

Prediction of the Permanent Dentition in Deciduous Anterior Crossbite

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Abstract: Early prospective evaluation for self-correction of deciduous anterior crossbite can enable identification of patients who require early treatment as well as those who do not. The purpose of the present study was to generate an algorithm that can be used to predict self-correction in the transitional dentition in 3-year-old subjects. The subjects were divided into 2 groups. One group comprised 22 subjects whose anterior crossbite self-corrected during the transitional stage (hereafter referred to as group N). The other group was comprised of 22 subjects whose anterior crossbite persisted during the transitional dentition (hereafter referred to as group R). All subjects were examined using lateral cephalometric radiography in order to evaluate differences in occlusion. Fifteen measurements were used for the evaluation. For each measurement, the variance ratio and the difference in the population mean between groups N and R were tested and *t*-values were derived. Based on the Student's *t*-test results, only measurements that had statistically significant differences ($P < .05$) were extracted. Predictor variables that had a partial *F* value of 5 or greater were selected for stepwise discriminant analysis, and the following equation was obtained: deciduous indicator (DI) = $-0.58(\text{cranial length anterior}) + 1.31(\text{posterior facial height}) - 0.76(\text{porion location}) - 2.02(\text{Wits appraisal}) - 70.28$. The lower the DI value (negative), the higher the probability that the crossbite will self-correct at the transitional dentition. On the other hand, a high (positive) discriminant score strongly suggests that the subject requires treatment in the primary dentition. The result of this analysis showed that the apparent error rate was 95.46% and the Maharanobis' generalized distance was 8.99. (*Angle Orthod* 2001;71:390–395.)

Key Words: Algorithm; Primary dentition; Self-correction; Cephalometric radiography; Discriminant analysis

INTRODUCTION

The incidence of anterior crossbite is high in malocclusions in Japanese subjects.¹ Because malocclusion may be regarded as an esthetic problem, parents, upon noticing such abnormalities in the deciduous dentition of their chil-

dren, often inquire as to whether or not treatment is required.

Without treatment, the skeletal malocclusion may be aggravated as the patient grows.² However, functional deciduous anterior crossbites also are known to occasionally correct themselves spontaneously.^{3–7} Furthermore, even if deciduous anterior crossbites are corrected through orthodontic treatment, the patients may develop a crossbite again during the transitional dentition, thus requiring further orthodontic treatment.

Therefore, evaluating the possibility of self-correction for deciduous anterior crossbite at an early stage may enable dentists to distinguish between subjects who require early treatment from those who do not.

We examined 44 deciduous anterior crossbite patients on regular 3-month intervals between the primary and the transitional dentition. All patients received no orthodontic treatment by our department. Examination revealed that self-correction of deciduous anterior crossbite occurred during either the primary dentition or transitional dentition. Characteristics of the crossbite before self-correction in 3-year-old patients were

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- the anterior crossbite range included all 8 primary incisors and both mandibular primary canines,
- there was no contact between the mandibular and maxillary deciduous canines in centric occlusion, and
- there were no occlusal conditions that might limit the movement of the mandible.

We also found the existence of positive overjet or edge-to-edge occlusion in the most retrusive mandibular positions.⁵

Nagahara et al⁶ reported morphological changes of deciduous anterior crossbites during the period from deciduous dentition to the eruption of the permanent central incisors. They divided the subjects into the following 3 groups:

- group N, in which the crossbite involved all 8 primary incisors and both mandibular primary canines and that corrected on its own when the permanent central incisors erupted;
- group R₁, in which the crossbite range was the same as that of group N but the crossbite remained unchanged following eruption of the permanent incisors;
- group R₂, in which the crossbite extended over all 8 primary incisors and both mandibular primary canines and remained that way until after the eruption of the permanent central incisors.

The skeletal characteristics of the subjects were evaluated using lateral cephalograms exposed when the subjects were 3 years old. They concluded that the mandibular position in group N was posterior compared with groups R₁ and R₂. Furthermore, the length of Pog'-Go was smaller in group N than in the other groups. The axial inclination of the lower central incisors in groups R₁ and R₂ was more lingually tipped than that in group N, and in group R₂, the S-N length was shorter than average and the maxilla underdeveloped. With the passing of time, group N showed an increase in maxillary size and mandibular forward growth was suppressed compared with groups R₁ and R₂. In addition, the amount of growth was reported to be the same in groups R₁ and R₂, whereas the difference in the size remained unchanged.

