Case Report

Prediction in an ortho surgical case: A report

ABSTRACT

The prediction of orthognathic treatment is an important part of treatment planning. The manual method of prediction tracing by Epker and Fish had been the gold standard in planning for orthognathic cases. Because it was time-consuming, hence computerized methods gained the popularity. A 19-year-old boy reported with a chief complaint of forwardly placed lower jaw and poor smile for the past 2 years. Examination revealed the mandibular prognathism, obtuse nasolabial angle, posterior cross bite with reverse overjet of 1 mm–0.5 mm of overbite, and bilateral Class III molar and canine relation. There was also the deviation of 1.5 mm midline to left present. On the basis of findings, a diagnosis of mandibular prognathism was made. Treatment planning included an orthognathic surgery (Bilateral sagittal split osteotomy) for the mandibular setback. For the surgical procedure, both manual and computerized methods of prediction were done. Both tracing methods result was same and recommended the mandibular setback of 5 mm.

Keywords: Bilateral sagittal split osteotomy, orthognathic, orthosurgical

INTRODUCTION

Various treatment modalities in orthodontics include growth modification procedures in growing children, orthodontic camouflage, and ortho surgical procedures in nongrowing individuals. Combined treatment of orthodontics with surgery had been the only answer to achieve the desired predictive results in adults with severe skeletal discrepancy.[1] Evolution is the key to life. Innovations and inventions have brought in a new era in every walk of human life is the field of orthodontics.

The prediction of orthognathic treatment outcome is an important part of treatment planning in ortho surgical cases and plays a very important role in obtaining the patient's consent for the procedure.[2] The predicted result must be presented to the patient before treatment to access the treatment feasibility, optimize case management helps, in patient understanding, and acceptance of recommended treatment.

Cephalogram prediction in orthognathic surgery can be performed by manual methods or computerized methods. Manual methods used a template or overlay method for prediction.[3] Historically, Cohen used cutout of different regions to be moved surgically along the occlusal plane of the original tracing to predict results. McNeil used mounted dental casts to establish tentative posttreatment dental relationship and used overlay cephalogram tracing for assessment of changes.[4] Henderson combined patients cephalogram tracing with profile photographic transparency. The assessment of the effect of different osteotomes on the profile was made by sectioning the transparency along projected osteotomy lines. Similarly, Hohl *et al*. combined cephalogram tracing with a profile photo.

The manual method of prediction tracing as illustrated by Epker and Fish had been the gold standard in planning for ortho surgical cases.[5] This method was adapted from

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Ricketts cephalogram analysis, growth prediction, and visual treatment objective construction as presented by Bench *et al*. Later on, Arnett simplified the prediction analysis of Epker and Fish and developed surgical treatment planning analysis for prediction of results.

Template method was more time-consuming, whereas acetate tracings were of lesser value in the visualization of profile outcome. Here, the final outcome of the profile depends on clinical experience and artistic skills. Hence, computerized methods gained popularity with the advent of two-dimensional (2D) digital imaging system and 2D cephalometric software-aided in the process of predictive assessment in treatment planning of ortho surgical cases. Nowadays, shift is occurring toward viewing the patient as co-decision-maker. Ackerman says that we should "talk with" rather than "talk to" the patient. 2D imaging software and 2D printing have made the process of diagnosis; treatment planning and patient involvement in their treatment are much simpler, more accurate, acceptable, and reliable for both orthodontist and patient.

I shall be discussing the commonly used method of manual tracing, i.e., Epker, Fish and Arnett's method, and computerized method of prediction using Nemoceph cephalogram software in this case report.

CASE REPORT

A 19-year-old boy who reported to the Department of Orthodontics, BBDCODS with a chief complaint of forwardly placed lower jaw and poor smile for 2 years. Extraoral examination revealed well-built, a mesomorphic boy with a symmetrical face, mesoprosopic facial form, and incompetent lips. There was 1 mm of mandibular incisors exposure at rest. On lateral examination, the mandibular prognathism with an obtuse nasolabial angle was noted [Figure 1].

Intraoral examination revealed the posterior crossbite w.r.t upper posteriors on left side and premolars and 1st molar on the right side. Both the arches were U-shaped with rotated molars in the upper arch and premolar rotation in the lower arch. There was a reverse overjet of 1 mm and 0.5 mm of overbite present with bilateral Class III molar and canine relation. There was also the deviation of 1.5 mm midline to left present [Figure 2].

