sciendo

DOI: 10.2478/aoj-2014-0016

Severity and outcome assessments of patients undertaking surgical orthodontic treatment

Yilong Zhao* and Peter V. Fowler†

Orthodontic Department, Melbourne Dental School, University of Melbourne, Australia* and Oral Health Centre, Christchurch Hospital, Christchurch, New Zealand†

Background: Combined orthognathic-orthodontic treatment can be lengthy and expensive. It is therefore important to evaluate the effectiveness of proposed treatment and the likely outcomes.

Objectives: To determine the demographic and surgical details of patients who received orthognathic-orthodontic treatment at Christchurch Hospital, New Zealand, and to assess treatment using the Severity and Outcome Index (SOI).

Methods: An observational and retrospective study was conducted of patients who received surgical orthodontic treatment between 2005 and 2012 at Christchurch Hospital. Pre- and post-treatment lateral cephalometric radiographs of 93 patients were evaluated. Seven cephalometric parameters were assessed using the Severity and Outcome Index. A severity score ranged from 0 for the most severe to 7 for the least severe, while the outcome score ranged from 0 for the worst to 7 for the best outcome.

Results: Class II patients had a severity score of 3.4 and the best outcome score of 6.2. Class III patients had a severity score of 3.3 and an outcome score of 6.1. Patients with an anterior open bite (AOB) had the worst severity score of 3.0, and the worst outcome score of 5.9. The overall treatment outcome scores for all groups were statistically significantly greater than the severity scores, which increased from 3.4 to 6.1 ($p < 0.05$).

Conclusions: Favourable outcomes were achieved for a group of patients with a high need for treatment. Christchurch Hospital appeared to be treating cases of increased severity and gained better treatment outcomes when compared with a United Kingdom (UK) national audit.

(Aust Orthod J 2014; 30: 184–191)

Received for publication: November 2013
Accepted: September 2014

Yilong Zhao: yilong.zhao@gmail.com; Peter Fowler: peter@iortho.co.nz

Introduction

For patients with severe dental and skeletal discrepancies, orthodontic treatment combined with orthognathic surgery is often indicated. This combined approach usually commences with orthodontics to align the dentition and to remove unfavourable dental compensations. Surgery involving the maxilla, mandible, or a combination of both, is performed to correct the underlying dentofacial deformity. A post-surgical orthodontic phase corrects any remaining occlusal or aesthetic discrepancies. This type of combined surgical-orthodontic treatment can be lengthy and expensive. It is therefore important for clinicians and health care providers to evaluate the effectiveness of proposed treatment based on current research of outcomes. To date, there has been no quantitative evaluation of treatment outcomes for patients receiving combined surgical and orthodontic care in New Zealand, nor is there evidence suggesting that the outcomes of the treatment are comparable with overseas treatment centres.

In 2002, Kennedy conducted a UK National Audit[1] of surgical orthodontic treatment. A Severity and Outcome Index (SOI) was developed using seven cephalometric measurements which described the pretreatment case severity and treatment outcome for patients undertaking surgical-orthodontic treatment. Kennedy's study involved a retrospective assessment of 566 surgical orthodontic patients and reported the demographic details, the severity of the different

presenting malocclusions and the surgical orthodontic treatment outcomes. The British Orthodontic Society later employed the Severity and Outcome Index as its main vehicle for assessing surgical orthodontic cases[2] managed within the National Health Service.

The present study aimed to determine the demographic details of patients who received combined surgical and orthodontic treatment at Christchurch Hospital, the type and duration of the orthognathic surgery undertaken, and to assess the treatment outcomes for these patients using the Severity and Outcome Index.

Materials and method

Patient selection and exclusion

This observational retrospective study examined pre- and post-treatment lateral cephalometric images of patients who received combined orthodontic and surgical treatment at Christchurch Hospital between January 2005 and December 2012. The names of all subjects who experienced orthognathic surgery during the study period were obtained from the hospital's operating lists. The age at surgery, gender, ethnicity, indication for surgery and details of the surgical procedures performed were recorded in Excel 2007 (Microsoft, WA, USA).

