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Costs of surgical-orthodontic treatment in community hospital care: An analysis of the different phases of treatment

To determine the distribution of costs and various influencing factors in the entire process of surgical-orthodontic treatment in community hospital care, a retrospective study was carried out. The records and radiographs of 99 community hospital patients operated on between 1994 and 2001 were included. Cost analysis data were gathered from 4 phases of treatment: the orthodontics, the surgical outpatient assessments, the surgery/surgeries, and the inpatient period. The results showed that the surgical phases together are responsible for roughly 61% of the costs, 28% of which were attributed to the surgical operation itself. Orthodontics made up approximately 39% of the total costs, with an average of 26 visits. The average total costs of all treatments were US $6,206 ± 912. Patients that could be operated on with bilateral sagittal split ramus osteotomy of the mandible only had the lowest costs, and those who required bimaxillary osteotomies had the highest costs. Of the several clinical and cephalometric measurements made in this study, only skeletal open bite and orthodontic space closure after tooth extraction were found to affect the costs. It can be concluded that surgical-orthodontic treatment is a rather expensive way to correct dentofacial malocclusions due to the high costs of the surgical phase. Skeletal open bite constituted the most costly entity, while malocclusion resulting from mandibular deformity was the cheapest.
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The rising expenses of health care should inspire analyses of cost-effectiveness. Surgical-orthodontic treatment is a long-lasting and costly process, as it includes the surgery itself, hospital care, and numerous outpatient visits. There are only a few reports on the costs of surgical-orthodontic treatment. In 1987 Dolan et al[1] analyzed the hospital charges for orthognathic surgery, focusing on the surgical phase. Later, Dolan and White[2] and Lombardo et al[3] compared different costs using the results of the previous study by Dolan et al[1] and found, for example, that the time spent in the hospital had decreased significantly during a few years. They concluded that this was the result of the introduction of an internal rigid fixation method, which was, on the other hand, also the reason for the increased expenses for orthognathic surgery.

However, modern surgical-orthodontic treatment is not merely a surgical procedure but also includes orthodontics as an essential part of the process. As there are no publications assessing the costs of the entire process of surgical-orthodontic treatment, the purpose of this study was to evaluate expenses incurred at the different phases of treatment. In particular, the aim was to find out the most costly phase of the treatment and the most and least expensive types of malocclusion and surgeries.

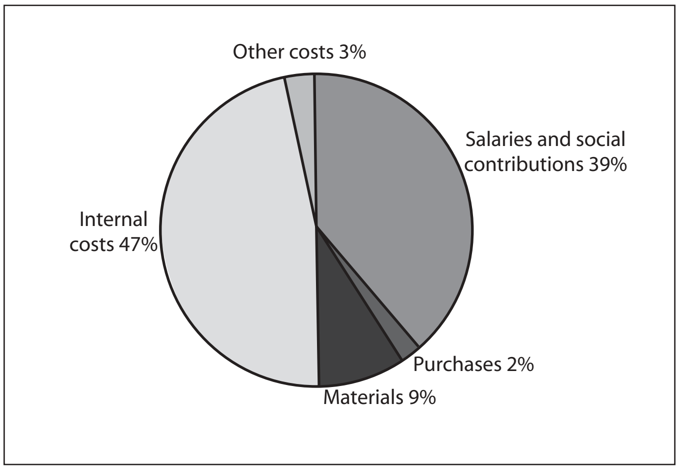

Fig 1 Distribution of different cost categories in the 1999 final accounts of the OMFS clinic. Internal costs = radiologic and instrument care service, rents, electricity, technical service, cleaning, administration; other costs = internal interest, education, bank and office services, depreciations, other purchases.

