OFA), compared using Mann-Whitney U test was used. The quality of life questionnaire (OQLQ) score after 6 months of surgery is also reported in the table

	OFA	SFA	*p*-value
n	35	35	
OQLQ score after surgery 6 months			
Mean±SD	29.54±20.35	24.40±16.67	0.301 (Mann-Whitney U test)
Operation cost (Material costs, billed minutes; Baht)			
Mean±SD	69703.028±8349.08	71420.43±12300.73	0.375 (Mann-Whitney U test)
Hospital cost (Operative cost and pharmacy/hospital costs; Baht)			
Mean±SD	97090.96±9848.57	100052.72±14984.16	0.363 (Mann-Whitney U test)
Operation time (minutes)			
Mean±SD	329.142±76.07	341.971±82.45	0.556 (Mann-Whitney U test)
Length of hospitalization (days)			
Mean±SD	4.09±0.61	4.03±0.86	0.643 (Mann-Whitney U test)

n, number of samples; SD, standard deviation.
The significance level was less than 0.05.

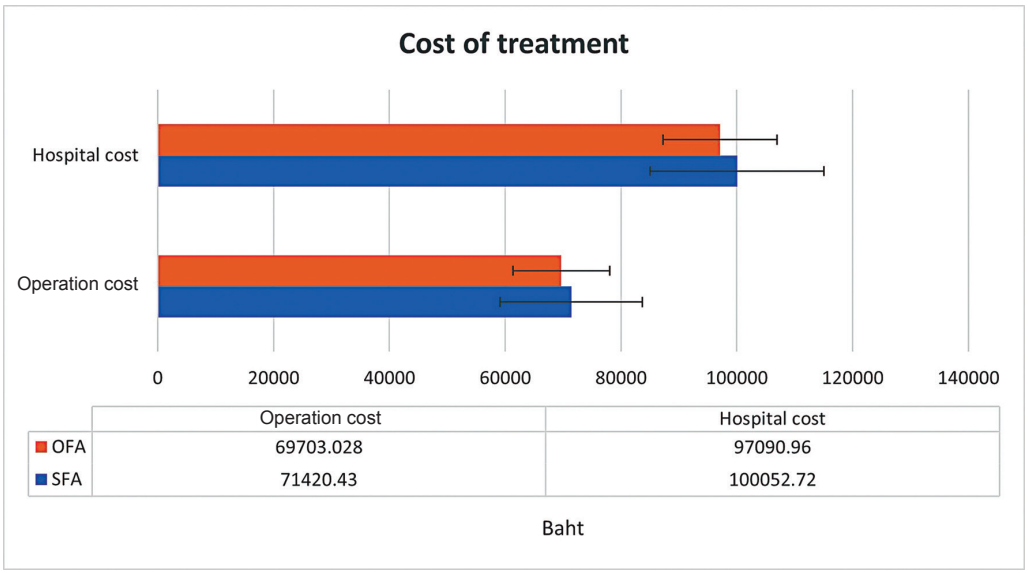

Figure 1: Comparisons of cost between surgery-first approach (SFA) and orthodontic-first approach (OFA)

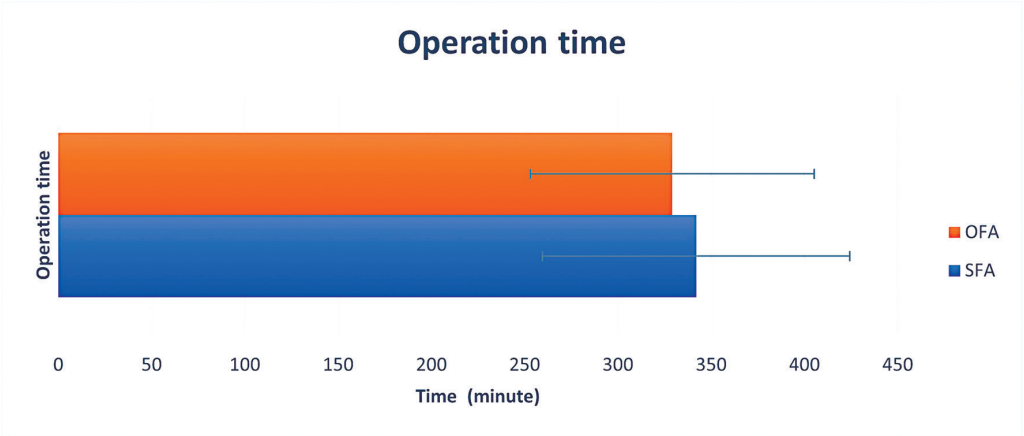

Figure 2: Comparisons of operation time between surgery-first approach (SFA) and orthodontic-first approach (OFA)