Of the 93 subjects initially identified, eight were excluded because of facial asymmetry or a transverse skeletal anomaly. These cases were considered inappropriate for the Severity and Outcome Index Assessment, which measures anterior-posterior and vertical discrepancies only. A further eight subjects were excluded because their pre- or post-treatment lateral cephalometric images were either of poor quality or missing. One patient who undertook orthognathic surgery without any orthodontic treatment and two patients who required two-stage surgical procedures but had only completed their first course of surgery were also excluded. Of the remaining 74 patients, 55 (74%) had their orthodontic treatment provided by hospital orthodontists and the other 19 (26%) by local private orthodontists. As this was a retrospective observational study using existing treatment records, no ethical approval was required but consent was obtained from the patients for the use of their records.

Severity and Outcome Index (SOI)

The Severity and Outcome Index[1] was used in the present study to assess the main skeletal, dental and soft tissue features which were considered important in cases planned for orthognathic surgery. The three skeletal measurements were ANB, SNB and the lower face height percentage. The three dental components were overjet, overbite and the angle of the upper central incisors relative to the maxillary plane, while the Holdaway angle[3,4] was used for the single soft tissue analysis. The seven parameters were used by the SOI to facilitate comparisons of key skeletal, dentoalveolar and soft tissue assessments.

The initial severity of the patient was assessed by the number of key parameters which fell outside of two standard deviations of the normal mean. Each parameter was scored with a zero if the measurement exceeded two standard deviations of the mean, and scored one if the parameter was within two standard deviations. Totalling the scores of the seven parameters produced an overall score for the case (minimum score = 0, maximum score = 7). The lower the total severity score, the more severe the case. The outcome scores for patients were determined using the same method and the more favourable the outcome, the higher the outcome score. Both the severity and outcome scores were recorded on the Severity and Outcome Assessment form (Table I).

Tracing and re-tracing

The lateral cephalometric radiographs were a mixture of hard-copy films or digital renditions. All were carefully calibrated using a mounted 50 mm ruler embedded in the mid-sagital nasion-positioning device of the cephalostat. An orthodontic consultant measured all of the pre- and post-treatment radiographs in a randomised order with no more than 10 radiographs measured per day. Hard-copy lateral cephalograms were assessed using digital calipers and a cephalometric protractor on an acetate tracing. The measurement tools within InteleViewer software (version 2.0, AirVisual Inc, NY, USA) were used for the digital lateral cephalograms. The pre- and post-treatment cephalometric radiographs of 10 randomly selected patients were retraced to check for errors of landmark identification and measurement. The intra-class correlations of all measurements were tested with each of the seven parameters for the Severity and Outcome Index with a score greater than 0.8, and were indicative of good agreement. The intra-rater weighted Kappa was tested with a pretreatment score of 0.76 and a post-treatment score of 0.68,

Table I. Severity and Outcome Assessment form.

Measurement	Acceptable range	Within range? (Yes = 1 or No = 0)
ANB	-1° to 7°	
SNB	72° to 84°	
LAFH%	51% to 59%	
OJ	1.3 mm to 5.3 mm	
OB	0.8 mm to 6.8 mm	
UI/Mx	97° to 121°	
Holdaway	7° to 14°	
Severity/Outcome Score = Total number of Yes grades		

Table II. Orthognathic surgical procedures performed by year of surgery and the average operating time required.