Based on information from the above-mentioned studies for early-stage prediction of self-correction of deciduous anterior crossbites, we sought to develop a method that would enable subjects who require early treatment to be distinguished from those who do not. We limited our study to 15 variables since the others have already been studied in Miyajima et al.⁸ The purpose of the present study was to make it easy for clinicians to determine whether to treat this malocclusion in 3-year-old subjects.

MATERIALS AND METHODS

Subjects

Of the 44 deciduous anterior crossbite patients who were examined but not provided with orthodontic treatment in

our department, 44 Japanese girls were chosen as the subjects in the present study. These 44 girls met the following criteria when they were 3 years old: absence of marked midline shift, normal number of teeth, and no history of caries or previous crown restoration. Furthermore, during the transitional dentition, the subjects had no deciduous crown restorations and all other dental conditions exhibited were the same as those exhibited when the subjects were 3 years old. These 44 subjects were examined using lateral cephalometric radiographs taken at age 3 with the child in centric occlusion.

Based on the radiographs, the patients were divided into 2 groups as follows (Figure 1): group N, in which the anterior crossbite self-corrected during the transitional dentition ($n = 22$), and group R, in which the crossbite persisted through the transitional dentition ($n = 22$). The mean age of both groups was not significantly different (Table 1).

Study methods

Data was recorded using a digitizer (Graphtec KD3200) and processed using a microcomputer (EPSON PC-486) and cephalogram analysis software (Versa-STAT, Yasunaga Computer System Co., Ltd.).

Lateral cephalometric radiographs were traced by a single person and checked by 1 other person in order to avoid interobserver errors. Fourteen measurements, as defined by Ricketts et al,⁹ and the Wits appraisal method proposed by Jacobson¹⁰ were applied. For each measurement, the variance ratio and the difference in population means between groups N and R were tested and t -values were derived. Subsequently, based on the results of the Student's t -test, only the parameters found to have a statistically significant difference ($P < .05$) were extracted. Predictor variables having a partial F value of 5 or greater were selected using stepwise discriminant analysis.^{8,11,12}

RESULTS

Comparison of the groups

The result of the t -test indicated significant differences ($P < .05$) existed in the following Ricketts et al⁹ measurements: cranial length anterior, cranial length posterior, posterior facial height, ramus position, porion location, and corpus length. Significant differences were also revealed in the Wits appraisal (see Table 2).

Discriminant analysis

A discriminant analysis was performed on the above-mentioned measurements, and the following 4 measurements were chosen: cranial length anterior, posterior facial height, porion location, and Wits appraisal (see Table 3).

Using the above-mentioned measurements, the following equation for identifying patients who require early treatment was derived: $y = -0.58(\text{cranial length anterior}) +$

