

Agreement among orthodontists regarding facial pattern diagnosis

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Abstract

Objective: To assess agreement among orthodontists trained in facial pattern diagnosis through the morphological evaluation of the face. **Methods:** Facial photographs were taken in front and side views, as well as photographs of the smiles of 105 individuals randomly selected among patients seeking orthodontic treatment. The photographs were sent to orthodontists trained in facial pattern classification. Intra-rater agreement, agreement between raters and the Gold Standard, as well as inter-rater agreement were assessed using the Kappa index. **Results:** Intra-rater agreement was almost perfect, with Kappa index reaching 0.85. Agreement between raters and the Gold Standard was moderate (Kappa = 0.48), higher for Pattern I (Kappa = 0.62) and lower for the Short Face Pattern (Kappa = 0.33). Agreement between raters was significant (Kappa = 0.61) and even higher than agreement with the Gold Standard for all patterns. **Conclusions:** The criteria used by raters to determine the facial pattern were the same in the first and second evaluation. Agreement between raters and the Gold Standard was moderate, with raters exhibiting greater agreement between them than with the Gold Standard.

Keywords: Orthodontic diagnosis. Facial analysis. Facial pattern.

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INTRODUCTION

Disagreement on the diagnosis of orthodontic problems is still very prevalent among orthodontists¹⁰ despite efforts to standardize the classification of malocclusions.

Initially, Angle³ classified malocclusions according to the mesiodistal relationship of first molars. After studying the quality of cases finished by North American orthodontists, Andrews² noted a lack of standardization among different practitioners and designed the six keys to a normal occlusion, which would serve as a guide to diagnose and assess the quality of finished cases.

These classifications were based, however, only on dental relationships and would eventually prove insufficient to define the diagnosis of sagittal and vertical facial discrepancies.

In an attempt to create a diagnosis method supported by evidence-based treatment plans, Ackerman and Proffit¹ developed a classification system based on five key malocclusion characteristics: Facial profile, alignment, vertical, horizontal and sagittal deviations. However, little agreement was reached among professionals who teach this classification, and consequently on the treatment strategy indicated by each professional.¹⁰

Driven by the same concern, to organize a diagnostic method supported by protocols and capable of providing specific predictions, Capelozza Filho⁶ developed a classification system for orthodontic problems based on facial morphology. According to this classification, the morphological analysis of the face is the main diagnostic tool for facial pattern determination.

Organizing orthodontic diagnosis according to facial patterns allows orthodontists to treat malocclusions based on the location of skeletal discrepancies if present, or the etiology of the malocclusion, establishing treatment protocols that are tailored specifically to each pattern in each age group, with short-term protocols and predictable long-term prospects by taking into account discrepancy severity.

The benefit of this new approach to orthodontics begins, however, with appropriate facial pattern diagnosis.

Considering the limitation of facial measures in expressing form or normality,¹⁴ pattern classification should be performed by means of an evaluation of facial morphology in front and side views.

Individuals can be classified as Pattern I, II, III, Long Face or Short Face. Pattern I consists of a normal face. Whenever the malocclusion is present it is just a dental malocclusion not associated with any sagittal or vertical skeletal discrepancy. Patterns II and III are characterized, respectively, by a positive and negative sagittal discrepancy between maxilla and mandible. The Long Face and Short Face patterns feature vertical discrepancies. In patients with skeletal errors, malocclusions usually result from these discrepancies.

The use of concepts that have been long established in the orthodontic literature, applied under this new perspective, imparts greater predictability to orthodontic treatment and assurance to professionals who learn to use such concepts, in addition to patient security and comfort.

The aim of this study was to evaluate agreement among orthodontists trained on facial pattern determination through the morphological evaluation of the face.

MATERIAL AND METHODS

The study sample consisted of 105 adults of both genders, aged at least 18 years, selected from the records of offices belonging to specialists in orthodontics. The authors randomly selected patients with the five following facial patterns: Pattern I, Pattern II, Pattern III, Long Face Pattern and Short Face Pattern. Individuals who were still in the growth period and those with craniofacial syndromes were excluded from the sample.

This research project was approved by the Ethics Committee of the São Paulo University School of Dentistry number 14/07.

