

Severity and Outcome Assessment score: a useful tool for auditing orthognathic surgery

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Abstract

Many indices and scoring systems exist for assessing skeletal patterns and malocclusion but none have been universally adopted by teams providing orthognathic surgery in the UK. Using a standardised objective measure of a patient's condition is important both for service provision, treatment allocation, and other clinical governance domains. The Severity and Outcome Assessment tool (SOA) developed by the British Orthodontic Society (BOS) and British Association of Oral and Maxillofacial Surgeons (BAOMS) provides a standardised method of assessing patients throughout the orthognathic pathway and lends itself to case selection, resource allocation and auditing treatment outcomes. The SOA uses 7 cephalometric skeletal, dental and soft tissue measures to produce an overall score. The SOA has been used by the current NHS Tayside orthognathic team since August 2006 to audit treatment outcomes. While we recognise that cephalometric analysis forms only one part of orthognathic treatment we believe that having an objective measure on which to assess treatment is useful. We present our experience of using this quick, simple and reproducible tool in auditing orthognathic treatment outcomes.

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Introduction

The Index of Orthodontic Treatment Need (IOTN) is widely used in the assessment of malocclusion, and for the allocation of resources.¹ The Index of Orthognathic Functional Treatment Need (IOFTN) was developed to prioritise the treatment of severe malocclusions that are not amenable to orthodontic treatment alone.² Other indices and scoring systems exist,^{3–5}

but none has been universally adopted by orthognathic surgical teams. The Severity and Outcome Assessment (SOA) tool, which was developed by the British Orthodontic Society (BOS) and British Association of Oral and Maxillofacial Surgeons (BAOMS) after a national audit of Class II and III malocclusions,^{6–8} provides a standard cephalometric assessment of patients throughout their treatment, as well as data for clinical governance. It assesses seven variables that are predictive of outcome, and assigns one point for each that is within 1SD of the Eastman standard values, and zero for those outside. The sum of these provides an overall score that ranges from zero to seven. There are two measurements of skeletal anterior-posterior projection (SNA and ANB angles); two dental measurements (overjet, and the inclination of the

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Table 1

Variables included in the Severity and Outcome Assessment (SOA) tool (severity score = total number of measurements within the standard range).

Measurement	Standard range
ANB	−1° to 7°
SNA	72° to 84°
LFH%	51% to 59%
Overjet	13 mm to 5.3 mm
Overbite	0.8 mm to 68 mm
UI/max	97° to 121°
Holdaway angle	7° to 14°

UI/max = inclination of the maxillary incisor to the maxillary plane; LFH% = percentage lower face height to overall face height.

maxillary incisor to the maxillary plane: UI/Max); two vertical measurements (overbite, and the percentage lower face height to overall face height: LFH%), and one of soft tissue anterior-posterior projection (Holdaway angle, defined as the angle of the soft-tissue nasion to the soft-tissue pogonion to the labrale superius) (Table 1).

The NHS Tayside orthognathic service was redesigned in 2006 to include a consultant orthodontist and consultant maxillofacial surgeon who assess and plan all cases. The SOA is used at initial assessment, during preoperative planning, and at postoperative review, in all patients. We describe our experience of its use in the first 181 routine orthognathic cases, and relate the SOA data to existing clinical outcomes.

Patients and methods

All 181 patients who had orthognathic surgery in NHS Tayside between August 2006 and December 2014 were initially included. Treatment comprised a period of preoperative orthodontic decompensation with fixed appliances followed by operation and a further period of orthodontic finishing. The same consultant oral and maxillofacial surgeon did all the operations, which included standard sagittal split mandibular osteotomy, Le Fort I osteotomy, and genioplasty, as required. Patients who had orthognathic surgery without preoperative and postoperative orthodontics (n = 8), malocclusion resulting from trauma (n = 1), previous cleft palate (n = 1), or operation for condylar hyperplasia (n = 1), were excluded. This left 170 patients.

Lateral cephalograms of each patient were taken using a standard protocol at four time points: the start of treatment, immediately preoperatively, immediately postoperatively (within two weeks) and two years postoperatively. The start and end of treatment were defined as the dates of orthodontic bonding and debonding, respectively. Digital radiography was installed at units across the area after some patients had started treatment. Any film radiographs were scanned and, together with digital images, converted to 600 dpi JPEG images for analysis. These were uploaded into the OPAL (www.opalimage.co.uk) lateral cephalometric prediction software program and traced manually. The SOA scores were automatically calculated for each patient before the start

of treatment, immediately before and after operation, and two years postoperatively. A score was also calculated for the treatment plan.

Of the 170 patients, 18 had missing data and were therefore excluded, which left 152 for final analysis. Most of the missing data related to film radiographs. A small number of patients did not attend the two-year review.

