Rating the characteristics of malocclusion: A systematic approach for planning treatment

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In a previous publication[1] we described a classification procedure for malocclusion which was based on systematic description of five characteristics of malocclusion. The scheme was designed to extend the Angle system and overcome its major weaknesses. Specifically, it provided a format for considering the effect of arch length problems, with or without an influence on the profile; took into account the effect of tooth position on facial esthetics; covered the transverse (cross-bite) and vertical (bite depth) planes of space as well as the anteroposterior plane; and differentiated skeletal and dental problems at the level of the individual planes of space. This approach is quite useful in teaching situations. It has proved most helpful to experienced orthodontists in complex cases, particularly those in which surgical as well as orthodontic procedures may be required. Routine malocclusions may not require so systematic an approach, simply because fewer factors must be considered.

We hoped originally that the classification system, despite its use of only five characteristics, was complete enough that a diagnosis would be inherent in the classification and that a treatment plan would logically emerge. This has proved not to be the case, for three reasons. First, the classification is merely a description of the morphologic problems. Although malocclusion is usually thought of as a different-from-ideal anatomic situation, other factors must be considered in making a treatment plan. The "data base" for treatment planning is incomplete if only an anatomic description is used.

A second difficulty in relating treatment planning directly to our classification scheme is that the original classification contained no quantitative elements per se. Not only the nature but the degree of variation from the ideal must be

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History: medico-dental, social, behavioral
Oral exam: function, other pertinent factors
Systematic description (structural analysis):

Alignment	
Profile/Esthetics	
Cross-bite	**Skeletal**
Class (Angle)	**Dental**
Bite depth	

Fig. 1. Orthodontic data base.

taken into account. This would be less true were it not for the third problem, which is related to classification (description) based on the concept of ideal occlusion. Ideal occlusion, ideal esthetics, and ideal stability after treatment are three major goals of orthodontic treatment. Angle wrote of achieving perfect harmony, but frequently these goals are incompatible. Ideal esthetics may require some compromise in occlusion plus permanent retention, for instance; or in the same person ideal occlusion and reasonable stability may be obtained at the cost of poor esthetics. Quantitative classification, allowing systematic ranking of deviations from ideal, becomes particularly important when such compromises must be part of a treatment plan. These compromises have nothing to do with lack of treatment solutions. This aspect of medical treatment planning is discussed comprehensively by Weed.[2]

In this article we present a systematic approach to orthodontic treatment planning in complex problems. It is based on the collection of an adequate data base; a quantitative systematic description of the malocclusion, which generates a list of problems and therefore defines the treatment objectives; tentative treatment plans for the individual problems; and generation of a final treatment plan based on interaction among the tentative solutions to the problems.

Data base for orthodontic diagnosis and treatment planning

The data base for orthodontic purposes can be divided into three areas: (1) medical, social, and behavioral history; (2) oral examination and other pertinent findings; and (3) analysis of the traditional orthodontic diagnostic records (Fig. 1). Since problems may be related to any of these areas, all must be taken into account. The patient's self-image, part of the behavioral history, is a potential problem-generating area which is frequently neglected. As oral physiology and form-function relationships become better understood, data on functional patterns will become increasingly important for making decisions about treatment. The etiology of malocclusion is contained within these two areas and will not be found from a structural analysis. Nevertheless, it is true that decisions about orthodontic treatment still must be based largely on morphologic criteria deduced from structural analysis of a malocclusion's characteristics.

Rating scales with Ackerman-Proffit group classification

Several systems[3-6] for scoring the extent of malocclusion have been proposed in the past few years. These methods are used particularly by third parties (the

military, state agencies, insurance companies) to establish priorities for orthodontic treatment and/or payment for treatment.

All the current indices have in common an aim of describing the degree of malposition of the teeth, and all attempt to do this "objectively," by making quantitative measurements of dental displacements, such as overjet, overbite, and deviation of individual teeth from ideal position in the dental arch. The methods are usually cumbersome to apply, since there are many measurements to be made which are not part of a normal diagnostic work-up. More seriously, much pertinent cephalometric and other information that is part of a normal, thorough morphologic evaluation is not included in most indices because it cannot be expressed in terms of easily defined measurements. Rigid definitions of the various measurements are necessary to obtain reproducibility of the scores, particularly if nonprofessionals generate the malocclusion scores, but this has a tendency to reduce complex judgments to oversimplifications. The selection of criteria for the "objective" indices introduces a silent but pertinent subjective component.