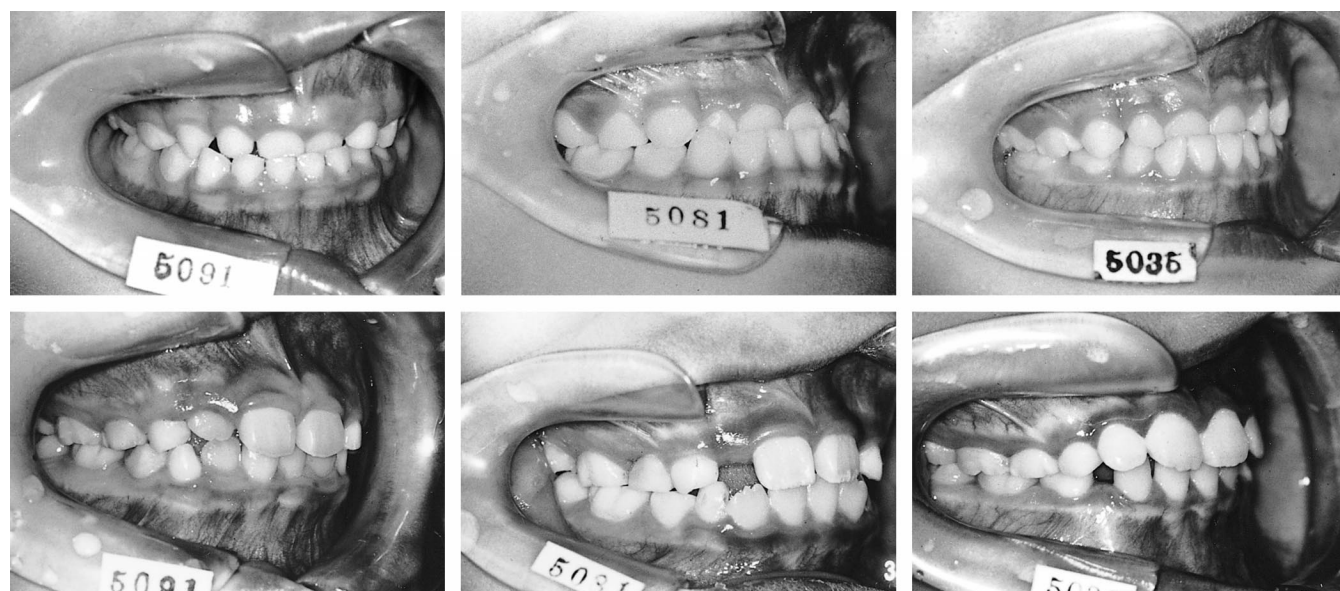


FIGURE 1. (A) Intraoral photographs from group N. Upper row is primary dentition and lower row is transitional dentition.

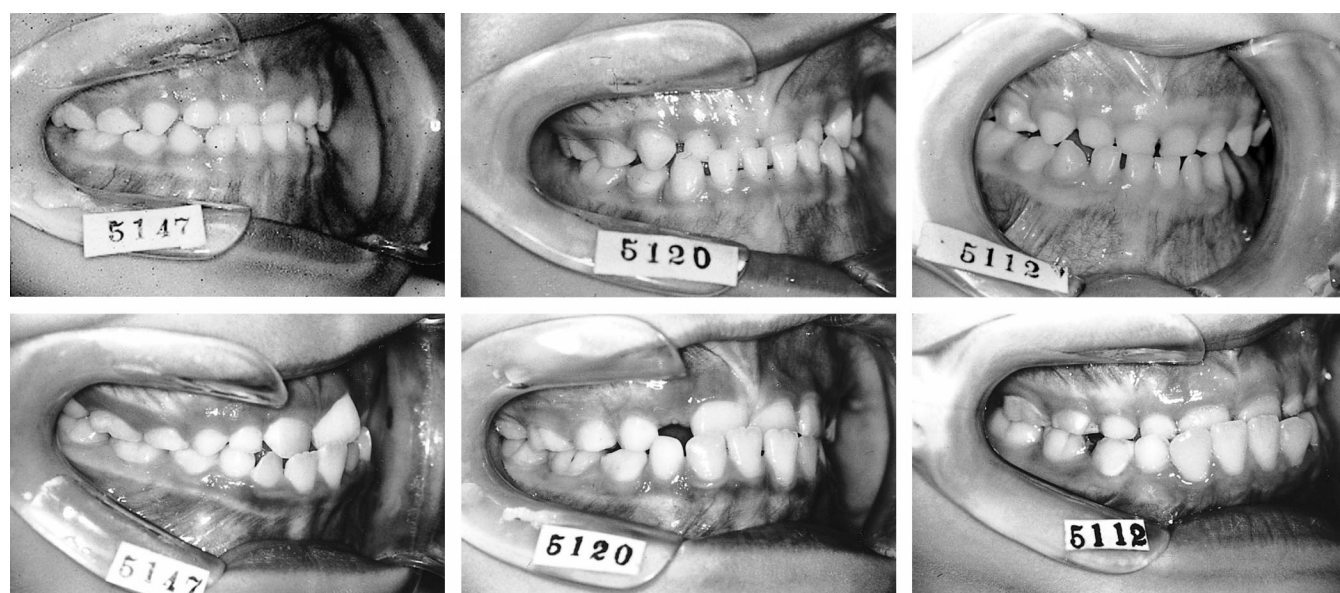


FIGURE 1. (B) Intraoral photographs from group R. Upper row is primary dentition and lower row is transitional dentition.

TABLE 1. Age (Months) of Groups N and R

Group (n)	Mean	SD	Statistical Significance ^a
N (22)	43.1	3.3	NS
R (22)	44.3	2.7	

^a NS, no statistically significant difference between groups N and R.