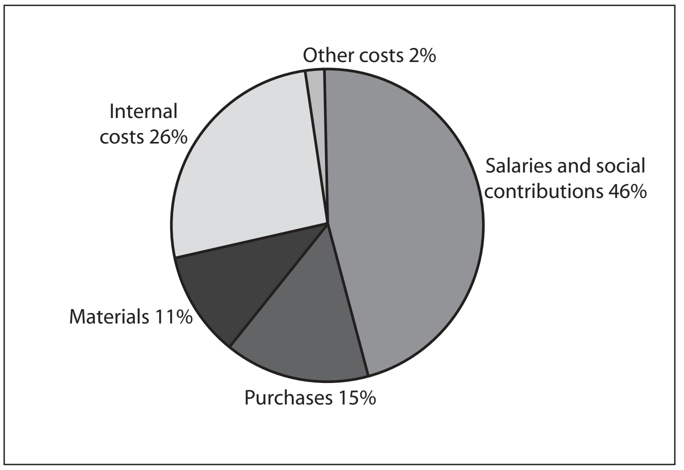

Fig 2 Distribution of different cost categories in the 1999 final accounts of the orthodontics clinic. Internal costs = radiologic and instrument care service, rents, electricity, technical service, cleaning, administration; other costs = internal interest, education, bank and office services, depreciations, other purchases.

Materials and methods

The patients in this study underwent their surgical-orthodontic treatment between 1994 and 2001. In all, 505 orthognathic operations were performed during this period, and the records of these patients were re-evaluated by one of the authors (KP). Only patients who were treated both orthodontically and surgically at the clinics of Oral and Maxillofacial Surgery (OMFS) and Orthodontics of Vaasa Central Hospital in Finland and who had good-quality lateral cephalograms were included. Patients treated with methods other than fixed orthodontic appliances, as well as patients with major complications, re-operations, or with a need for bone grafts, were excluded.

Finally, data on 99 patients (61 women and 38 men) were obtained. The patients' mean age at the time of operation was 38.3 years (range, 18 to 64 years).

Vaasa Central Hospital produces specialist-level health care services for a population of 165,000. The clinics of Orthodontics and OMFS are situated in the same facility and constitute small but independent cost units under a larger administrative unit, called the operative unit. The clinics are equipped with ordinary dental working units. The OMFS clinic employs 2.0 physicians and 2.6 auxiliary persons, had 2,060 patient visits in 1999, and had an annual budget of US$442,012. The respective data for the orthodontics clinic are 1.3 physicians, 2 auxiliary persons, 2,009 visits, and US$195,653. Figure 1 illustrates the costs by different subgroups in the OMFS clinic, while Fig 2 shows the costs in the orthodontics clinic. These data constitute the basis for the cost analysis in the outpatient clinics.

The clinical and cephalometric (skeletal) diagnoses of the patients are shown in Tables 1 and 2, and the distribution of surgical operations is presented in Table 3.

The treatment process was divided into 4 phases: *(1)* pre- and postoperative orthodontics up to the removal of fixed appliances and the beginning of the retention phase, *(2)* treatment at the OMFS clinic, *(3)* the surgical operation, and *(4)* the inpatient period.

Orthodontic treatment included examinations, counseling, treatment with fixed appliances using the straight-wire technique, orthodontic preparation needed for surgery, postoperative finishing of the arches, and the installation of removable retention plates. The costs of the dental laboratory were included. The total treatment time for orthodontics is usually 1 to 2 years. The visits to the OMFS clinic included clinical and radiographic examinations, treatment planning, counseling, removal of third molars when necessary, surgical planning, and model surgery with its dental

Table 1 Clinical diagnosis of 99 surgically/ orthodontically treated patients

Diagnosis	No. of patients
Malocclusion due to the mandible (retrognathia, prognathia, or laterognathia mandibulae)	66
Maloccusion due to the maxilla (retrognathia or hypoplasia maxillae)	13
Malocclusion due to both jaws (retrognathia or hypoplasia maxillae and prognathia mandibulae)	9
Open bite deformities	11
Total	99

Table 2 Cephalometric (skeletal) diagnosis of 99 surgical/orthodontic patients adapted from RMO-Joe software data analysis