Another approach to the problem of scoring deviations from ideal is the use of rating scales. These are commonly employed to deal with situations in which integration of complex variables into a "judgment call" is required. Familiar examples are grades on essay examinations (A through F), military efficiency reports (0=poor, 5=very good), laboratory pathology reports (malignant tissue: grade 1=relatively well differentiated, grade 4=highly anaplastic), etc. If a logical outline is used for evaluation and synthesis of the pertinent information, reasonable validity of the rating scales can be established. It is obvious that the synthesis-judgment approach of the group classification system lends itself to this approach.

At this point, the purpose of the quantitative rating must be closely examined. If the purpose of the rating is to establish priorities for treatment of a group of patients, interexaminer reliability is important, since it is unlikely that the same examiner will see all patients. This purpose is stated or implied for the various indices of malocclusion. If the purpose is to establish priorities for treatment of multiple problems within the same patient, interexaminer differences are less important.

For the second purpose, which is the focus of this article, rating scales are entirely satisfactory. There has been no test of rating scales versus the various indices of malocclusion. Experiences at the Universities of Kentucky and Pennsylvania indicate that graduate students and faculty have no difficulty in producing similar ratings, but these individuals have more similar backgrounds than orthodontists generally. In the large-scale Burlington (Ontario) study of epidemiology of malocclusion, it was also observed that the orthodontic staff reasonably reproduced clinical judgments using a rating scale.[3] Freer and associates[7] have recently observed good, though not perfect, agreement among orthodontists rating study models. It may be, therefore, that the rating scales will work for the first purpose also if (and only if) the judgments are made by orthodontists.

Method for scoring

Although with experience we have modified the group classification system slightly, it remains essentially as described in the previous publication.[1] The symbolic logic of the classification, as expressed in its Venn diagram, poses a misleading impression of complexity. For use of the system, qualitatively or quantitatively, it is necessary only to describe, in sequence, the five characteristics which are included in the classification. The brief written description provides the first step in scoring the malocclusion

The first characteristic, *alignment,* is described on the basis of the dental casts only, as examined from an occlusal view. Alignment of the teeth within the arches and internal symmetry of the arches are noted. In this, as in all characteristics, only deviations from the near-ideal are noted.

The second characteristic of the classification, *profile,* is extended now to include facial esthetics in broader view and is better expressed as *profile and facial esthetics.* The examination is of the patient himself or of photographs, including full-face views. For details of dentoalveolar protrusion as it affects the profile, cephalometric films may also be used.

The interarch relationships in three planes of space, as seen in the occluded dental casts and in the cephalogram, are examined next. Deviations from normal occlusion are noted in the transverse plane as *cross-bite;* in the anteroposterior plane as *Angle class;* and in the vertical plane as *bite depth.* In each plane of space, a distinction is made between skeletal and dental components of the malocclusion, or if both contribute to the problem this is noted. A brief description, summarizing pertinent deviations from ideal relationships, suffices.

By the logic of the system, any characteristic not described is defined as normal. The group numbers, taken the original Venn diagram, serve only to indicate the characteristics that are described. The group number, in itself, has little meaning. The brief description, not the group number, is the classification. Diagnostic information from all available sources has been synthesized by the orthodontist in writing these descriptions, which will differ in style and format from one individual to another but which should contain the same essential information.

The rating scales are produced by placing ideal characteristics at one end of an arbitrary scale (score=0 for ideal) and extreme deviations at the other end (score=5 for maximum deviation). In our use, all characteristics are scored on a five-point scale. The rating scales and definitions are shown in Fig. 2.

As each characteristic of the malocclusion is assessed, the severity is also scored. Consider, for example, a patient who has a complete bilateral maxillary palatal cross-bite. The maxilla is judged to be hypoplastic, on the basis of the finding of a high, constricted palate. It should be clear that this cross-bite problem would be scored somewhere between 3 (moderate—this deviation alone would justify treatment) and 5 (severe—the patient is handicapped because of this deviation). If function is impaired or if the patient manifests temporomandibular joint symptoms, then one would rate the characteristic as 5. If there were no obvious functional problems, one might rate the cross-bite as 3 or 4.

Characteristic	Ideal		Slight	Moderate		Severe
Alignment	0	1	2	3	4	5
Profile/Esthetics	0	1	2	3	4	5
Cross-bite	0	1	2	3	4	5
Class (Angle)	0	1	2	3	4	5
Bite Depth	0	1	2	3	4	5

Definitions:

0—Ideal; no deviations.

1—Slight; deviation from ideal exists; however, patient would not require treatment if this were the only characteristic involved.

2—Slight-moderate.

3—Moderate; this deviation from ideal alone would justify treatment.