Standardized facial photographs in front and side views, as well as photographs of each patient's smile, were taken from their initial orthodontic records for use in the study. The photographs were inserted in a PowerPoint presentation, with the photographs of the smile of each patient and of their face in front and side views on the same slide.

The rater sample consisted of 20 orthodontists trained in facial pattern classification. Most were teachers who taught this classification at different institutions.

Each rater received by mail a CD containing a presentation with 105 slides, each comprising the photographs in front and side views, along with the photograph of the smile of the same patient.

Raters were instructed to classify the facial pattern of each patient according to the following classification: (1) Pattern I, (2) Pattern II, (3) Pattern III, (4) Long Face Pattern, and (5) Short Face Pattern.

The sample was also assessed by the author who developed the classification method,⁶ whose evaluation was set as the Gold Standard.

Thirty-five patients were randomly selected and subjected to the same classification with at least one week interval between the two evaluations with the purpose of assessing intra-rater agreement in terms of profile morphology.

Kappa coefficient, which evaluates agreement between two non-parametric variables, was used to analyze evaluation error.

Determining the value that defines a good correlation is inherent in each study, but in general, the following classification is acceptable:⁸

- » If $Kappa < 0.0$ = Poor agreement;
- » If $0.00 < Kappa < 0.20$ = Slight agreement;
- » If $0.21 < Kappa < 0.40$ = Fair agreement;
- » If $0.41 < Kappa < 0.60$ = Moderate agreement;
- » If $0.61 < Kappa < 0.80$ = Substantial agreement;
- » If $0.81 < Kappa < 1.0$ = Almost perfect agreement.

Kappa coefficient was used in the total sample and in the different patterns in order to assess agreement between raters, as well as between raters and the Gold Standard.

RESULTS

Eighteen of the 20 raters performed sample classification. As regards intra-rater assessment, the mean percentage of correct classifications found between the first and second evaluations was 84%. Kappa coefficient was 0.8 and showed substantial agreement between the first and second evaluation (Table 1). However, while most raters exhibited higher than 80% correct classifications between the two evaluations, two of them showed significantly lower agreement (60%, with $Kappa = 0.5$ - Moderate agreement) and were excluded from the sample, since these raters either did not master the method or did not implement it with due attention. The study was therefore conducted with 16 raters and the Gold Standard. Intra-rater agreement among the 16 raters was almost perfect, with Kappa index reaching 0.85 (Table 1).

Kappa coefficient was used in the total sample and in the different patterns in order to assess agreement between raters and the Gold Standard. The percentage of agreement was 59% with $Kappa = 0.48$ (moderate agreement).

TABLE 1 - Intra-rater agreement between first and second evaluations with 18 and 16 raters.

Number of raters	p(a)	p(e)	Kappa Index
18 raters	84%	16%	0.8
16 raters	88%	12%	0.85

p(a) = percentage of correct classifications, p(e) = percentage of error.

TABLE 2 - Agreement between raters and the Gold Standard.

Pattern	n (Gold Standard)	p(a)	p(e)	Kappa Index
I	27	70%	30%	0.62
II	37	56.5%	43.5%	0.46
III	17	53%	47%	0.41
Long Face	14	59%	41%	0.49
Short face	10	47%	53%	0.33
Total	105	59%	41%	0.48

p(a) = percentage of correct classification, p(e) = percentage of error.

TABLE 3 - Assessment of inter-rater agreement.

Pattern	n (Gold Standard)	p(a)	p(e)	Kappa Index
I	27	77%	23%	0.71
II	37	76%	24%	0.7
III	17	69%	31%	0.61
Long Face	14	71%	29%	0.64
Short face	10	61%	39%	0.51
Total	105	72%	28%	0.65

p(a) = percentage of correct classifications, p(e) = percentage of error.

For the different patterns the percentage of agreement with the Gold Standard was: 70% for Pattern I (Kappa = 0.62), 56.5% for Pattern II (Kappa = 0.46) and 53% for Pattern III (Kappa = 0.41), 59% for the Long Face Pattern (Kappa = 0.49) and 47% for the Short Face Pattern (Kappa = 0.33) (Table 2).