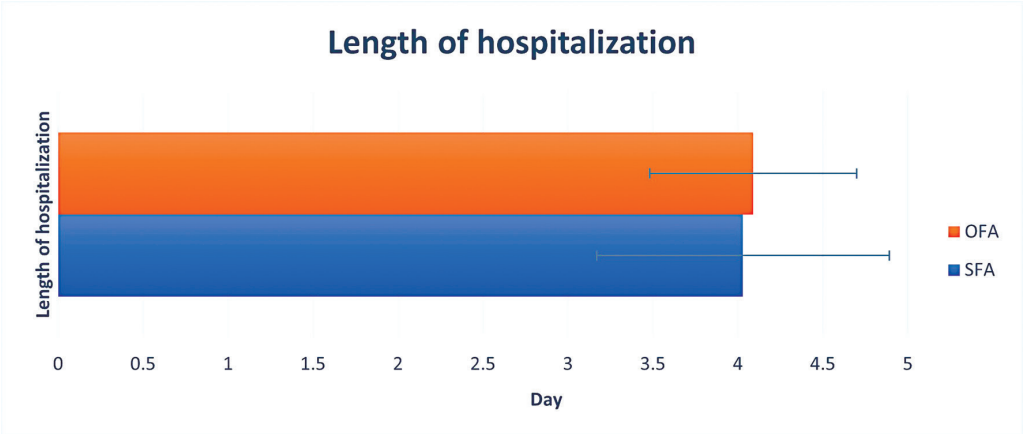

Figure 3: Comparisons the length of hospitalization between surgery-first approach (SFA) and orthodontic-first approach (OFA)

Comparison of time and cost between the SFA and OFA

The cost and time comparison between the SFA and OFA groups was shown in Table 2, Figures 1, 2, and 3. The operation cost, hospital cost, and operation time were slightly higher in the SFA group than the OFA group. However, there were not significant differences between the SFA and OFA groups in terms of operation cost (p=0.375), hospital cost (p=0.363), or operation time (p=0.556). The length of hospitalization was not different between the SFA and OFA groups.

Comparison of OQLQ scores between the SFA and OFA

The changing OQLQ scores of patients in the OFA and SFA groups was described in Table 3 and Figure 4. The mean±SD of change in OQLQ scores were 20.63±14.27 and 25.60±19.74 for patients in the OFA group and the SFA group, respectively. The difference in change in OQLQ score in the SFA more than OFA group, which mean the QOL in SFA group improved more than OFA. However, the difference between the groups was minimal, and there was no significant difference (p=0.344) between the groups. Moreover, there was no significant difference in terms of facial esthetics, oral function, awareness of dentofacial esthetics, or social aspects of dentofacial deformity between patients in the OFA and SFA groups.

Comparison of cost effectiveness between the SFA and OFA

The results of the cost effectiveness analysis were presented in Table 4. The ICER of operation cost in the SFA group compared with the OFA group is 345.55 baht per additional ΔOQLQ point gained, and the ICER of hospital cost is 595.93 baht per additional ΔOQLQ point gained. The ITER of operation time in the SFA group compared with the OFA group was calculated as 2.58 minutes per additional ΔOQLQ point gained, and the ITER of length of hospitalization in the SFA group revealed a reduction in time of 0.012 days per ΔOQLQ point gained when compared to the OFA group. It means the intervention costs and time of the SFA group in the surgical phase result in improved QOL at an increased cost and time compared to the OFA group.

Discussion

Orthognathic surgery is one of the treatments used to correct dentofacial deformities. The OFA and SFA are concepts of orthognathic treatment. Both have advantages and disadvantages, but the SFA is outstanding in terms of time savings. J. Hu *et al.,* showed that the SFA group had a shorter overall treatment duration when compared to the OFA group.[8] Although the SFA uses a shorter total duration than the OFA, the previous study showed the intraoperation time of SFA is significantly longer than OFA.[8] However, in this study, the data showed that the intraoperation time of SFA was slightly longer than OFA but without statistical significance.

A possible explanation for the higher intraoperative duration in SFA might be an unstable occlusion during surgery which might affect the determined occlusion.[8] In OFA, the occlusion and interference were corrected before surgery. In SFA, the occlusion during surgery mainly depends on the occlusal splint[12]; any minor error in the device can affect intraoperation treatment. The expert opinion team in our institute suggested that the minimally higher amount of operation time in SFA may be caused by the occlusal plane's poor alignment, which makes the surgery usually move in 360 degrees of rotation more than in OFA. The OFA usually moves the segment of the jaw following the occlusal plane, which is prepared before surgery. However, the SFA group does not prepare the occlusal plane before surgery; the surgical plan usually moves the occlusal plane with a clockwise or counterclockwise rotation. The rotation of the maxillomandibular complex (MMC) to change the occlusal plane has increased bone management at the surgical site and made the operation more complex. Additionally, predicting the soft tissue esthetic and final occlusion is harder in SFA than in OFA. W. S. Jeong *et al.,* suggests that if a single surgeon performed all approaches with identical techniques and a proper surgical plan, the effect of surgical factors appears to be minimal.[13] Similarly to previous study[8], the terms of duration of hospitalization and postoperative recovery were not different between the two groups.