4—Moderate-severe.

5—Severe; the patient is handicapped because of this deviation.

Fig. 2. Rating scales and definitions for quantitative group classification.

When there is a skeletal component to a problem, one should tend toward a higher rating. All other characteristics of this patient would be rated similarly.

An interesting aspect of this method is that it may be used for initial examination as well as with complete diagnostic records. Rekow[8] found, in patients being screened for the clinics at the University of Kentucky, that the scores from visual examination at the initial appointment were within ± 10 per cent of scores obtained later when complete diagnostic records were available.

When this has been done for each of the characteristics, they are then listed in the descending order of their severity. This list outlines the ideal treatment objectives, which are the correction of the listed problems.

Individualized treatment planning from problem lists

As we have pointed out above, it may not be possible to correct all of a patient's problems in a complex case. The list of problems related to individual characteristics, ranked in order of severity, now serves two purposes: (1) it gives a preliminary list of treatment priorities, and (2) it reduces a complex situation to a series of smaller problems which are easier to solve singly. The logical sequence of steps from problem list through tentative treatment plans to final treatment plan is outlined in Fig. 3.

As a first step in treatment planning, tentative solutions for each individual problem are listed in terms of general procedures, not specific mechanotherapy. The aim at this point is to consider the possibilities systematically. Only after the tentative solutions to individual problems have been written (not before, if the maximum potential for generating ideas is to be realized) should the necessary compromises for a final over-all treatment plan be considered. Individualized treatment objectives, specific treatment sequences, and therapeutic modifiability (the ability of treatment to correct the deformity[9]) are all appropriate considerations at the last step in making the final treatment plan.

Rating scales for expected treatment benefits can also help in evaluating the tentative treatment plans. In the previous example of the bilateral cross-bite, the

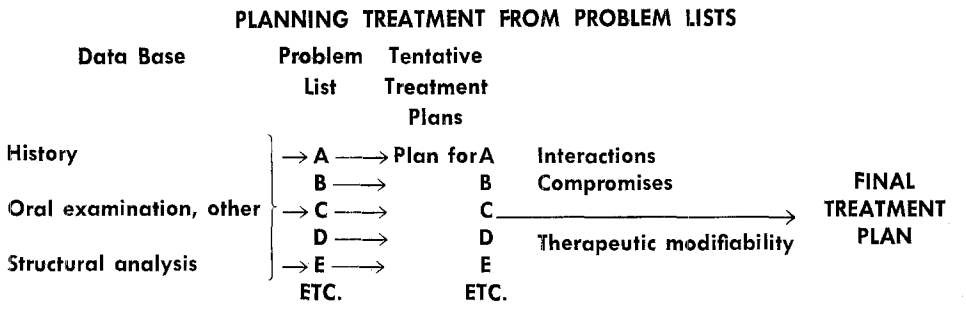


Fig. 3. Logical sequence in treatment planning.

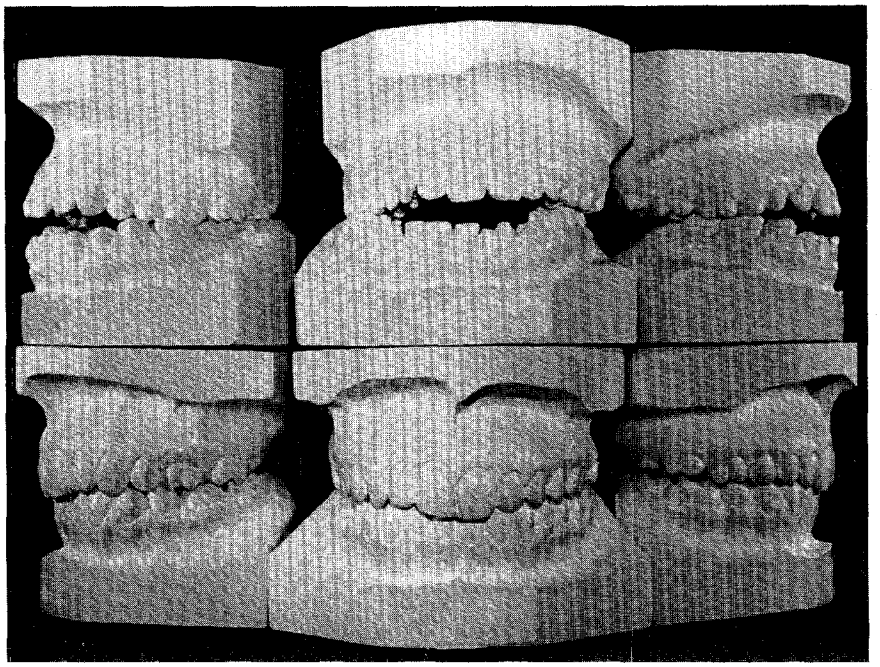


Fig. 4. Initial and posttreatment dental casts of Patient J. M.