1.31(posterior facial height) – 0.76(porion location) – 2.02(Wits appraisal) – 70.28, where the y on the left-hand side of the equation is referred to as the deciduous indicator (DI).

Discriminant analysis of groups N and R using this equa-

tion resulted in only 1 error in each of the 2 groups. Therefore, the apparent error rate was 95.46%, which is very favorable. The Maharanobis' generalized distance was 8.99 (Figure 2).

DISCUSSION

Selection of study subjects

We examined 44 deciduous anterior crossbite patients at 3-month intervals between the primary and the transitional dentition. These patients received no orthodontic treatment in our department. Self-correction of crossbites occurred during the deciduous dentition in some patients and during

TABLE 2. Group Means, Standard Deviations, and *t*-Values Shown for 2 Groups

Variable	Unit	Group N (n = 22)		Group R (n = 22)		t-Value ^a
		Mean	SD	Mean	SD	
Ricketts						
Facial axis	(°)	90.1	3.3	89.1	2.6	1.0
Facial depth	(°)	84.3	2.4	85.0	2.5	0.9
Mandibular plane angle	(°)	28.5	3.1	28.4	4.0	0.1
Lower facial height	(°)	47.7	3.8	47.0	3.6	0.7
Mandibular arc	(°)	28.9	2.7	29.1	4.5	0.2
Total facial height	(°)	58.3	3.6	57.8	3.2	0.5
Convexity	(mm)	2.7	1.7	1.7	2.2	1.7
Cranial deflection	(°)	25.4	2.0	25.0	1.7	0.6
Cranial length anterior	(mm)	50.7	2.6	48.4	2.6	2.9**
Cranial length posterior	(mm)	37.7	2.3	40.0	2.4	3.3**
Posterior facial height	(mm)	46.9	2.5	48.7	1.7	2.7**
Ramus position	(°)	77.3	3.4	73.3	3.1	4.0***
Porion location	(mm)	−33.5	2.5	−36.4	2.6	3.8***
Corpus length	(mm)	54.3	2.1	56.1	3.1	2.3*
Jacobson						
Wits appraisal	(mm)	−4.1	1.7	−5.7	1.7	3.0**

^a Level of significance: * $P < .05$; ** $P < .01$; *** $P < .001$.

TABLE 3. Discriminant Analysis Between Groups N and R

Variable	<i>F</i> -Value	Discriminant Coefficient			
Cranial length anterior	7.45	-0.58			
Posterior facial height	23.58	1.31			
Porion location	13.05	-0.76			
Wits appraisal	37.49	-2.02			
Constant		-70.28			
		In/out	N	R	Total
Maharanobis' distance	8.99	N	21	1	22
Apparent rate	95.46%	R	1	21	22

the transition stage to permanent dentition in others. The latter group is referred to as group N. Group N consisted of 16 patients who took part in a study by Nagahara et al⁶ and 6 girls who had moved but who were asked to visit our department for the purpose of tracing their respective occlusal states.

The other 22 female patients (group R) were randomly selected crossbite patients. All subjects selected met the following criteria when they were 3 years old: absence of marked midline shift, normal number of teeth, and no history of caries or previous crown restoration. Furthermore, subjects with a transitional dentition had no deciduous crown restorations. These subjects were divided into 2 groups: 22 subjects whose anterior crossbite disappeared by self-correction during transitional dentition (group N) and the other 22 subjects, whose anterior crossbite persisted during transitional dentition (group R). Lateral cephalometric radiographs in centric occlusion were exposed for evaluation.

Differences between groups N and R

The results of the *t*-test indicated significant differences ($P < .05$) in the following parameters of the Ricketts et al⁹ method: cranial length anterior, cranial length posterior, posterior facial height, ramus position, porion location, and corpus length. The Wits appraisal by Jacobson¹⁰ was also significantly different.

The ramus position was significantly larger in group N than in group R, and the most retrusive mandibular position was a positive overjet or edge-to-edge dental relationship in all group N subjects. This indicated that the group N subjects were pseudo-Class III and the mandible was in a forward position. This, in turn, indicated a potential skeletal Class III pattern (group R). Furthermore, the cranial length posterior, porion location, and posterior facial height were significantly smaller in group N than in group R, suggesting underdevelopment of the posterior portion of the base of the cranium in the horizontal and vertical directions.