Vertical relationship	Sagittal relationship			
	Class I	Class II	Class III	Total
Normal	11	15	10	36
Deep	10	8	9	27
Open	12	16	8	36
Total	33	39	27	99

Table 3 Surgical operations on 99 surgical/ orthodontic patients

Type of surgery	No. of patients
BSSO	
Advancement	58
Advancement with GP	5
Setback	2
Le Fort I osteotomy (advancement with or without intrusion or extrusion)	12
Bimaxillary	
Le Fort I osteotomy with BSSO setback	4
Le Fort I osteotomy with BSSO advancement	10
Le Fort I osteotomy and BSSO advancement with GP	1
Segment	2
Segment in connection with other osteotomies	
Le Fort I osteotomy with segment	1
BSSO advancement with segment	2
BSSO setback with segment	1
GP with segment	1
Total	99

BSSO = bilateral sagittal split ramus osteotomy of the mandible; segment = anterior subapical segmental osteotomy of the mandible; GP = genioplasty.

laboratory costs. The costs of laboratory tests were also included in this phase. The operation phase included the surgery itself and postoperative treatment in the recovery room. The total inpatient period was assessed.

In estimating the costs of surgery, it was assumed that the operation was performed by 1 surgeon assisted by 2 nurses and that an anesthesiologist and a third nurse were responsible for the anesthesia. The anesthesiologist was also responsible for 1 or 2 additional patients at the same time, which was also considered in the calculations.

The aim of the first part of the analysis was to examine the cost structures. The total annual costs of the activities at the 2 clinics in the fiscal year of 1999 were assessed and used as the basis for the calculations. The final accounting included salaries and social security contributions; the pension fees of the medical and auxiliary personnel; costs of materials and drugs; dental laboratory services; education and training; services provided by other units in the hospital (eg, radiology, instrument care service, rents, electricity, technical service, cleaning, administration); internal interest; and charges for investments.

The costs in phases 1 and 2 were assessed as follows. First, the proportion of total costs allocated specifically to surgical-orthodontic treatment was calculated on the basis of the annual number of visits for surgical-orthodontic treatment in both clinics. These visits were classified into 4 (orthodontics) to 6 (OMFS) different cost categories. This enabled us to calculate individually the outpatient costs of surgical-orthodontic visits when the number of visits of each patient in each category was known. Altogether, there were 343 such visits at the OMFS clinic (16.7% of all visits) and 2,009 at the orthodontics clinic (100% of the visits).

At the time of this study, a comprehensive activity-based type and resource targeting cost analysis was being performed in the central surgical unit, which covered all operations. The mean costs that emerged in the operating room and the recovery room included fixed costs (eg, rents, charges for pharmacy, inhalations, and total supplies) and time-dependent charges for personnel (including salaries with social security contributions). These calculations were used as the cost of each individual orthognathic operation and the entire operative phase.

The costs of the inpatient period were calculated using the day-based invoices sent to the municipalities. These invoices included basically the same cost factors as mentioned above in conjunction with the analysis of outpatient clinic costs. Day-based invoices were considered precise enough for this study, because the nursing care intensity scores (NCI)[4] are constant during the ward period for surgical-orthodontic patients. This index represents the workload caused by each individual patient in the ward. Ninety-two patients (92%) remained in the ward for 3 days and the other 7 stayed for 4 days, including the day of operation.

In the second part of the analysis, the relevant background factors possibly influencing the various costs were then identified as far as possible. This was done by gathering the clinical and cephalometric data that were usually used in patient treatment. The following clinical factors were considered:

1. The intercanine and intermolar distances between the edges of the maxillary and mandibular canines and between the lingual cementoenamel junctions of the maxillary and mandibular first molars were measured from both the pretreatment and the retention cast models to analyze the influence of changes on the width of the dental arches.
2. The number of missing molars (excluding the third molars) was recorded (reflecting the amount of orthodontic anchorage).
3. The number of teeth extracted for orthodontic reasons was recorded, since this was thought to influence the work needed for space closure.
4. The treatment-induced differences between pretreatment and the early retention phase values for overjet and overbite were recorded and analyzed.
5. The problems with fixed appliances were assessed.
6. The number and category of outpatient visits at the OMFS clinic and the orthodontics clinic, as well as the operation time for each individual surgical procedure, were recorded.