Type of operation/ Procedures	Average length of surgery (Mins)	Grafts		Years								Total	%
		Iliac	Medpore	2005	2006	2007	2008	2009	2010	2011	2012		
BSSO (advancement)	252	4	1	2	2	4	2	1	3	3	3	20	17
BSSO (setback)	196			2	1	1		1	2		2	9	9
LeFort1	222	2		3	2	1	1	6	4	3	3	23	21
SARPE	123						5	2	7	1	1	16	14
Class II Bimaxillary osteotomy	338		1	2		2			1	2	4	11	9
Class III Bimaxillary osteotomy	361	1		2	1	1	2	3	4	1	3	17	14
Revisions	123							1			1	2	2
Distraction osteogenesis (Max)	234			1					4			5	5
Distraction osteogenesis (Mand)	214								1		1	2	2
Distractors removal	87			1					4	1	1	7	6
Genioplasty	95										2	2	1
Total		7	2	13	6	9	10	14	30	11	21	114	
Adjunct genioplasty				3	2	2	2	1	6	3	8	27	

BSSO, Bilateral sagittal split osteotomy
SARPE, Surgical-assisted rapid palatal expansion

both of which indicated good strength of agreement. No inter-rater reliability was calculated as only one assessor conducted the measurements.

Statistical analysis

The collected data was subjected to statistical analysis using the PASW statistical software package (version 21.0, SPSS, CHI, USA).

Results

Demographic data: of the 74 patients, 33 (45%) were female and 41 (55%) were male. The average age of all patients at the time of surgery was 21.3 (SD = 4.0). The majority (N = 68) of patients were European (92%), while a small number (N = 4) were Asian (5%), one Maori and one Pacific Islander (3%). The majority (N = 61) of the patients had an unremarkable medical background (82%), while the remaining patients (N = 13) had a cleft lip/palate, a craniofacial syndrome or a combination of both (18%).

Surgical data: a summary of the different types of orthognathic surgical procedures, the average time for each procedure, and the yearly surgical totals undertaken from January 1, 2005 to December 31, 2012 is listed in Table II.

The patients were grouped by their pretreatment incisor classification as defined by the British Standards

Institute[5] for a more detailed analysis. The majority were either Class II (N = 30) or Class III (N = 40) and the remainder (N = 4) Class I. Those patients who were identified with an associated anterior open bite of 3 mm or more[6] (N = 14) from within these incisor relationship classifications, were grouped for more detailed analysis.

Class I incisor relationship patients

Only four patients were classified with a Class I incisor relationship of equal gender distribution. The mean age was 22.9 years with a minimum age of 18.5 years and a maximum age of 30.5 years. Two (50%) patients were identified with an anterior open bite and the other two patients received surgical orthodontic treatment due to severe obstructive sleep apnoea (N = 1) and malocclusion caused by previous bilateral condylar fractures (N = 1). Due to the low number in this group (N = 4), no further in-depth analysis was performed.

Class II incisor relationship patients

There were 30 Class II patients of which 14 (47%) were female and 16 (53%) were male. The mean group age was 21.5 years with a range of 16.6 years to 36.6 years at the time of surgery. Four patients (13%) had an associated anterior open bite and one patient had a craniofacial syndrome.

Each of the seven cephalometric parameters was assessed separately (Table III). The number of patients with measurements within two standard deviations of the normal mean was recorded pre- and post-treatment and the percentage changes calculated. For Class II patients, the greatest change was seen in overjet (76.7%) and overbite (60%). Four (13.3%) patients had their pretreatment overjet within the mean ± 2 SD while a total of 27 (90%) patients had their post-treatment overjet within the mean ± 2 SD. Ten (33.3%) patients had their pretreatment overbite within the mean ± 2 SD while a total of 28 (93.3%) patients had their post-treatment overbite within the mean ± 2 SD. The smallest changes were noted for lower facial height percentage (6.7%).

The surgical procedures undertaken for Class II patients were mandibular advancement (bilateral sagittal split osteotomies, BSSO, 53.3%), bimaxillary osteotomies (33.3%) or maxillary impactions (13.3%). The mean overjet pretreatment was 11.7 mm and the mean overjet post-treatment was 3.9 mm (Table IV).

Class III incisor relationship patients

There were 40 (54.1%) Class III patients of which 17 (42.5%) were female and 23 (57.5%) were male. Four patients (10%) were Asian, 12 patients (30%) had a cleft lip/palate, a craniofacial syndrome (or a combination of both) and eight patients (20%) had an associated anterior open bite. The mean age was 21.7 years with a range of 16.8 to 35.2 years at the time of surgery.