Kappa index was also employed to assess agreement between raters. A 72% percentage of correct classifications was found for the total sample, with Kappa index = 0.65 (substantial agreement). For Pattern I this percentage was 77% (Kappa = 0.71); for Pattern II, 76% (Kappa = 0.7); for Pattern III, 69% (Kappa = 0.61), for the Long Face Pattern, 71% (Kappa = 0.64) and for the Short Face Pattern, 61% (Kappa = 0.51) (Table 3).

DISCUSSION

Different diagnoses by different orthodontists for the same patient result in different treatment plans and outcomes which are not always compatible.⁹ Lack of agreement among professionals instills great uncertainty in patients, tarnishing the scientific credibility of orthodontics, a dental specialty whose literature is replete with studies that allow evidence-based practice.

Diagnoses based on occlusal classification and cephalometric landmarks lead to results that often fail to meet the esthetic expectations of patients.¹¹ Above and beyond seeking an ideal occlusal relationship one should seek the best possible esthetics.¹⁵ To this end, diagnoses should be

based primarily on the evaluation of facial morphology in front and lateral views, and evaluation of the smile, complemented by an assessment of the occlusion, whose discrepancy is often a consequence of skeletal error. Radiographs are also important complementary exams but 75% of orthodontic diagnoses are defined without radiographic evaluation and tend to remain unchanged after orthodontists have reviewed the X-rays.⁴

A diagnosis based on facial morphology constitutes the first step in facial pattern classification. By means of a correct diagnosis one can identify, in different age groups, treatment protocols substantiated by scientific evidence and, therefore, with well established short and long term prognoses.

After three years of clinical application of this concept, the authors decided to evaluate the degree of agreement of trained orthodontists who teach this methodology.

The study sample consisted of Brazilian adults past the growth period. Adults were intentionally chosen owing to the fact that facial pattern can only be established after complete facial growth. Some patterns, such as Long Face and Pattern III, tend to worsen during adolescence and are often identified only during that period. The inclusion of growing patients in this group might raise diagnostic issues related to the complete expression of each pattern.

Furthermore, only Caucasian individuals were included since the concept of normal facial features is specific to each population.⁵ For Caucasians, a normal facial profile, or Pattern I, should display a smooth convexity. In Asians, a less convex facial profile is accepted as characteristic of normality. In Afro-descendants, on the other hand, an increased vertical growth results in increased facial convexity in Pattern I patients.

Sample raters were selected for their specific training in this classification and for teaching it at different institutions. The photographs were sent to 20 of them and 18 completed the questionnaire.

The percentage of agreement found between the first and second assessment was 84%, with Kappa = 0.8, showing substantial agreement, i.e., high consistency among raters regarding facial pattern diagnosis. This result indicates that the criteria for determining the pattern was the same in both studied periods. All raters achieved Kappa indexes for the two evaluations that showed substantial or almost perfect agreement, with the exception of two raters for whom the Kappa index yielded only moderate correlation between the two assessments. Due to the vast difference between these two raters and the others it was decided that they should be excluded, either because they did not master the classification method, or because they failed to carry out the assessments with the required attention. After this exclusion, the general intra-rater agreement changed from substantial to almost perfect (Kappa = 0.85) (Table 1).

The diagnosis performed by the raters was then compared with the Gold Standard, whose agreement was moderate (Kappa = 0.48).

Patients classified as Pattern I are characterized by vertical and sagittal facial balance in front and side views. They are not necessarily beautiful, but sagittally and vertically balanced.

After analyzing separately the different individuals and their facial patterns it was noted that Pattern I had the highest percentage of correct classifications. Seventy percent of the 27 individuals classified as Pattern I using the Gold Standard as reference received the same rating by the raters (Kappa = 0.62 - substantial agreement).

Eleven percent of Pattern I individuals were classified as Pattern III, and another 11.3% as Long Face Pattern. Six percent were mistaken for Pattern II and 1.6% for Short Face Pattern (Table 4). Among the 27 Pattern I patients, only 2 (7.4%) were rated by most raters as Long Face Pattern. All others who showed discrepancies in classification were correctly assessed by most raters.