Cephalometric (skeletal) analysis was added to the background factor assessment. It was done twice using RMO-Joe software data analysis (Rocky Mountain Company): on the pretreatment lateral cephalograms and on the lateral cephalograms taken during the early retention phase (after the removal of fixed appliances). After a cephalogram is digitized, this program can be used to assess cephalometric data with many different methods; the Ricketts and McGann methods were used in this study. It can also give a definitive cephalometric diagnosis. The differences between the pretreatment and the early-retention-phase cephalometric measurements were recorded and used in the analysis. The skeletal diagnoses are shown in Table 2 and the measured and analyzed cephalometric factors are shown in the "Landmarks used" list.

Landmarks used

A1 inclination to A-Po–line = angle formed by the long axis of the upper incisor to a plane from hard tissue point A to pogonion; describes the position of the upper incisor relative to the mandible and maxilla

B1 inclination to A-Po–line = angle formed by the long axis of the lower incisor to a plane from hard tissue point A to pogonion; describes the position of the lower incisor relative to the mandible and maxilla

Facial depth = angle formed by the planes nasion-pogonion and Frankfort horizontal plane; determines the horizontal relationship of the mandible to the cranium

Interincisal angle = angle formed by the long axes of the upper and lower incisors; describes both the vertical and horizontal dimensions of the occlusion of the incisors

Lower facial height = angle formed by the planes Xi–anterior nasal spine and Xi-pogonion; describes the vertical relationship of the mandible and the maxilla

Maxillary depth = angle formed by the plane nasion–point A and Frankfort horizontal plane; describes the horizontal relationship of the maxilla to the cranium

Nasolabial angle = angle formed by a plane from vermilion superius to subnasale and a plane from subnasale to a tangent point on the inferior border of the nose

Xi = A point located at the geographic center of the ramus (Ricketts).

Statistical testing of the data was done with SAS for Unix, version 8.2, and the data-based analysis was performed with analysis of covariance (ANCOVA) to test the costs of orthodontics, surgery, and inpatient care and the total costs in relation to the different clinical and cephalometric test values mentioned above. ANCOVA accepts different regression-type and classifying factors (eg, type of diagnosis, different orthodontists) into the model at the same time. The outpatient surgery clinic cost was tested first by ANCOVA and then by a regression-type model, because none of the classifying factors were significant. The differences between the various diagnostic and operative groups were tested with analysis of variance (ANOVA) and paired *t* tests. Because of the multiple comparisons, a Bonferroni procedure to correct the *P* values was added.

The correlations between costs in the various phases and the tested clinical or cephalometric values were calculated using Pearson's correlation coefficient if the factors were continuous, and the classifying test factors were analyzed by both Pearson's and Kendall's correlation coefficients. *P* values were regarded as significant when $P < .05$.

Results

An average of 5 outpatient surgical-orthodontic visits per patient were made to the OMFS clinic (range, 2 to 10). In fiscal year 1999, the visits to the OMFS clinic for surgical-orthodontic treatment represented 16.7% of the total number of visits. The costs of these visits made up 17.5% of the costs. The average number of visits per patient to the orthodontics clinic was 26 (range, 11 to 55), but only 24 patients made more than 30 visits, while 1 made more than 40 visits and 1 made more than 50 visits. The majority of these 24 patients had skeletal discrepancies in the vertical dimension: 11 patients had skeletal open bite and 9 had skeletal deep bite. Half of these patients had normal sagittal skeletal relations. Almost all visits and costs recorded at the orthodontic clinic were made for surgical treatment.