The number of patients with measurements within two standard deviations of the normal mean was recorded for pre- and post-treatment (Table III) and the percentage change was calculated. For Class III patients, the greatest change was for overjet (90%) and the ANB angle (60%). Four (10%) patients had their pretreatment overjet within the mean ± 2 SD, while all (100%) patients had their post-treatment overjet within the mean ± 2 SD. The smallest change was noted in the angle of the upper central incisors relative to the maxillary plane (-5%).

The surgical procedures undertaken for the Class III patients were maxillary advancements (40%), bimaxillary osteotomies (37.5%) or a setback BSSO (22.5%), with five patients undergoing distraction osteogenesis in the maxillary advancement subgroup (Table IV). The mean overjet pretreatment was -3.6 mm and the mean overjet post-treatment was 2.9 mm.

Anterior open bite patients

There were 14 (19%) patients with an anterior open bite of which six (43%) were female and eight (57%) were male. The mean age was 22.9 years with a range of 17.4 to 31.0 years at the time of surgery. Two (14%) patients had a Class I malocclusion, four (29%) a Class II malocclusion and eight (57%) a Class III incisor relationship. Three patients (21%) had a cleft lip/palate, a cranial facial syndrome or a combination of both.

The number of patients with measurements within two standard deviations of the normal mean was recorded for pre- and post-treatment (Table III) and the percentage change was calculated. For AOB patients, the greatest change produced improvement in anterior open bite (92.9%) and overjet (71.5%).

Table III. Percentage of all patients with parameters within 2 SD in each category.

	Parameters	Pretreatment	Post-treatment	Difference between pre- and post-treatment
Class II (N = 30)	ANB	46.7%	96.7%	50.0%
	SNB	83.3%	93.3%	10.0%
	LAFH	80.0%	86.7%	6.7%
	OJ	13.3%	90.0%	76.7%
	OB	33.3%	93.3%	60.0%
	UI/Mx	53.3%	90.0%	36.7%
	Holdaway	30.0%	70.0%	40.0%
Class III (N = 40)	ANB	32.5%	92.5%	60.0%
	SNB	67.5%	77.5%	10.0%
	LAFH	75.0%	95.0%	20.0%
	OJ	10.0%	100.0%	90.0%
	OB	35.0%	92.5%	57.5%
	UI/Mx	82.5%	77.5%	-5.0%
	Holdaway	30.0%	65.0%	35.0%
AOB (N = 14)	ANB	42.9%	85.7%	42.8%
	SNB	64.3%	64.3%	0.0%
	LAFH	50.0%	85.7%	35.7%
	OJ	21.4%	92.9%	71.5%
	OB	0.0%	92.9%	92.9%
	UI/Mx	71.4%	100.0%	28.6%
	Holdaway	50.0%	57.1%	7.1%

No patient had their pretreatment open bite within the mean ± 2 SD, while a total of 13 (92.9%) patients had their post-treatment overbite within the mean ± 2 SD. The smallest change was seen in the SNB angle (0%).

The surgical procedures used for the AOB patients were bimaxillary osteotomies (57.1%), maxillary osteotomies (28.6%) or a setback BSSO (14.3%). The mean overbite pretreatment was -4.7 mm, and the mean overbite post-treatment was 1.6 mm. In the maxillary subgroup, there were three cases of maxillary impaction with or without advancement and one case requiring distraction osteogenesis (Table IV).