tentative treatment plans would involve expansion of the maxillary arch. One might consider rapid maxillary expansion, which could modify this characteristic from 4 points to 1 on the deviation scale. On the other hand, if dental expansion had to be used, it might only be possible to reduce the problem to 2. In an adult, if the improvement from dental expansion was not sufficient, surgical intervention would have to be considered. Thus, the same rating scale used for assessing the severity of the problem can also be used to express the therapeutic modifiability. In this application, the rating scales contribute to a cost-benefit type of analysis. Cost is taken in its broadest sense, including patient discomfort and risk as well as economic factors. The rating scale expresses quantitatively the expected treatment benefit and would allow treatment results to be compared to a goal other than ideal occlusion.

The final treatment plan that is written for the patient takes into account

the necessary compromises between conflicting goals and possibilities. This final treatment plan represents, then, the individualized treatment objectives for that patient.

The application of these concepts is illustrated with a brief case review. (A case report on this patient has been published previously.[10] Here, only an abstract emphasizing diagnostic records is presented. Details of diagnostic findings and treatment results are given in the previous publication.)

J. M., a 19-year-old white female patient, was referred to the National Institute of Dental Research for treatment of mandibular prognathism, severe anterior open-bite, and facial asymmetry. A body cast for treatment of scoliosis had been worn between the ages of 12 and 14. The malocclusion was reported to have developed subsequently. There was a long history of motor disability with generalized muscular weakness. The patient had completed high school satisfactorily but particularly desired treatment of the facial deformity before attempting college.

The orthodontic diagnostic records are shown in Figs. 4 to 7. Functional analysis showed that there was a mandibular shift to the left, which accentuated the skeletal asymmetry. Intermittent temporomandibular joint pain was reported.

From the data base provided by these records, a problem list can be derived as follows:

History: Scoliosis, generalized muscular weakness, progressive open-bite.

Examination, other: Mandibular shift; resistance to treatment stress?

Characteristic	*Rating (0-5)*
Alignment: 3| missing, maxillary dental asymmetry; mandibular incisor crowding	3
Profile/Esthetics: Convex lips, prominent chin, mandibular skeletal asymmetry	5
Cross-bite: Mandibular buccal, unilateral right, skeletal	4
Class (Angle): III skeletal	4
Bite depth: Severe anterior open-bite, skeletal and dental	5

A tentative treatment plan for each of the individual problems ranked in order of severity was as follows:

Problem 1: History of progressive open-bite, myopathy, scoliosis
Plan: Identify nature of myopathy, if possible

Problem 2: Profile/Esthetics—Convex lips; prominent chin with skeletal asymmetry, chin to left
Plan: A. Orthodontic retraction of incisors
B. Mandibular surgery to reposition chin in all three planes of space, if possible
Estimated rating after treatment: 1

Problem 3: Bite depth—Severe anterior open-bite, skeletal and dental
Plan: A. Mandibular surgery to position chin upward: body procedure?

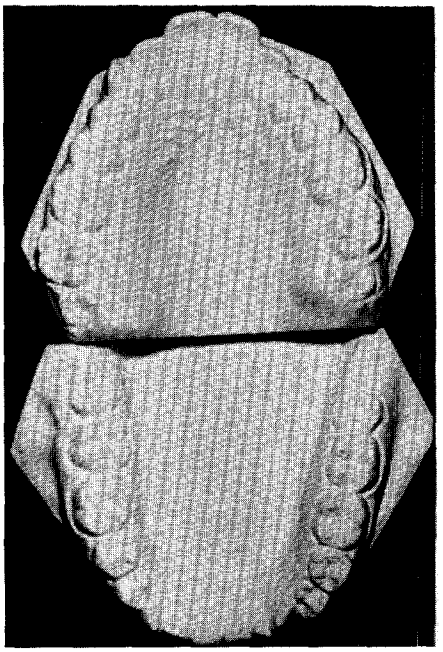


Fig. 5. Occlusal view, initial casts, Patient J. M.

B. Molar extraction to collapse bite posteriorly?

Estimated rating after treatment: 3 if A or B; 1 if both

Problem 4: Class III skeletal

Plan: Mandibular surgery to position chin distally? Ramus procedure? Body procedure?