The average cost of routine surgical-orthodontic treatment was US$6,206 ± 912 (standard deviation), and the cost distribution of the different phases of treatment is shown in Table 4 and Fig 3. Orthodontic treatment accounted for an average of 39% of the total, ie, US$2,425 ± 600, followed by the surgical operation phase, which amounted to 28% of the total, ie, US$1,708 ± 627. No correlation was found between gender or age and costs. Space closure after tooth extraction raised the orthodontic costs compared to the non-extraction cases ($P = .0015$). There was a positive correlation between the total outpatient costs and overbite (statistically significant, $P = .04$) and a negative correlation between the total outpatient costs and lower facial height (statistically significant, $P = .05$) .

A diagnosis of malocclusion due to the mandible resulted in the cheapest treatment, while open bite was the most expensive condition to treat. Also, the cephalometric skeletal analysis showed that the patients with open bite fell into the most expensive category, as did also the Class III patients, although the differences were not statistically significant. The skeletal diagnostic data were assessed separately in the horizontal and in vertical dimensions, because the subgroups based on the combined skeletal diagnosis were too small to allow statistical evaluation (see Table 2). The inpatient period was cheapest (US$847) for malocclusion due to the mandible and most costly for malocclusions due to the maxilla (US$929) ($P < .01$). There were no other statistically significant correlations between the various test factors and costs.

When the data were assessed from the point of view of the performed operation, malocclusion treated with bilateral sagittal split osteotomy (BSSO) (advancement or setback with or without genioplasty) turned out to be the cheapest procedure (US$5,839), and bimaxillary operations (Le Fort I osteotomy + BSSO, with or without genioplasty) were the most costly (US$7,342) (Fig 4 and Table 5).

Personnel costs, ie, salaries, social security contributions, and pensions, accounted for the major part of the surgical operation costs: 71% of a BSSO, 52% of a Le Fort I osteotomy, and 65% of a bimaxillary operation (Le Fort I/BSSO). The material charges

Table 4 Total costs (mean ± SD) and percentages of costs in various phases of surgical/orthodontic treatment per patient according to clinical diagnosis

Clinical diagnosis	n	Costs per patient (US$)	Orthodontic costs	Surgical costs: Outpatient clinic	Surgical costs: Operation	Surgical costs: Hospital stay
Malocclusion due to the mandible	66	5,935 ± 831	42%	20%	23%	15%
Maloccusion due to the maxilla	13	6,424 ± 695	36%	18%	31%	15%
Malocclusion due to both jaws	9	6,921 ± 543	31%	18%	39%	12%
Open bite deformities	11	7,113 ± 978	36%	17%	35%	12%
Mean total cost		6,206 ± 912	39%	19%	28%	14%

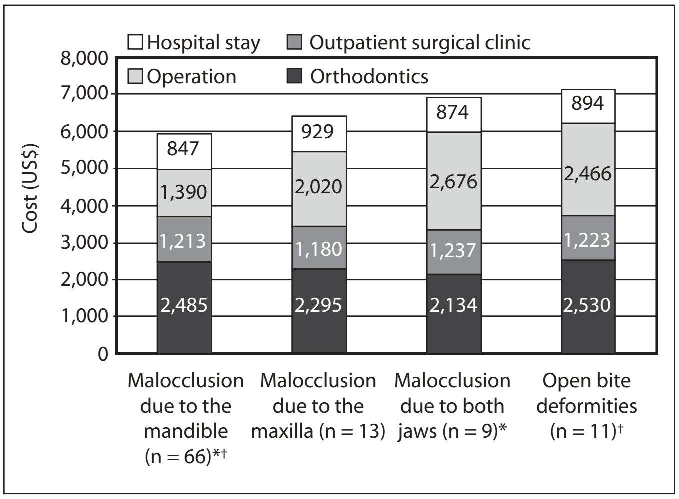

Fig 3 Costs of the different patient groups according to clinical diagnosis in the various phases of treatment (US dollars). * and † = statistical difference, $P < .05$.

for rigid fixation accounted for fewer than 10% of the costs (US$58 for BSSO, US$590 for Le Fort I osteotomy, US$648 for bimaxillary operation). The average actual operation time was 83 min for BSSO, 97 min for Le Fort I, and 178 min for bimaxillary osteotomy. A remarkable proportion of the working time of the operating room team was found to be spent outside the actual operation: 75 min in BSSO and 80 min in Le Fort I osteotomy. This time was not recorded for bimaxillary osteotomies.