Digital cephalogram was traced manually, and also cephalogram tracing was conducted using Nemoceph software, and values of Steiner's, cephalometrics for orthognathic surgery, and Arnett analysis were interpreted to know about the quality and quantity of skeletal discrepancy [Tables 1-3]. Cephalometric findings revealed that maxilla was the retrognathic sagittally and normal vertically and mandible was prognathic with a horizontal growth pattern. Maxillary central incisors were both protruded and proclaimed, whereas mandibular central incisors were retroclined. Orthodontic camouflage would have corrected the reverse overjet by doing extraction in the mandibular arch, but this would not address the patient's chief complaint of forwardly placed lower jaw.

Considering the chief complaint, the extent of skeletal discrepancy and amount of reverse overjet, it was decided to correct the skeletal Class III malocclusion by doing orthodontic treatment initially followed by mandibular setback surgery and later FOSLA was made. Surgical treatment was planned with the aim of achieving facial esthetics and optimal functional occlusion.

After performing a scaling, treatment was begun with 0.022" × 0.028" Roth system. The upper and lower arches were aligned until a 0.019" × 0.025" stainless steel archwire could be placed [Figure 3].

To predict the final outcome, we decided to do prediction by both manual and computerized method as will be explained now.

Manual predictive tracing: The following steps were taken.

a. All usual structures (cranial base, maxilla, mandible, teeth, soft tissue, etc.) were traced from the pretreatment cephalometric radiograph

Figure 1: Showing the preoperative pic

Figure 2: Intraoral preoperative frontal pictures

Table 1: Cephalometric readings for steiner analysis

Steiner's Analysis	Mean	Indians	Presurgical manual tracing	Presurgical Nemoceph tracing	Inference
SNA	82	82.28	80	81.6	
SNB	80	78.52	84	84.1	Prognathic mandible
ANB	2	3.52	−4	−2.5	Class III skeletal pattern
SND	76		77	84.3	
Mx I	4 mm/22	5.65/23.17	7 mm/43	5.7/33.9	Proclined maxillary central incisors
Md I to NB	4 mm/25	6.02/27.80	3.5 mm/20	4.4/19.6	Retroclined mandibular incisors
Pog to NB	0 mm		3 mm	2.6	Prognathic mandible
Pog-NB: Md I-NB	1:1		3:3.5	2.6:4.4	
OP to SN	14.5		10	23.2	
Go-GN to SN	32	26.83	29	30.4	Horizontal grower
U1 to SN	104±7	104.8	122		Proclined maxillary CI
U1 to FH	107		133		Proclined maxillary CI

CI: Confidence interval, NA: Not available

Figure 3: Intraoral preoperative occlusal view

b. Frankfort horizontal and subnasal perpendicular were dropped
c. Following surgical reference marks were made [Figure 4]:
   - Ref Line no 1: A line across ramus parallel to and 5 mm above the occlusal plane (just above the lingual). This corresponds to horizontal osteotomy of the sagittal split
   - Ref Line no 2: A line just distal to mandibular 2nd molar and perpendicular to the occlusal plane. This corresponds to vertical osteotomy of the sagittal split
   - Ref Line no 3: A line crossing the reference line no 2, parallel to and 20 mm below the occlusal plane
   - Ref Line no 4: Two dots on the reference line 3, 20 mm apart, one on either side of reference line no 2. This simplifies access to the location of the posterior dot at surgery
   - Ref Line no 5: It corresponds to the horizontal osteotomy for a genioplasty when needed in conjunction with the mandibular setback. This line lies 5 mm below the mental foramen and intersects the inferior border of the mandible below the first molars.