Cost of treatment in the surgical phase consisted of both operation costs and hospital costs. This study shows that the operation cost in SFA was slightly higher than in OFA due to the slightly longer intraoperation time. The more time spent on general anesthesia, the higher the cost.

Table 3: Comparison of different OQLQ scores (total and subdomain) before surgery and 6 months after surgery, using the independent *t*-test

$\Delta OQLQ_{T1-T6}$			
Domain	**OFA Mean difference±SD**	**SFA Mean difference±SD**	***p*-value**
Social (0-32)	8.26±8.14	8.37±7.77	0.958
Esthetic (0-20)	5.00±5.72	4.03±5.95	0.513
Function (0-20)	2.94±6.46	4.29±5.75	0.413
Awareness (0-16)	5.63±5.13	7.20±5.72	0.176
Total (0-88)	20.63±14.27	25.60±19.74	0.334

OQLQ=orthognathic quality of life questionnaire
The significance level was less than 0.05.

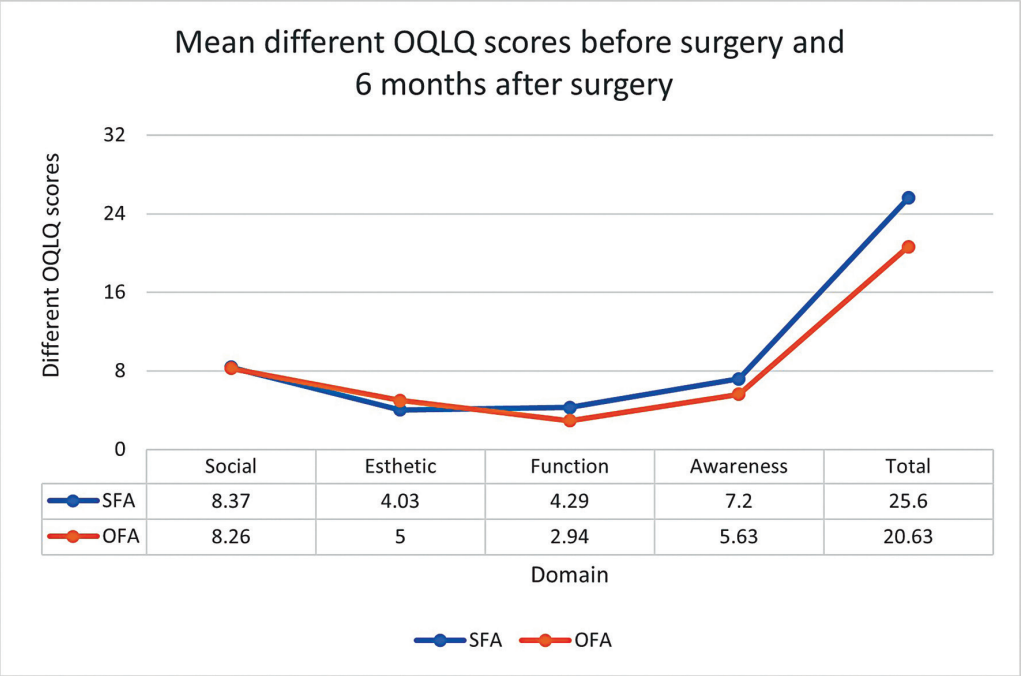

Figure 4: Comparison of different OQLQ scores (total and subdomain) before surgery and 6 months after surgery

Thus, the overall hospital cost was also be increasing. However, there were no significant differences between these two groups. The result was in accordance with the previous study.[8]

In this study, the OQLQ scores at before treatment (T_0) of SFA and OFA were compared and showed no significant difference. After surgery, at 6 months (T_6), the different OQLQ scores compared between before and after surgery show the QOL in the SFA group improved more than that in the OFA group. But the difference in OQLQ scores between the groups were minimal, and there were no significant difference between the groups in each domain.[14] The results were similar to previous.[14,15] While the skeletal classification was mostly based in class I, II, and III patterns, no studies had reported a significant difference in the total OQLQ score between these groups.[16-19] It had been reported that gender affects differences in the outcome of OQLQ between males and females.[16] However, many studies did not find significant variation in QOL associated with gender.[1,17,20,21]