Discussion

The Finnish health care system is financed mostly by public funding, while various private insurers cover only a minor portion, approximately 25% of the total costs. It is very uncommon for surgical-orthodontic treatment to be done privately, while adult orthodontics is very often performed by private practitioners. Although most central hospitals in Finland have started to recruit orthodontists into their teams, until now, surgical-orthodontic treatment has often been performed in co-operation by the public and private sectors. Because the cost structures may be so different in these 2 sectors, it was decided that, for the sake of homogeneity, the whole chain of surgical-orthodontic treatment should be assessed within the public health care system, ie, a central hospital.

Table 5 Total costs (mean ± SD) and percentages of costs grouped by various types of 99 orthognathic operations

Clinical diagnosis	n	Costs per patient (US$)	Orthodontic costs	Surgical costs: Outpatient clinic	Surgical costs: Operation	Surgical costs: Hospital stay
BSSO	65	5,839 ± 757*	42%	21%	23%	14%
Le Fort I	12	6,365 ± 690*	37%	18%	30%	15%
Bimaxillary	15	7,342 ± 593*	33%	16%	39%	12%
Segment	2	7,022 ± 1186	40%	22%	26%	12%
Segment + other	5	7,086 ± 641*	29%	18%	40%	13%

*Statistically significant difference ($P < .05$) between BSSO and bimaxillary, BSSO and segment + other, Le Fort I and bimaxillary, Le Fort I and segment + other.
BSSO = bilateral sagittal split ramus osteotomy with or without genioplasty (GP); bimaxillary = BSSO + Le Fort I with or without GP; segment = anterior subapical segmental osteotomy of the mandible (ASSOM); other = BSSO or Le Fort I or GP.

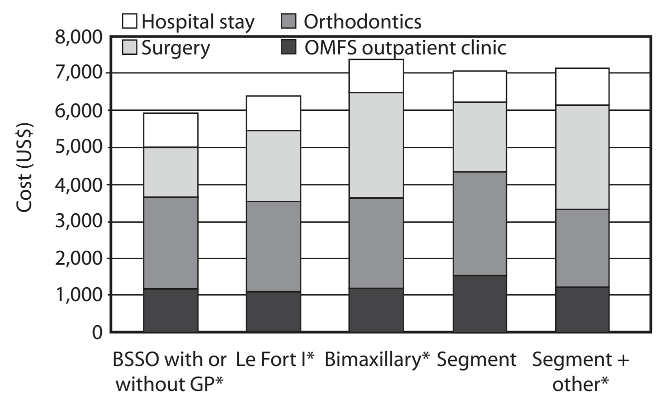

Fig 4 Costs grouped by the various operations. BSSO = bilateral sagittal split osteotomy; GP = genioplasty; bimaxillary = BSSO + Le Fort I osteotomy with or without GP; segment = anterior subapical segment osteotomy of the mandible; other = BSSO, Le Fort I, or GP. *Statistical difference, $P < .05$.