Comparison of the Severity and Outcome Index for different groups

A comparison of the Severity and Outcome scores demonstrated that Class II patients had a Severity Score of 3.4 (SD = 1.2) and the best Outcome Score of 6.2 (SD = 0.9). Class III patients improved from a Severity Score of 3.3 (SD = 1.2) to an Outcome Score of 6.1 (SD = 0.9). AOB patients had the lowest Severity Score of 3.0 (SD = 1.6) and the worst outcome score of 5.9 (SD = 0.8). There were no statistically significant differences between the scores of males and females. The Severity Scores were 3.5 and 3.4 respectively, and the Outcomes Scores were 6.2 and 6.0 respectively. The overall treatment Outcome Score of all groups was statistically significantly greater than the Severity Score which changed from 3.4 (SD = 1.3) to 6.1 (SD = 0.9) ($p < 0.05$) (Table V).

Kennedy[1] determined that the criterion for a successful outcome was a score of 6 or 7. There were 21 (70%) Class II, 31 (78%) Class III and 10 (71%) AOB patients in the present study who met this criterion.

Discussion

The present study investigated the demographic and surgical data of patients who received combined surgical and orthodontic care at Christchurch Hospital and specifically evaluated the caseload, treatment standards and cephalometric changes of treatment.

Table IV. Surgical procedures undertaken for patients from all three groups.

Surgical procedure	Number of cases and percentage	Pre overjet		Post overjet		Operating time (Mins)	Number of nights stayed in hospital
		Mean	Range	Mean	Range		
Class II:							
Advancement BSSO	16 (53.3%)	13.3	6.0 to 18.8	3.9	2.1 to 6.3	256.8	2.3
Maxillary impaction	4 (13.3%)	7.6	5.0 to 11.7	3.9	2.0 to 6.3	257.0	2.5
Bimaxillary osteotomy	10 (33.3%)	11.0	4.8 to 17.0	3.9	2.0 to 5.7	324.3	2.9
Overall	30 (100%)	11.7	4.8 to 18.8	3.9	2.0 to 6.3	279.3	2.5
Class III:							
Setback BSSO	9 (22.5%)	0.2	-2.0 to 2.0	2.8	1.5 to 4.0	207.2	2.2
Maxillary advancement	16 (40.0%)	-4.3	-17.0 to 1.6	2.9	2.0 to 5.0	205.1	2.1
Bimaxillary osteotomy	15 (37.5%)	-5.0	-12.0 to 1.9	3.0	2.0 to 4.9	361.5	2.7
Overall	40 (100%)	-3.6	-17.0 to 2.0	2.9	1.5 to 5.0	264.2	2.4
AOB:							
Setback BSSO	2 (14.3%)	-6.0	-8.0 to -4.0	2.0	2.0 to 2.0	228.5	2.0
Maxillary	4 (28.6%)	-4.1	-7.0 to -3.0	1.2	-0.5 to 2.5	211.3	2.9
Bimaxillary osteotomy	8 (57.1%)	-5.1	-6.9 to -3.7	2.1	1.0 to 2.8	377.8	2.8
Overall	14 (100%)	-4.7	-8.0 to -3.0	1.6	-0.5 to 2.8	308.9	2.7

The results compared favourably with a UK national audit and suggested acceptable treatment outcomes were achieved for a group of patients exhibiting a high need for treatment.

Previous studies[7,8] suggested that women were twice as likely to seek evaluation for surgical-orthodontic treatment compared with men and the decision to accept or reject treatment did not appear to relate to the severity or type of malocclusion. In the current audit, 55% of the surgical population were male and 45% were female, which may be a reflection that the severity of the presenting malocclusion was the primary determinant of treatment acceptance. The present study used Caucasian norms of lateral cephalometric measurements for all patients, but there was a small proportion of Asians (N = 4), Maori (N = 1) and Polynesians (N = 1) in the study population. Since the Severity and Outcome Index only scores measurements outside two standard deviations of the normal values, it could be assumed that differences between ethnic norms would be of minor consequence to the Index score.