After a careful study of the sample, it was observed that all individuals rated as Long Face Pattern by the raters were dolichofacial. Noteworthy, however, were the presence of lip seal competence and the absence of excessive exposure of the upper incisors at rest, or of the gingiva when smiling, essential features for diagnosing the Long Face Pattern. This means that even in individuals with excessive vertical growth whose facial esthetics was compromised, normality may be present indicating that there is sagittal balance between the maxilla and mandible, lip seal competence and no excessive vertical growth of the maxilla (Figs 1 and 2). In dolichofacial Pattern I patients, only orthodontic treatment is indicated (Fig 3). For individuals with Long Face Pattern, on the other hand, orthodontic treatment can balance the occlusal relationships but it does not correct the skeletal discrepancy, nor does it benefit facial esthetics, which could only be achieved through a combination of orthognathic surgery and orthodontics.

In Pattern I patients who were classified as Pattern III, an expressive mandible can be observed in front and side views, although in balance with the maxilla. Among those rated as Pattern II there was again the influence of an increased vertical dimension, which enhances facial convexity. Once again it should be stressed that in Pattern I patients, maxillomandibular relationships are balanced and, therefore, no sagittal or vertical changes can be made.

Among the patients in the sample, 37 were classified as Pattern II according to the Gold Standard. This number is not surprising since

TABLE 4 - Percentages of diagnoses by Pattern.

Pattern	I	II	III	Long Face	Short Face	Total
I	69.8%	6.2%	11.1%	11.3%	1.6%	100%
II	30.5%	56.5%	0.5%	6.4%	6.1%	100%
III	30.5%	0.7%	53%	11.8%	4.0%	100%
Long Face	10.7%	26.8%	3.1%	59.4%	0%	100%
Short Face	23.7%	11.8%	17.5%	0%	47%	100%



FIGURE 1 - Pattern I, dolichofacial patient diagnosed as Long Face Pattern by 31.25% of raters. Lip seal competence and absence of vertical maxillary excess exclude Long Face diagnosis.



FIGURE 2 - Morphological evaluation of lateral cephalogram confirms basal bone balance.



FIGURE 3 - Class I malocclusion with upper and lower anterior crowding treated with extraction of tooth 32 and stripping in upper arch.



FIGURE 4 - Pattern II patient rated by 75% of raters as Pattern I. Raters overlooked discrepancy given its small size.



FIGURE 5 - Lateral cephalogram of patient in Figure 4 discloses mandibular deficiency and incisor compensation in opposite direction to skeletal error, which should be preserved with orthodontic treatment, influencing bracket choice.

the sample was collected in orthodontic offices and Class II malocclusion is very common, affecting 42% of Brazilians adults,¹³ 75% of whom also exhibit skeletal discrepancies.¹² Pattern II is characterized by increased facial convexity without, however, the presence of vertical discrepancy. Most of these patients present with mandibular deficiency in association (or not) with maxillary excess. Maxillary excess seldom occurs in isolation. Mandibular deficiency is characterized by a short chin-neck line,

deficiency in chin protrusion and lower lip eversion. Upper lip posture depends on the uprighting or protrusion of the upper incisors.

The major manifestations of Pattern II in frontal view are reduced height of the lower lip and chin, and lower lip eversion. Pattern II patients do not present with vertical maxillary excess or any deficiency in dental exposure when smiling. These are the key elements for differential diagnosis of the Long Face and Short Face patterns, respectively. Such diagnosis may be elusive at times, mainly because most patients with these patterns display a Class II malocclusion.

Among sample subjects with Pattern II, 56.5% were correctly classified by the evaluators (Kappa = 0.46, moderate agreement). The most frequent error was classifying individuals with mild Pattern II discrepancies as Pattern I, with raters tending to disregard the minor mandibular deficiencies (Figs 4 and 5). Thirty and half percent of Pattern II patients were rated as Pattern I (Table 4).

Even mild discrepancies between the maxilla and mandible should be identified as treatment differs from that of Pattern I patients. Patients with mild Pattern II should be treated by means of primary compensatory orthodontic treatment.⁶ The upper and lower incisors should normally

preserve any compensations that might be present, such as: Reduced buccal inclination of upper incisors, absence of incisor and canine tip, and buccal inclination of lower incisors⁷ (Fig 5). Depending on Class II size, compensatory atresia is common in the maxilla and should be preserved. Non-identification of Pattern II may affect the appropriate choice of brackets and bonding resources and the preservation and acquisition of adequate compensation.

In this study raters only evaluated facial photographs, which may have favored the error component. Complementary examination of lateral cephalograms assists in the identification of the skeletal discrepancies and dental compensations that should be preserved.