Other data collected were age at operation, sex, British Standards Institute incisor classification before operation (British Standard 4492), presence of an anterior open bite (AOB), presence of transverse asymmetry, type of operation, and whether surgical plates were removed during the two years after operation. Treatment variables measured were overall duration of treatment, duration of each stage, and duration of operation.

Data were collected using Excel (Microsoft) and analysed with the help of IBM SPSS Statistics for Windows version 22 (IBM Corp).

Statistical analysis

To assess intraobserver reproducibility, we redigitised 25 lateral cephalograms on two separate occasions one month apart using the same technique.⁹ Random and systematic error were calculated using the Dahlberg formula,¹⁰ a two-sample *t* test and Cohen's kappa, respectively. The level of significance for the systematic error was $p < 0.05$. The weighted kappa coefficient was 0.89.

We used descriptive statistics to summarise the whole sample, then calculated the improvement in the SOA score for each patient from the start of treatment to two years after operation. Before treatment, patients were analysed in groups according to their incisor classification, sex, AOB, degree of asymmetry, and operation. We used Mann-Whitney *U* tests ($p < 0.05$) to assess the significance of differences between groups with two variables – for example, sex, AOB, and asymmetry; and Kruskal-Wallis tests ($p < 0.05$) to assess those with more than two – for example, incisor classification, and operation.

Results

Random error and systematic error were both less than 0.5 degrees and $p < 0.05$, respectively. Of the 152 patients, 40 were male and 112 female (mean age 26 (SD 9.83) years). Before treatment two had a Class I skeletal pattern (treated for anterior open bite), 61 had Class II, and 89 had Class III malocclusions.

Forty-eight patients had an AOB and 35 had transverse asymmetry. In the AOB group, 14 were Class II and 33 Class III. In the asymmetry group only 4 had Class II, while 32 had Class III malocclusions. This difference was significant ($p < 0.005$).

Most patients had a bimaxillary osteotomy while a minority required segmental maxillary surgery (Table 2).

SOA scores (Table 2)

The mean SOA score at the start of treatment was 3.27. At two years postoperatively it was 5.70, a mean improvement of 2.43. Differences in the scores for incisor classifications between these times were not significant.

At the start of treatment, patients with an AOB had a lower SOA score than those without, although the difference was not significant. There was a similar pattern in patients with transverse asymmetry. Scores at the start of treatment, and at two years after operation, were worse in patients with asymmetry than in those without, but not significantly so.

By the end of treatment SOA scores were slightly higher in women than in men, but again, not significantly so.

Patients who were planned to have osteotomies of the mandible alone had the highest postoperative SOA score (6.10), but they also had the highest score at the start of treatment.

The best overall improvement in SOA (2.64) was in those who had procedures that involved segmental osteotomy of the maxilla. The difference in the final score between the different surgical planning groups was significant (p=0.03).

Removal of plates (Table 2)

Of the 152 patients, 25 (six men and 19 women) had plates removed within two years of operation. These were removed secondary to local pain, infection, or exposure of metalwork, and most were removed from the mandible (17 patients). The mean time from operation to removal was one year and one month. The mean improvement in SOA score for patients who had a plate removed was 1.88 compared with 2.54 in those who did not. Despite the seemingly negative effect of removal on the score, the difference between the groups was not significant.

Planned and actual outcomes (Table 2)

There were no significant differences between planned outcomes for any of the groups. Comparison between the planned and overall final scores showed that the final scores fell short of the planned scores by 0.25, and this difference was significant (p=0.03).

Duration of treatment

The mean duration of treatment (defined as orthodontic bonding to debonding) was 1097 days (3 years and 1 day). Treatment in men took around 128 days longer than it did in women, and this difference was significant (p=0.05). There was no significant difference in the time taken to treat any of the other groups.

Table 2
Severity and outcome (SOA) scores.