A mandibular advancement BSSO was the most frequently used surgical approach for Class II correction (53.3%). Maxillary impaction was performed in carefully selected patients who presented with an AOB and a mild overjet (13.3%). A bimaxillary osteotomy approach was used for more complicated cases resulting in the longest operating time (324.3 minutes on average) and generally required a longer stay in hospital (2.9 nights on average). Sixteen Class III patients (40%) were treated with a maxillary advancement alone and 15 patients (37.5%) were treated with bimaxillary osteotomies. There were no significant differences in pretreatment overjet (-4.3 mm and -5.0 mm, respectively) and post-treatment overjet (2.9 mm and 3.0 mm, respectively). The mandibular setback BSSO procedure (N = 9) was undertaken on selected patients (22.5%) in whom the initial reverse overjet was mild (0.2 mm on average) and the patency of the airway would not be compromised. It appeared that after surgical orthodontic treatment, fewer patients (a decrease from 82.5% to 77.5%) had the maxillary incisor angle (UI/Mx) within the mean ± 2 SD. Since all Class III patients had an acceptable level of overjet post-treatment (within the mean ± 2 standard deviations), it was likely that, in the final orthodontic phase, the maxillary incisor angle increased as a result of possible surgical relapse in conjunction with the maintenance of a favourable overjet. AOB patients were distributed within all three incisor relationship groups; however, the majority were associated with the Class III group

Table V. Severity and Outcome Scores of different groups.

		Number of cases and percentage	Severity Score		Outcome Score	
			Average	SD	Average	SD
Incisor groups	Class II	30 (40.5%)	3.4	1.2	6.2	0.9
	Class III	40 (54.1%)	3.3	1.2	6.1	0.9
	AOB	14 (18.9%)	3.0	1.6	5.9	0.8
Gender	Male	42 (55.4%)	3.5	1.2	6.2	0.9
	Female	33 (44.6%)	3.4	1.4	6.0	1.0
All		74 (100.0%)	3.4	1.3	6.1	0.9

Table VI. Comparison of Christchurch and UK Audit Severity and Outcome Score.

		Christchurch Hospital		UK
		Frequency	Percentage	Percentage
Severity score	1 or less	6	8%	3%
	2 or less	15	20%	16%
	3 or less	38	51%	41%
	4 or less	61	82%	69%
	5 or less	69	93%	92%
	6 or less	74	100%	100%
Outcome score	7	31	42%	20%
	6 or above	55	74%	52%
	5 or above	69	93%	80%
	4 or above	74	100%	91%

(57%). Due to the complicated nature of anterior open bite correction, the bimaxillary osteotomy approach was the most frequently used (57.1%). All three groups in the study achieved a favourable correction and outcome of their anterior open bite.

The Severity and Outcome Index scores of the three groups (Class II, Class III and AOB), indicated that the AOB group had the worst Severity Score and also the worst Outcome Score. However, the level of improvement achieved (difference between Outcome Score and Severity Score) in all groups was similar (2.8, 2.8 and 2.9, respectively). The UK National Audit presented a mean Severity Score of 3.8 and a mean Outcome Score of 5.4. The patients treated at Christchurch Hospital revealed a mean Severity Score of 3.4, which indicated increased severity, and a mean Outcome Score of 6.1, indicating a more favourable outcome. Of the patients seen at Christchurch Hospital, 82% had a Severity Score of 4 or less, compared with 69% of the UK patients. In addition, 42% of the Christchurch patients scored an Outcome Score of 7 compared with 20% of patients in the UK audit (Table VI). This finding could be attributed to the fact that 8% of the UK National Audit patients presented with a cleft and/or craniofacial syndrome. Cleft and syndromic patients comprised 18% of the sample in the present study (N = 13).

In February 2011, Christchurch was affected by a significant earthquake and numerous aftershocks, resulting in severe damage to many buildings including the Hospital Oral Health facility. Access to these buildings was denied and many clinical records were lost. A patient from the present study died in the earthquake and several moved overseas before their review appointments. Record collection and collation was rendered extremely difficult and resulted in inconsistent periods between surgery and the selected post-treatment cephalometric radiograph for individual patients. This perhaps created bias in the present results as 48 patients (65%) had their post-

operative radiographs taken within 12 months of their surgery while the remainder (35%) had their post-operative radiographs after 12 months but no longer than 24 months post-surgery. The majority of patients with incomplete data came from private orthodontic practices as a result of practice transition and the earthquake. An agreed protocol between the Hospital and private practices should be established for future research. As technology advances, the availability of digital lateral cephalograms should enable easier access and safer storage of key information.