In contrast with group N, group R showed a significantly larger corpus length and Wits appraisal and a significantly smaller cranial length anterior. This indicated that the mandible was longer and that the anteroposterior positioning of the upper and lower central incisors was inadequate in group R as compared with group N. Hopkin et al¹³ mentioned that a shorter anterior base of the skull is believed to be responsible for the significantly frequent occurrence of Class III. Therefore, there is a tendency toward Class III in group R.

Selection of predictor variables

Rather than selecting parameters randomly, we narrowed the possible parameters affecting this condition through 2

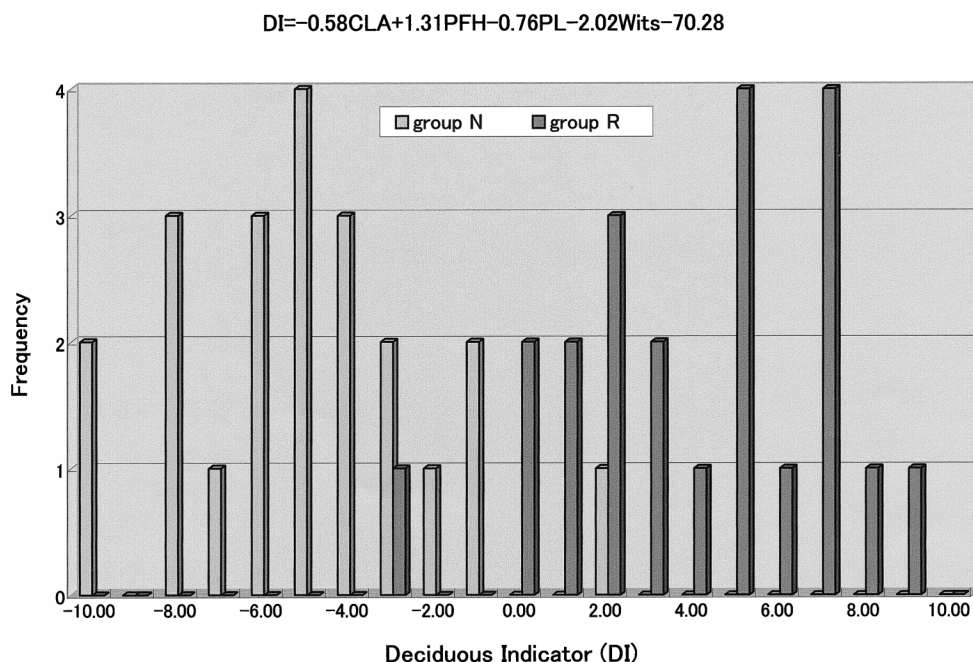


FIGURE 2. Bar graph of standardized discriminant scores.

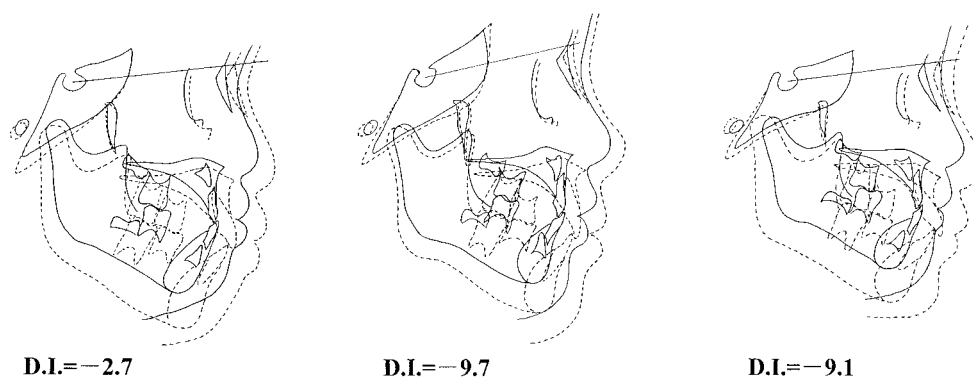


FIGURE 3. Composite cephalometric tracing of 3 sample cases from group N, where deciduous anterior crossbite showed self-correction at the transitional dentition.

steps in order to provide statistical objectivity. First, the difference in population mean was tested (Student's *t*-test). Next, a discriminant analysis was performed stepwise on parameters having a partial *F* of 5 or greater.^{8,11,12} Although the inclusion of more variables might improve the accuracy of an equation, doing so in this case results in the equation becoming redundant and less practical. Therefore, setting the value of a partial *F* for the variables should narrow the number of variables. Because no fixed value for a partial *F* exists, this value can be chosen at the researcher's discretion. The apparent error rate for the present study was 95.46% and Maharanobis' generalized distances were 8.99 when the partial *F* was set at 5 or greater. Errors of this system were so small as to be insignificant (Table 3). Therefore, setting the partial *F* value at 5 or greater can improve the practicality of the equation because the number of var-

iables is decreased and the equation is simplified without degrading its performance.