The patients of the present study represented well the basic surgical-orthodontic patient population of this hospital[5] with respect to the diagnoses and surgical operations performed. Patients with re-operations, bone grafting to the osteotomy sites, or major complications, such as bad splits or major bleeding, were excluded from the study because their much higher costs would have distorted the data in the assessment of the costs of ordinary, routine, surgical-orthodontic treatment. The costs of this study for each diagnostic and treatment category were assessed at the 1999 cost level. The treatment principles and routines in orthodontics and surgery, the use of rigid internal fixation, the personnel, and the physical facilities remained unchanged in the participating clinics between 1994 and 2001, which made it possible to use patient data from this period for comparisons. The surgical-orthodontic treatment process in this study was evaluated in 4 phases of treatment. This division was considered natural due to the distinct physical and economic differences between the phases, which have their own budgets and involve work done mostly in different premises. Finnish hospitals are owned by municipalities, and economically, they are nonprofit institutions. This must be kept in mind while comparing the costs of surgical-orthodontic treatment with the costs in the private sector or in other countries.

The costs of the surgical operation phase made up 28% of the total. Since personnel costs make up the greatest portion of the surgical operation costs, the efforts to reduce these costs should be focused on developing the efficiency of teamwork and reducing the waiting times between operations. Cost data from the operation phase showed that BSSO and Le Fort I osteotomies included 75 min and 80 min, respectively, of team time outside the actual operation. This time was spent to prepare the operating room and anesthesia, and it seems rather long. Part of this time is probably due to some waiting for the anesthesiologist to finish his or her other anesthesias in another operating room. However, the team time is the most expensive cost factor in the operating room and should not be wasted. Especially BSSO, with 71% of its costs going to personnel, is a procedure that could be made cheaper with efficient cooperation. Professional education and training should be systematic and continuous.

Although surgical-orthodontic treatment can be considered quite expensive, and the comparisons with other cultures and systems must be made with great prudence, the overall costs found in this study seem to be very moderate compared to the study of Lombardo et al,[3] where the hospital charges alone for BSSO, excluding professional fees, were US$5,023 in 1992. The material charges for rigid internal fixation (RIF) in Le Fort I osteotomy were US$1,400, while in our study they were US$590, ie, 10% of the costs of this type of surgery. One part of the explanation for the difference is the 22% value-added tax deduction for acquisitions, which public health service producers in Finland are allowed to make. In our units, RIF material is not routinely removed, but in places where this is often done, biodegradable materials can be recommended due to the cost savings attainable in the later phase. Biodegradable materials continue to be slightly more expensive than the traditional titanium material, but the proportion of RIF material accounts for only a minor part of the surgery costs.

If the malocclusion could be treated with BSSO only, the costs of total treatment would be less than if the surgery were Le Fort I, segment, or bimaxillary osteotomy. This is a fact that can help pretreatment planning, especially in borderline cases, where several treatment alternatives exist.

The costs of the inpatient periods account for only a minor part of the total costs (14%), but it should be possible to reduce the 3- to 4-day stay safely, as shown by Lombardo et al.[3] Even outpatient surgical-orthodontic treatment seems possible.[6] This would, however, require good cooperation with the anesthesia team to ensure quick recovery after the operation. It was rather surprising that patients with single-jaw maxillary discrepancies required a longer hospital stay than the other groups—longer even than the patients with discrepancy in both jaws. Perhaps this was a result of the greater intra- and perioperative blood loss, which resulted in fatigue.

Open bite deformities were found to be most expensive to treat. None of the cephalometric factors analyzed appeared to have a specific influence on this, but it is well known that these discrepancies often require bimaxillary operations, with all their inherent costs, and are sometimes supplemented by segmentalization of the jaw parts. When possible, one could therefore choose single-jaw surgery instead, usually Le Fort I osteotomy of the maxilla, with good and considerably stable results, as shown in the study by Hoppenreijs et al.[7] Two thirds of their open bite patients were treated with Le Fort I osteotomy.