Combined surgical-orthodontic treatment is heavily subsidised at Christchurch Hospital. With the limited resources currently available, it is important to ensure that the most severe cases are targeted and provided treatment is beneficial. The Severity and Outcome Index is a relatively simple, effective and internationally recognised assessment method that only requires pre- and post-treatment lateral cephalograms. The standardised protocol enabled the results from the present study to be compared with similar audits and to assess the treatment standard with that in the UK. The index is consistent in identifying severe cases and considers changes in all three malocclusion classes (skeletal, dental and soft tissue). The Holdaway angle is the only soft tissue analysis in SOI and it generally complements the hard tissue analysis. An assessment of soft tissue aesthetics is complex and highly subjective, which makes the use of a single sagittal angular measurement to reflect the patient aesthetics problematic. Furthermore, the SOI does not have the ability to measure transverse discrepancies, facial asymmetries, and detailed occlusal deficits. It also does not assess the quality of treatment result related to occlusal, aesthetic or self-reported quality of life outcomes. Future outcome studies should incorporate additional qualitative and quantitative measures (e.g. PAR index and OHIP-14) to complement the Severity and Outcome Index in treatment outcome assessment for orthognathic patients.

Conclusions

- The mean pretreatment Severity Score for patients presenting for surgical-orthodontic treatment was 3.4 and the post-treatment Outcome Score was 6.1.
- AOB cases, on average, were the most severe and were associated with the worst treatment outcomes, although 93% of AOB cases had their post-treatment overjet and overbite within an acceptable range.
- Class II cases, on average, were the least severe and obtained the best treatment outcomes. The overjet following treatment was within an acceptable range in 90% of cases.
- Although all Class III cases completed treatment within an acceptable range of overjet, maxillary incisor angulation remained proclined beyond 2 SD in 22% of cases. The Class III group was the most successfully treated after a consideration of the number of patients with an Outcome Score of 6 or 7.
- More consistency related to post-treatment review is required. An agreed protocol between a hospital and private practice to ensure that records are accessible will benefit future analyses.

Corresponding author

Dr Peter Fowler
Oral Health Centre
Christchurch Hospital
Christchurch
New Zealand

Email: peter@iortho.co.nz

References

1. Kennedy D. An investigation of initial presentation and treatment outcomes for patients with dentofacial deformity who require surgical orthodontic treatment. Submitted as an M.Phil thesis Sept 2002. Queens University of Belfast.
2. Johnston C. Severity and Outcome Assessment for Surgical-Orthodontic cases – A proforma developed by the Clinical Effectiveness Committee of the British Orthodontic Society 2004.
3. Holdaway RA. A soft-tissue cephalometric analysis and its use in orthodontic treatment planning. Part I. Am J Orthod 1983;84:1-28.
4. Holdaway RA. A soft-tissue cephalometric analysis and its use in orthodontic treatment planning. Part II. Am J Orthod 1984;85:279-93.
5. British Standard Classification of Malocclusion. British Standard Institute, London 1982: BS4492.
6. Lopez-Gavito G, Wallen TR, Little RM, Joondeph DR. Anterior open-bite malocclusion: a longitudinal 10-year postretention evaluation of orthodontically treated patients. Am J Orthod 1985;87:175-86.
7. Proffit WR, White RP Jr. Who needs surgical-orthodontic treatment? Int J Adult Orthodon Orthognath Surg 1990;5:81-9.
8. O'Brien K, Wright J, Conboy F, Appelbe P, Bearn D, Caldwell S et al. Prospective, multi-centre study of the effectiveness of orthodontic/orthognathic surgery care in the United Kingdom. Am J Orthod Dentofacial Orthop 2009;135:709-14.