Clinical application of the equation

The possibility of the clinical application for DI was investigated using N and R cases in order to predict at an early stage self-correction of deciduous anterior crossbite. Three cases whose anterior crossbite was self-corrected during the transitional dentition are shown in Figure 3, and another 3 cases whose anterior crossbite persisted through the transitional dentition are shown in Figure 4.

The following equation was derived for identifying whether or not crossbite would self-correct: $DI = -0.58(\text{cranial length anterior}) + 1.31(\text{posterior facial height}) - 0.76(\text{porion location}) - 2.02(\text{Wits appraisal}) -$

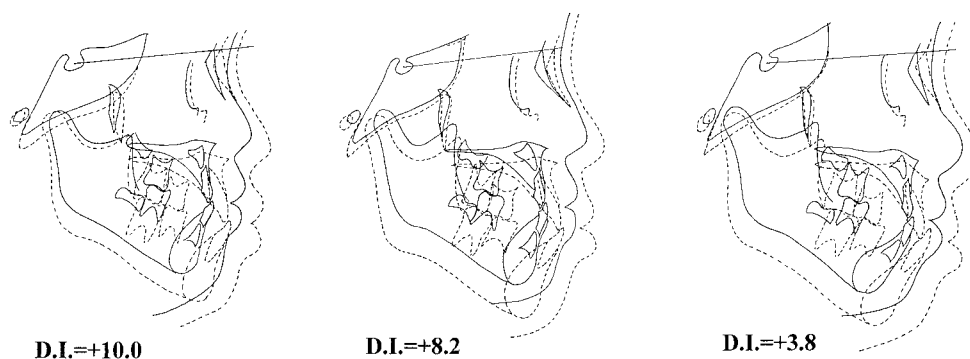


FIGURE 4. Composite cephalometric tracing of 3 sample cases from group R, where deciduous anterior crossbite persisted at the transitional dentition.

70.28. The lower the DI values (negative), the higher the probability that the crossbite will self-correct at transitional dentition. Therefore, a high (positive) discriminant score strongly suggests that the subject requires treatment in the primary dentition.

Cranial length anterior (1), posterior facial height (2), porion location (3), and Wits appraisal (4) were chosen as the predictor variables. Interpretation through roentgenographic cephalometry suggests that these parameters indicated (1) the length of the base of the anterior part of the cranium, (2) the height of the posterior part of the facial skull, (3) the length of the posterior part of the maxilla, and (4) the difference in anteroposterior direction of the central incisors of the maxilla and mandible, respectively.

Cranial length anterior, porion location, and Wits appraisal indicated Class III malocclusion, and posterior facial height indicated the height of the mandible, so that 4 measurements were applicable to the DI. In the field of orthodontics, each parameter is usually evaluated separately, and the present study is the first time a comprehensive evaluation using weighted parameters has been conducted. The advantage of this type of comprehensive evaluation lies in the ability to quantitatively derive an equation.

CONCLUSION

Based on the idea that a prospective evaluation of self-correction for deciduous anterior crossbite at an early stage enables subjects who require early treatment to be identified and distinguished from those who do not, an equation was generated for estimating the occlusal state at the transitional dentition for subjects that are 3 years old.

The following equation was developed: $y = -0.58(\text{cranial length anterior}) + 1.31(\text{posterior facial height}) - 0.76(\text{porion location}) - 2.02(\text{Wits appraisal}) - 70.28$. We called the y value on the left-hand side of this equation the deciduous indicator, or DI.

Discriminant analysis between groups N and R using the above equation resulted in an apparent error rate of 95.46% and Maharanobis' generalized distances of 8.99. The test

reliability of this algorithm on an independent population is not available at this time, but it would be possible to report in another paper.

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