This drawing is referred to as the Tracing (Black line).

d. The prediction (red line) was done by tracing the distal mandible, mandibular teeth, and reference lines on a new piece of tracing acetate overlaid on the black line tracing. Bony and soft-tissue chin are traced with the dashed line. This approximates actual geometry of distal mandible which will be repositioned at surgery [Figure 5]

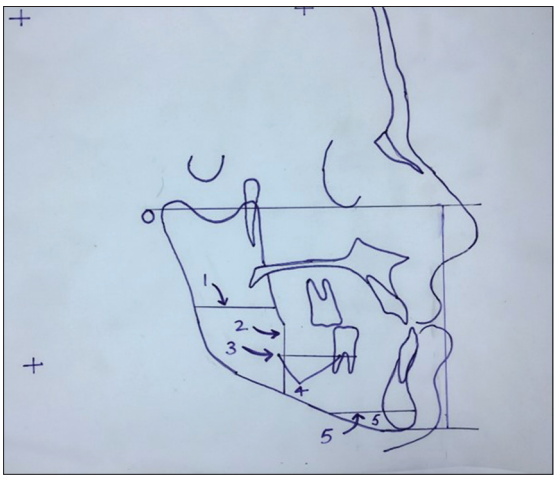

Figure 4: Showing the reference marks

e. Prediction is moved backward by 5 mm on the tracing to achieve the ideal occlusal relation and stable structures, including the proximal mandible and reference lines were traced. The relation of proximal and distal ramus segments is noted in the body area laterally and in the anterior border area of ramus (Shaded area). The amount of overlapping represents the amount of bone to be removed in the orthognathic reconstructive surgery section that follows, i.e., 5 mm [Figure 6]
f. Subnasal perpendicular and vertical facial soft-tissue reference as previously constructed on tracing plans the soft-tissue relation. Thus, maintaining the super imposition shown in the figure, the relation of the soft-tissue chin on prediction to the soft-tissue reference on tracing is visualized. Ideally, the soft-tissue chin is 4 + 2 mm behind the subnasal perpendicular. After setback at pogonion was 2 mm from subnasal

Table 2: Cephalometric readings for COGS (Hard tissue) analysis

Measurements	Mean±SD		Pre Surgical Pre Tracing	Nemoceph Pre surgical Tracing	Inference
	Male	Female			
Cranial base					
Ar-Ptm (II HP)	37.1±2.8 mm	32.8±1.9 mm	30 mm	28.6	
PTM-N (II HP)	52.8±4.1 mm	50.9±3.0 mm	55 mm	51.6	Increased ant cranial base length
Horizontal (skeletal)					
N-A-Pg (angle)	3.9±6.4°	2.6±5.1°	−12	−7.6	Protruded mandible
N-Pg (II HP)	−4.3±8.5 mm	−6.5±5.1 mm	5.5	8.3	
Vertical (skeletal, dental)					
N-ANS (I HP)	54.7±3.2 mm	50.0±2.4 mm	51	49	
ANS-Gn (I HP)	68.6±3.8 mm	61.3±3.3 mm	66	64.3	
PNS-N (I HP)	53.9±1.7 mm	50.6±2.2 mm	52	50.5	
U1-NF (I NF)	23.0±5.9 mm	27.5±1.7 mm	25	23.6	
L1-MP (I MP)	30.5±2.1 mm	40.8±1.8 mm	37	37.4	
U6-NF (I NF)	45.0±2.1 mm	23.0±1.3 mm	21	23.6	The decreased maxillary posterior vertical height
L6-MP (I MP)	26.2±2.0 mm	32.1±1.9 mm	32	30.4	The increased mandibular posterior vertical height
Maxilla- mandible					
PNS-ANS (II HP)	57.7±2.5 mm	52.6±3.5 mm	54		
Ar-Go (linear)	52.0±4.2 mm	46.8±2.5 mm	50	47.1	
Go-pog (linear)	83.7±4.6 mm	74.3±5.8 mm	84	80.5	
B-Pg (II MP)	8.9±1.7 mm	7.2±1.9 mm	4	8.5	
Ar-Go-Gn (angle)	119±6.5°	122±6.9°	125°	126.8	
Dental					
OP upper-HP (angle)					
OP lower-HP (angle)	6.2±5.1°	7.1±2.5°	4	14.3	
A-B (II OP)	−1.1±2.0°	−0.4±2.5°	6°	14.5	
U1-NF (angle)	110.0±4.7°	112.5±5.3°	130	122.9	
L1-MP (angle)	95.9±5.2°	95.9±5.7°	92	83.7	