Group	No. of patients	SOA start	p value	SOA 2-years postoperatively	p value	Improvement in SOA	Planned	p value	Planned cf final	p value
Overall	152	3.27	-	5.70	0.28	2.43	5.95	-	-0.25	0.03
Class I	2	4.00	0.61	5.50		1.50	6.00	0.96	-0.50	0.24
Class II	61	3.31		5.85		2.54	5.90		-0.05	
Class III	89	3.22		5.61		2.38	5.99		-0.38	
AOB	48	3.13	0.24	5.38	0.20	2.25	5.79	0.15	-0.42	0.29
No AOB	104	3.34		5.86		2.52	6.03		-0.17	
Asymmetry	35	3.20	0.62	5.43	0.07	2.23	5.89	0.55	-0.46	0.25
No asymmetry	117	3.29		5.79		2.50	5.97		-0.19	
Male	40	3.30	0.91	5.45	0.15	2.15	5.88	0.68	-0.43	0.49
Female	112	3.26		5.79		2.54	5.98		-0.19	
Mandible only	30	3.70	0.20	6.10	0.03	2.40	6.07	0.31	0.03	0.07
Maxilla only	19	2.89		5.21		2.32	5.47		-0.26	
Bimaxillary	89	3.22		5.66		2.44	6.02		-0.36	
Multi-segment maxilla	14	3.14		5.79		2.64	5.92		-0.08	
Plate removed	25	3.64	0.19	5.52	0.54	1.88	6.12	0.47	-0.60	0.32
No plate removal	127	3.20		5.74		2.54	5.92		-0.18	

Cf = compared with; AOB = anterior open bite.

Discussion

The 2002 BOS national audit¹¹ calculated SOA scores that were based on cephalograms from six consecutive cases submitted by each unit that provided surgical orthodontic treatment in the UK. While the mean severity score in the UK was 3.8, the group in our study had a slightly worse starting point of 3.27. Despite this, our mean outcome score of 5.95 was better than the national score of 5.4, and our mean improvement of 2.43 was also better than the national score of 1.6. It is also interesting to compare our results with those in a subsequent New Zealand study of 74 patients in which the SOA score rose from 3.4 at the start of treatment to 6.1 (mean improvement of 2.7).¹²

At the start of treatment, differences in the SOA scores between the groups were not significant. Scores in all the groups had improved at two years, but by varying amounts. Scores in patients who were planned to have operations on the maxilla alone were not as high as those in patients planned for other procedures, and this difference was significant ($p=0.03$). However, the difference in the degree of improvement between patients planned to have different procedures was not significant. Scores in patients with an AOB were not as high as those in patients without, however this difference was not significant. There was a similar pattern in patients with transverse asymmetry although the difference in their final scores was not significant. Zhao and Fowler also reported poorer outcomes in patients with an AOB.¹²

Our finding that men take significantly longer to treat than women is at odds with two papers from Leeds that investigated the determinants of the duration of orthodontic treatment in the preoperative and postoperative phases, and found no significant difference between the sexes.^{13,14} An initial analysis of our data, which included fewer patients, suggested that men achieved lower final scores than women, but this was not found in the complete data set that we have presented. Anecdotal evidence suggests that men miss more appointments than women, but an investigation of this was beyond the scope of our study.

The greatest improvement in SOA score was, as expected, during the surgical phase when the greatest movement of tissues occurs. We expected that immediately postoperatively, swelling of the soft tissues would falsely reduce the score because the Holdaway angle was outside the accepted range in a large proportion of patients. The angle worsened in 67 patients (44%), but the overjet worsened in 117 (77%). Possible reasons for the latter include alteration of the previously normal neuromuscular pathway of occlusion, residual discomfort, oedema, and altered sensation resulting in a reduced ability to achieve centric occlusion. Again, these were beyond the scope of this investigation.

The significant improvement in all the groups immediately after operation to the two-year postoperative stage was probably because of a mixture of orthodontic detailing, and in spite of any relapse.

To meet the requirements of clinical governance, there must be a standard method for the audit of surgical outcomes. The measurements within the SOA system are based on radiographs that are recorded routinely, and the ability to calculate the score is already included in the OPAL software package. Unlike any other index, the SOA incorporates the measurements of both hard and soft tissues, which is an important benefit, but it lacks (in common with similar indices) any measurement of transverse dimension. Assessment of the score during planning enables optimum selection of the surgical movements, and although cephalometric planning may eventually be replaced with 3-dimensional methods, it is currently fast, reproducible, and universally available.

The SOA, however, does have limitations. The variables, particularly in the vertical dimension, do not tease out the aesthetic and functional difficulties that are associated with an AOB, particularly in high-angle cases. The score could be revised to include an eighth “vertical” variable, such as exposure of the upper incisor, or angle of the maxillary-mandibular plane.

Cephalometric evaluation is only a small part of orthognathic planning and is currently being replaced by 3-dimensional techniques in many developed health systems globally. As yet, however, we know of no audit tools for 3-dimensional planning. The NHS is currently under intense scrutiny, and the success of particular services and units is being compared to rationalise provision. Self-audit against a universally-recognised benchmark is an important part of the clinical governance process.

Orthognathic outcomes encompass functional, aesthetic, and psychological results. The SOA is an objective and reproducible tool for the audit of outcomes and, together with clinical judgement, ensures the quality of the service provided.

Conflict of interest

We have no conflicts of interest.

Ethics statement/confirmation of patients' permission

Not required.

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