The orthodontic phase constituted 39% of the costs of surgical-orthodontic treatment. It must be kept in mind that the orthodontic costs are distributed over a 1- to 2-year period. The costs of orthodontics are a result of the many visits (26 on average) needed for the completion of the surgical-orthodontic treatment. However, the cost per visit is cheap compared to the surgical outpatient phase, where the average of 5 visits makes up altogether half of the costs of the orthodontic phase (19% of total costs). Orthodontic visits are often short due to the technical development in, for example, brackets and wires (eg, the straight-wire technique), which helps the materials to retain their activity longer than before. Surgical outpatient visits, on the other hand, include less routine procedures than orthodontics: over half of the visits are made for counseling; planning; examinations (cephalometric analysis, cast model surgery, laboratory tests); and removal of third molars. The costs of these procedures include more chair time, material costs, and internal costs from other departments and cannot be standardized as easily as can visits to the orthodontics clinic.

The majority of high-cost patients had skeletal open or deep bite discrepancies. When these cases were examined more closely, there turned out to be problems with the loosening of the parts of the fixed appliances, especially with deep bite deformities, poor oral hygiene, difficulties in aligning the maxillary canines, and difficulties in closing the remaining open bite after surgery. Patients' cooperation in using maxillomandibular elastics may also be inadequate. Proper and very precise bite closure in surgery is extremely important in open bites and reduces postoperative orthodontic costs.

Space closure after tooth extractions for orthodontic reasons was a factor that seemed to add cost, probably because of the greater time and effort needed to align the arches. This also has been observed in the study of Dowling et al,[8] who found treatments involving extractions to result in significantly increased presurgical and total treatment times. This is an additional factor that speaks for non-extraction treatment whenever possible, eg, nasolabial support is often considered esthetically optimal if extractions of maxillary teeth can be avoided.

Surprisingly, expansion of the arches did not have any direct influence on the orthodontic costs. The number of missing molars, which affects orthodontic anchorage, had a slight but statistically insignificant cost-enhancing effect.

Cain et al[9] recently used a questionnaire to assess the degree of agreement in a larger group of United States orthodontists regarding the criteria they deemed important in determining readiness for mandibular advancement surgery. They concluded that arch compatibility in the transverse dimension, crossbite, and torque of the anterior teeth were important factors to be considered in efforts to minimize cost in time and money. All of these factors were also assessed in the present study. An interesting finding of Cain et al was that more experienced orthodontists tended to rate certain features as more important than orthodontists with less experience, which may also affect costs.

Surgical-orthodontic treatment is a rather expensive way to correct dentofacial malocclusions. Approximately 61% of the costs concern surgery and 39% of costs are for orthodontics. Both of these demand special skills and resources, with their inherent high costs. Presumably, these costs could be reduced with early treatment during growth. Systematic screening of children in health care centers can help to recognize early the patients in need of orthodontics, so that treatment can be started with light and easy equipment.

Of the several clinical and cephalometric measurements of this study, only skeletal open bite and tooth extraction followed by orthodontic space closure were relevant findings that could affect the costs. As far as we know, this is the first survey to examine the whole process of surgical-orthodontic treatment from an economic point of view. Although a comparison with everyday practice in other hospitals—or especially other countries—is difficult, this study roughly outlines the cost structures and the distribution of costs between the various phases. It may also support the logistic quality control of the process itself by critically evaluating the different parts of the treatment chain. In the future, cost-effectiveness assessments could analyze the overall effects and benefits of the surgical-orthodontic process. The basic data of the present study may be helpful when a study of this kind is performed.

It can be concluded that surgical-orthodontic treatment is a rather expensive way to correct dentofacial malocclusions due to the high costs of the surgical phases, which constitute roughly 61% of the costs, 28% of which are due to the surgical operation itself. The average total costs of all the treatments amounted to US$6,206 ± 912. Orthodontics make up approximately 39% of the total costs, due to the long treatment time and numerous visits. Skeletal open bite constituted the most costly diagnostic entity, while malocclusion due to the mandible was the cheapest. If the malocclusion could be treated with BSSO of the mandible only, the costs of total treatment would be lower than with the other types of surgery. Of the several clinical and cephalometric measurements of this study, only skeletal open bite and tooth extraction followed by orthodontic space closure were found to affect the costs.

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