Six percent of Pattern II patients were classified as Long Face Pattern and another 6.5% as Short Face Pattern. Those rated as Long Face Pattern are the Pattern II dolichofacials, and as Short Face the Pattern II brachyfacials. Differential diagnosis must be made by identifying the treatment needs of each patient. When in doubt between Pattern II and Long Face Pattern, professionals must ask themselves if the patient requires upper replacement of the maxilla. If the answer is affirmative, the patient is Long Face, if negative he/she is Pattern II. For a differential diagnosis between Pattern II and Short Face the question is whether the maxilla needs to be repositioned inferiorly, and the patient is Short Face if the answer is positive.

Pattern III, in turn, is characterized by reduced facial convexity due to maxillary deficiency, mandibular prognathism or a combination of both. In patients with maxillary deficiency, infraorbital depression and zygomatic prominence are missing. The middle third is poor. The chin-neck line is long, less pronounced in prognathic dolichofacial patients. The differential diagnosis of these patients relative to the Long Face Pattern is determined by gingival exposure when smiling, which is normal in prognathic patients, who do not require upper replacement of the maxilla in orthognathic surgery.

Individuals with Short Face Pattern may also experience a reduction in facial convexity, which confuses them with Pattern III patients. Differential diagnosis is once again performed according to the amount of exposure of upper incisors when smiling. A reduced exposure, indicative of the need for lower repositioning of the maxilla, determines the diagnosis of individuals with Short Face Pattern.

In frontal view, Pattern III patients are mainly characterized by excessive lower lip and chin height, and deficiency in the middle third of the face, which is expressionless. Minor discrepancies are not perceived when evaluated in frontal view, improving the prognosis of nonsurgical treatment.

Seventeen patients were classified as Pattern III according to the Gold Standard. The percentage of correct classifications was 53%, with Kappa = 0.41 (moderate agreement). Once again, the worst confusion occurred between mild Pattern III and Pattern I individuals (Fig 6). Thirty and a half percent of Pattern III individuals were classified as Pattern I. Lateral cephalograms should be evaluated in order to facilitate differential diagnosis. Lateral cephalograms allow the identification of lower incisor uprighting, upper incisor protrusion and skeletal discrepancy (Fig 7). These characteristics should be preserved in the compensatory treatment of these patients, thereby influencing the choice of brackets.

Twelve percent of Pattern III patients were rated as Long Face Pattern. These patients, however, are Pattern III dolichofacials and show no vertical maxillary excess.

Patients with Long Face Pattern are characterized by excessive vertical growth of the maxilla, downward and backward rotation and lip seal incompetence, excessive gingival exposure when smiling and likewise in the upper incisors at rest. Due to excessive vertical growth and deficiency in the sagittal growth of the facial bones, these patients present with maxillary and mandibular retrusion. The percentage of



FIGURE 6 - Pattern III patients diagnosed as Pattern I by 68.75% of raters. Height of lower lip and chin increased relative to upper lip height allows discrepancy identification even in front view photograph.



FIGURE 7 - Lateral cephalogram of patient in Figure 6. Lower incisor compensation should be preserved with orthodontic treatment, influencing bracket choice.

correct classification for this Pattern was 59.4% (Kappa = 0.49, moderate agreement). Their facial convexity is increased due to mandibular rotation downwards and backwards. Therefore, 26.8% of the patients with Long Face Pattern were classified as Pattern II (Table 3 and Fig. 8). In defining the differential diagnosis one must check the sealing of perioral muscles typically present in Pattern II individuals and

the amount of gingival exposure when smiling, which is normal in Pattern II patients.

In evaluating the profile of Long Face patients one should check gonial angle opening, long and narrow symphysis, increased distance between molar apex and palatal plane, and excessive exposure of upper incisor at rest (Fig 9).

When lip seal is present in the patients, it is forced and forms a double chin.

These patients are usually esthetically unpleasant and require orthognathic surgery associated with orthodontic treatment to restore facial balance and allow proper sealing of the perioral musculature. Surgical planning of these patients includes maxillary replacement and expansion, upward and forward rotation, mandibular advancement or setback, and vertical chin reduction.

In 11% of Long Face Pattern evaluations these patients were classified as Pattern I and 3% as Pattern III (Table 4).