Cephalometrics for orthognathic surgery (cogs) (soft tissue)				
Facial form	**Mean**	**Manual tracing pre**	**Nemoceph tracing pre**	**Facial Form**
Facial convexity angle (G-Sn-Pg′)	12°	9°	10.1	Concave profile
Maxillary prognathism (G-Sn) (II HP)	6 mm	10 mm	10	
Mandibular prognathism (G-Pg) (II HP)	0 mm	−7 mm	−8.6	Mandibular prognathism
Vertical height ratio (G-Sn/ Sn-Me) (I HP)	1	1.04	1	
Lower face-throat angle (Sn-Gn′-C)	100°	95°	86.2	
Lower vertical height- depth ratio (Sn-Gn′/C-Gn′)	1.2	1.11	1.3	
Lip position and facial form				
Nasolabial angle (Cm-Sn-Ls)	102°	115°	114	
Upper lip protrusion (Ls to Sn-Pg′)	3 mm	0.5	0.6	
Lower lip protrusion (Li to Sn-Pg′)	2 mm	−2	−3.5	
Mentolabial sulcus (Si to Li-Pg′)	4 mm	3.5	−4.2	
Vertical lip-chin ratio (Sn-Stms/ Stmi-Me′)	0.5	−0.4	−0.5	
Maxillary incisor exposure	2 mm	0	0.7	
Interlabial gap (Stms-Stmi)	2 mm	2	2.9	

perpendicular and hence was within the normal range. Hence, genioplasty was not planned for this case

g. The lower lip is traced on prediction as final step [Figure 7].

Table 3: Arnett's analysis

Measurement	Mean	Manual tracing pre	Nemoceph tracing pre	Inference
Dentoskeletal factors				
Mx1 projection to TVL	−9.2 mm	−12	−13	
Mx1 inclination (Mx1-Mx OP)	56.8°	47	53.6	Protruded maxillary incisor
Overjet	3.2 mm	−2	−2.5	Prognathic mandible
Md1 projection to TVL	−12.4 mm	−10	−11	Prognathic mandible
Md1 inclination (Md1-Md OP)	64.3°	72	77	
Overbite	3.2 mm	0.5	−1.7	
Postheight (Mx OP-TVL angle)	95.6 mm	91	92	
Mx1 exposure relaxed lip	4.7 mm	2	0.7	
Soft tissue thickness				
Upper lip (UL inside-ULA)	12.6 mm	12	12.3	
Lower lip (LL inside- LLA)	13.6 mm	12.5	14.7	
Pogonion-chin (Pg-Pg′)	11.8	9	9.7	Shows decreased soft tissue thickness over chin area
Menton (Me-Me′)	7.4 mm	5.5	6.6	
Facial height or length				
Upper lip length (Sn-ULI)	21 mm	17	21.6	
Interlabial gap (ULI-ULS)	0.0 mm	2	1.3	
Upper incisor exposure relaxed lip	4.7 mm	2	0.7	
Lower lip length (LLS-Me′)	46.9 mm	48	46.2	
Lower 1/3 height	71.1 mm	72	69.1	
Total facial height (N′-Me′)	124.6 mm	122	118.8	
Maxillary height (Sn-Mx1 tip)	25.7 mm	24	22.2	
Mandibular height (Md1 tip-Me′)	48.6 mm	46	38	
Postheight (Mx-OP-TVL angle)	95.6 mm	91	92	Decreased posterior maxillary height
True vertical line projections				
Glabella (G′-TVL)	−18.6 mm	−10.5	−10	
Soft tissue A point (A′-TVL)	−0.1 mm	−3	−2.5	
Upper incisor tip (Mx1-TVL)	−9.2	−12	−13	
Upper lip anterior (ULA-TVL)	3.7 mm	0	0.2	
Upper lip angle (UL-TVL)	12.1°	−0.9	0.8	
Nasolabial angle (Cm-Sn-ULA)	103.5°	112	114.7	
Lower incisor tip (Md1-TVL)	−12.4 mm	−10	−11	Shows uprighting of mandibular incisors
Lower lip anterior (LLA-TVL)	1.9 mm	3.5	3.9	
Soft tissue B point (B′-TVL)	−5.3 mm	−4	−3	
Soft-tissue pogonion (Pog′-TVL)	−2.6 mm	−0.5	−1.4	Mandibular prognathism
Throat length (NTP-Pog′)	58.2 mm	58	56.9	
Harmony values				
Facial angle (G′-Sn-Pog′)	169.3°	172	169.9	
Forehead to maxilla (G′-A′)	8.4 mm	16	7.5	
Forehead to mandible (G′-Pog′)	5.9 mm	20	8.6	Prognathic mandible
Nasal base to chin (Sn-Pog′)	3.2 mm	7	1.4	
Max base - Md base (A′-B′)	5.2 mm	5	0.6	
Upper lip-lower lip (ULA-LLA)	1.8 mm	6	3.7	
Incisor tip anterior to chin (Md1 tip-Pog′)	9.8 mm	−15	−11.6	
Lower lip anterior - chin (LLA-Pog′)	0.0 mm	0	5.3	
Chin contour (B′-Pog)	0.0 mm	4	1.6	