To compare the cost effectiveness between SFA and OFA, the previous study showed that in terms of time spent in the operating room, the time spent in the SFA was slightly more than that of the OFA.[8] This study's findings resemble previous studies; data showed the ICER and ITER of operation costs, hospital costs and operation time of SFA was slightly more than OFA. Although the intervention costs and time of SFA were slightly higher but more effective than the comparator. It means the intervention costs and time of the SFA group in the surgical phase resulted in improved QOL at an increased cost and time compared to the OFA group. This balance of benefits

Table 4: Comparison of cost effectiveness of the surgical first approach (SFA) and the orthodontic first approach (OFA)

Varibles	Mean±SD	Between-treatment increment	Mean±SD different OQLQ score between T_0 and T_6	Between-treatment incremental	ICER or ITER
Cost effectiveness of operation cost					
SFA	71420.43±12300.73	1717.402	25.60±19.74	4.97	345.55 (Baht/ΔOQLQ)
OFA	69703.028±8349.08		20.63±14.27		
Time effectiveness of operation time					
SFA	341.971±82.45	12.829	25.60±19.74	4.97	2.58 (min/ΔOQLQ)
OFA	329.142±76.07		20.63±14.27		
Cost effectiveness of hospital cost					
SFA	100052.72±14984.16	2961.76	25.60±19.74	4.97	595.93 (Baht/ΔOQLQ)
OFA	97090.96±9848.57		20.63±14.27		
Time effectiveness of length of hospitalization					
SFA	4.03±0.86	-0.06	25.60±19.74	4.97	-0.012 (day/ΔOQLQ)
OFA	4.09±0.61		20.63±14.27		

ICER, incremental cost effectiveness ratio; ITER, incremental time effectiveness ratio; SD, standard deviation. The significance level was less than 0.05

and limitations, in terms of economics, was called "trade-off". In trade-off scenarios, the decision-making depends on willingness to pay.[9]

In order to compare the intra- and post-operative risks of SFA with OFA, it was typical for complications from both operations to occur, including bleeding, oronasal communication, perforation of the endotracheal tube, changes in neurosensory changes, periodontal damage, tissue necrosis, and infection.[22] Although there was not much research on SFA complications, all the approaches were able to refer to those technique complications indirectly. SFA-related complications included the existence of an impacted lower third molar, bonding failure, and extensive surgical movements to allow for a post-operative decompensation of the teeth. Because segmental osteotomies were frequently required with this procedure, the SFA group may be slightly more susceptible to complications. However, as surgical skills and knowledge improved, these problems became less prevalent. It had been demonstrated by several authors that, when performed according to basic principles and a meticulous treatment plan, multisegmental surgery may be safe and had only a few minimal problems.[23,24]

There were some limitations concerning the study's findings. The number of patients enrolled here was relatively small, and the data were collected retrospectively, which might lead to bias. The study analysis was conducted in a government-supported tertiary referral dental hospital; it may not represent the data from a private hospital. This study concerns only the surgical phase of orthognathic treatment; it may be better to do a long-term study of total treatment time in the future, which concerns the timing of the pre-surgical phase, the surgical phase, and the post-surgical phase.

Conclusions

In conclusion, the comparison of the cost effectiveness of SFA and OFA in the surgical phase of orthognathic surgery in the study showed that the intervention costs and time of SFA were slightly higher but more effective than those of OFA. However, the cost, time, and OQLQ scores of both groups did not show significant differences. Thus, if the proper criteria are to use both SFA and OFA, the decision to plan treatment depends on the preferences of the patient and clinician. Although the previous study showed significantly more intraoperation time spent in the SFA group, this study shown no significant difference between SFA and OFA. Moreover, the SFA had higher outcomes (QOL score). Depending on the result of this study, SFA treatment planning was a good choice for orthognathic treatment.

Author Contributions

Conceptualization, methodology, formal analysis, original draft preparation were handled by P.C.; project management and review and editing of the writing were handled by S.P., C.O., and N.C. The manuscript's published form was approved by all authors once they had read it.

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Institutional Review Board Statement

The study was conducted in accordance with the Declaration of Helsinki and approved by the Institutional Review Board (or Ethics Committee) of Thammasat University (Science), Pathum Thani, Thailand (protocol code 141/2565 and date of approval April 28,2023).

Informed Consent Statement

Informed consent was obtained from all subjects involved in the study. Written informed consent has been obtained from the patients to publish this paper.

Data Availability Statement

Not applicable

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Conflicts of Interest

The authors declare no conflict of interest.

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