When Long Face patients fail to be diagnosed as such, the use of unsuitable orthodontic mechanics may lead to an increase in vertical dimension and the worsening of this pattern, compromising facial esthetics and occlusal function (anterior guidances) by reducing overbite.



FIGURE 8 - Patient with Long Face Pattern diagnosed as Pattern II by 43.75% of raters. Vertical excess results in lip seal incompetence and maxillary and mandibular retrusion.



FIGURE 9 - Lateral cephalogram of patient in Figure 8. Opening of gonial angle, long and narrow symphysis, increased distance between molar apex and palatal plane, and excessive exposure of upper incisor at rest.

Patients with Short Face Pattern exhibit small vertical growth associated with upward and forward mandibular rotation. Their chin is usually prominent. There is little upper dental exposure when smiling even in young patients, and excessive lip compression at rest, indicating lower repositioning of the maxilla as a mandatory procedure in orthognathic surgery for these patients.

Short Face was the pattern that showed the least agreement between raters and the Gold Standard.

Only 47% of the evaluations of patients with this pattern were correct. Kappa was 0.33, indicating fair agreement between evaluations. Twenty-four percent of patients with this pattern were confused with Pattern I, 11.8% with Pattern II and 17.5% with Pattern III (Table 4). Individuals with Short Face Pattern may have slightly convex profile similarly to Pattern I, or a markedly convex profile, typical of Pattern II, or even reduced convexity, like Pattern III. This explains why there was such confusion in the evaluation of patients with this pattern (Figs 10, 11 and 12). Differential diagnosis is performed by studying photographs of smiles in which these patients expose very little of their upper incisors since childhood. Another important aspect is soft tissue excess, resulting in compressed lips and facial creases since youth. The impact of aging on this pattern is greater than on any other pattern. Ideally, the orthodontic treatment must be associated with surgery for lower replacement of the maxilla, downward and backward rotation with mandibular advancement or setback, and vertical increase of the chin.

When a patient opts for compensatory treatment, one should avoid procedures that reduce oral volume and vertical dimension, such as dental extractions. Orthodontic treatment of these



FIGURE 10 - Patient with Short Face Pattern diagnosed as Pattern III by 56.25% of orthodontists. Reduced facial convexity is due to reduced vertical height of maxilla and forward and upward mandibular rotation.



FIGURE 11 - Lateral cephalogram of patient in Figure 10, showing forward and upward mandibular rotation, compounded by subsequent tooth losses.



FIGURE 12 - Facial photographs of patient in Figures 10 and 11 after increase in vertical dimension by Surgically Assisted Rapid Maxillary Expansion and provisional prosthetic rehabilitation. Short Face Pattern is still present as it can only be corrected with orthognathic surgery, but significant improvement was achieved in smile esthetics.

patients is usually limited to improving esthetics and establishing satisfactory occlusion.

Evaluation of inter-rater agreement showed a higher percentage of accurate classifications for the entire sample and for all patterns compared with the percentage between raters and the Gold Standard.

Agreement was substantial for the total sample (Kappa = 0.65) and for Patterns I (Kappa = 0.71), II (Kappa = 0.7), III (Kappa = 0.61) and Long Face (Kappa = 0.64), and moderate for the Short Face Pattern (Kappa = 0.51). These results show that rater error tends to be in the same direction when classifying a patient in a pattern different from the Gold Standard.

CONCLUSIONS

Identifying points of problem in the diagnosis of facial patterns makes it easier to correct potential errors that might result in inappropriate treatment plans and unrealistic prognoses.

An almost perfect agreement was noted between the first and second evaluation by the same rater, which demonstrates that the criteria for diagnosis of facial pattern are well established.

Agreement between rater evaluation and the Gold Standard was moderate. A tendency was detected whereby raters disregarded minor mandibular deficiencies in Pattern II, and mild

discrepancies in Pattern III. Individuals with Long Face Pattern were often diagnosed as Pattern II due to increased facial convexity resulting from downward and backward mandibular rotation.

Short Face Pattern showed less agreement and these individuals were classified as Pattern I, II or III.

Agreement between raters in evaluating patterns was substantial, showing that raters tended to classify individuals under the same pattern, which was different from the Gold Standard. In other words, errors tend to be committed in the same patients and in the same direction.

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