Computerized cephalogram predictive tracing (Nemoceph) using the following steps:

a. Patient's cephalogram and pictures were uploaded in Nemoceph software
b. The cephalogram was calibrated, and tracing was performed using the software
c. Once all the landmarks were marked, and tracing was completed, the adjustments of landmarks and various planes were done
d. Following this, the patient's lateral profile photo was superimposed on the cephalogram and the tracing

e. After this, a new treatment plan, i.e., surgical plan, was selected
f. Positive overjet was achieved, molars were moved into Class I molar relationship on setting the mandible back by 5 mm
g. The new cephalogram tracing was automatically drawn with this new setback reading
h. The morphing was done to appreciate the change in the lateral profile of the patient [Figure 8].

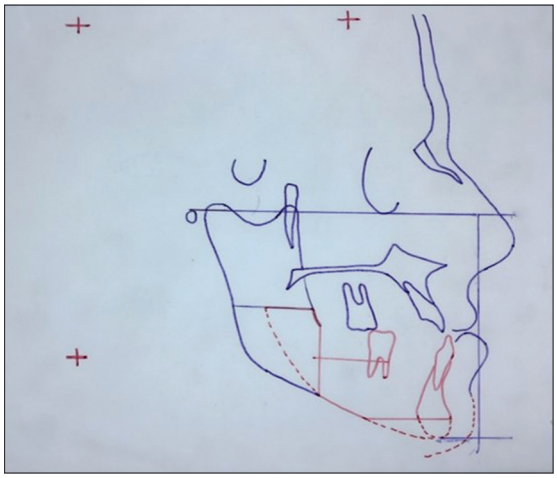

Figure 5: Showing the actual geometry of mandible

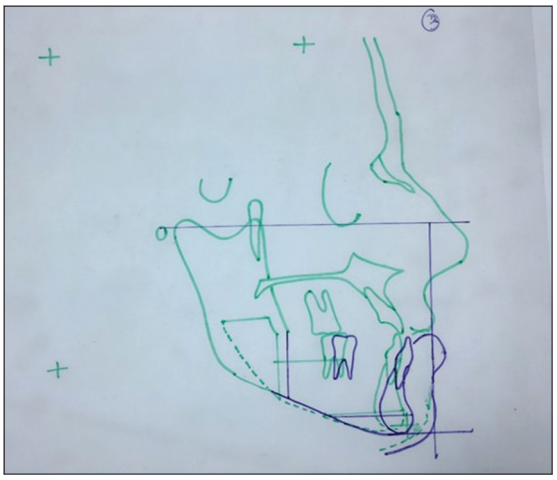

Figure 6: Showing the amount of overlapping

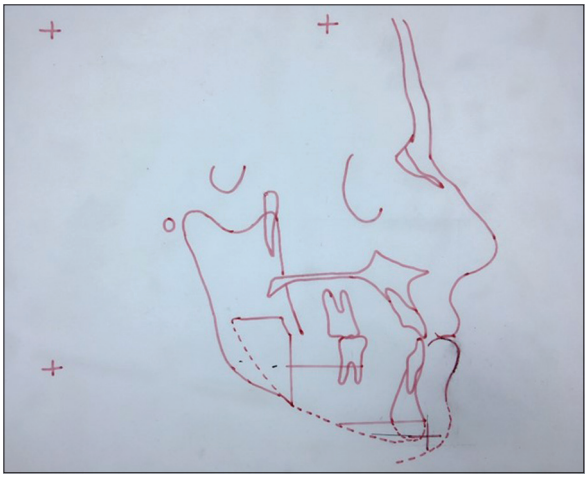

Figure 7: Tracing of the lower lip

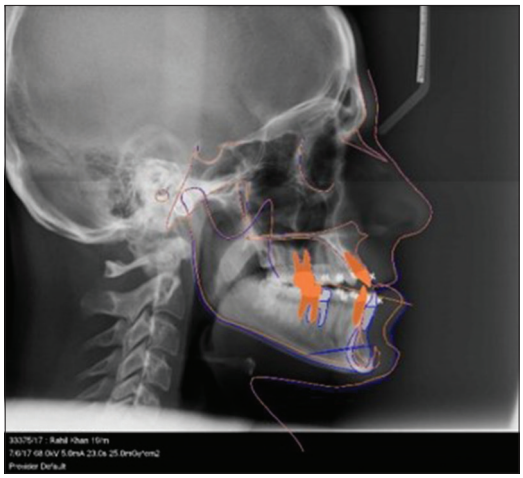

Figure 8: Showing the morphing

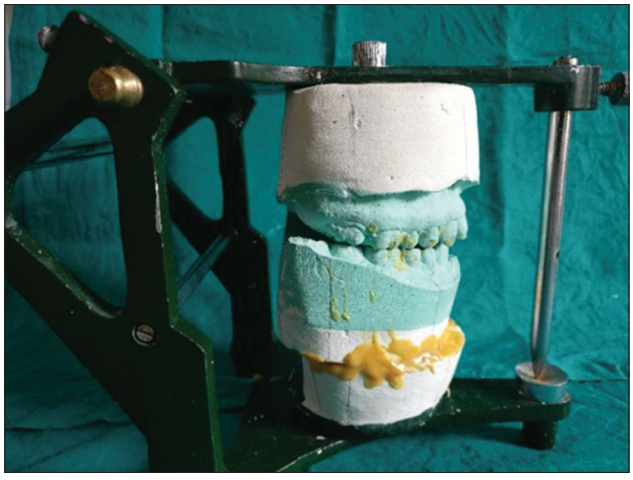

Figure 9: Showing the mock surgery

Figure 10: Showing the surgery

RESULTS

The value for mandibular setback as predicted using both the methods was 5 mm. Following this, a model mock surgery was done for visualizing 3D postoperative relationship of jaws with positive overjet and Class I molar relation [Figure 9]. The surgical stent was made at this position.

Surgery was performed with the support of the Department of the Maxillofacial Surgery of BBDCODS, Lucknow. The bilateral sagittal osteotomy was conducted, and rigid fixation was placed in the mandible through the use of four-hole miniplates on both sides [Figure 10]. To keep the mandible in the correct position, the use of intermaxillary elastics for 30 days was given to achieve maximum stability. Active orthodontic treatment was resumed 4 weeks after surgery. The objective is to achieve ideal occlusal relationships, regarding canine class, molar relationship, overjet, overbite, and matching dental midlines. The patient is still under orthodontic treatment [Figure 11].

DISCUSSION

When the skeletal or dentoalveolar deformity is so severe that the magnitude of the problem lies outside the envelope of possible correction by orthodontics alone and even the camouflage is also not the option then orthognathic surgery is the best plan. This case report was done to compare the accuracy of cephalometric readings of manual tracing of to digital software tracing. The reproducibility of cephalometric points in the manual method as compare the analysis of digital image was controversial for a long time. Nowadays, due to advancement in the technology, the manual method is becoming a handicap. The operator experience is crucial in landmark identification. Therefore, only one operator did all the predictive tracings to rule out interoperator error as stated by Sayinsu *et al*.[6] Both findings of manual tracing and digital tracing showed the same values which are contrary to the findings of Chen *et al*.[7] Although in this case report, the values of both predictive tracing methods were same because of the less time-consuming, less chances of error, and ease of identification of anatomical landmarks, the digital tracings is a more accurate method for cephalometric analysis.

Figure 11: Postoperative picture

CONCLUSION

A careful prediction is mandatory before planning for an orthognathic case. Computerized predictions do not directly affect the patient's treatment decisions but may indirectly affect them by strengthening the patients' self-image, motivation and expectations and confirming the necessity of surgery as a treatment option by painting a verbal picture.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

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