Estimated rating after treatment: 0

Problem 5: Cross-bite—Mandibular skeletal cross-bite, unilateral right

Plan: Mandibular surgery to reposition chin transversely: ramus procedure

Estimated rating after treatment: 1

Problem 6: Alignment—Maxillary dental asymmetry, 3 missing; mandibular incisor crowding

Plan: Extract teeth, maxillary left, mandibular left and right; Which teeth?

Estimated rating after treatment: 0

Problem 7: Possible poor response of patient to stressful treatment

Plan: Establish realistic prognosis; provide excellent support

The estimated rating after treatment can represent the end of active treatment or postretention, if these might be different.

Although not all possibilities for treating the various problems are listed, it is apparent that correction of some problems conflicts with others. For example, surgical intervention in the body of the mandible would offer an advantage in closing the open-bite, but it would not allow nearly so good a correction of the facial asymmetry. Molar extraction in the lower arch would facilitate correction of the open-bite, but it would not allow much, if any, retraction of incisors and

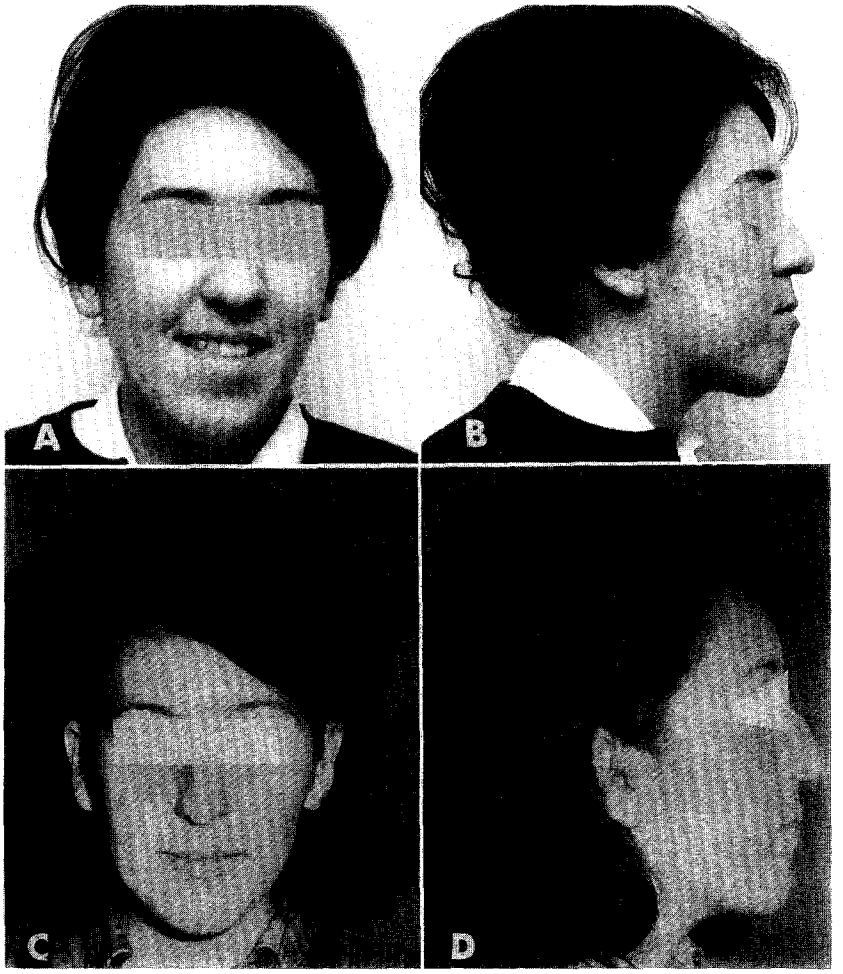


Fig. 6. Pre- and posttreatment facial photographs of Patient J. M.

correction of lip convexity. Diagnostic setups and cephalometric predictions were used to examine the effects of various treatment approaches.

The final treatment plan considered the interactions among the possibilities and reflects, with the necessary compromises, the individual treatment objectives for this patient:

Treatment plan: (1) Extraction of mandibular right and left first molars, and maxillary left second premolar; (2) closure of space orthodontically, correcting the asymmetry and the dental component of the open-bite; (3) mandibular osteotomy in the ramus, correcting the skeletal asymmetry and protrusion; (4) detailed tooth positioning, orthodontically.

Relationship to computer diagnosis and treatment planning

In a sense, the procedure used to complete the orthodontic data base (including quantification of characteristics) establishes a syndrome of malocclusion. Writing a treatment plan becomes a process of maximizing possible gains

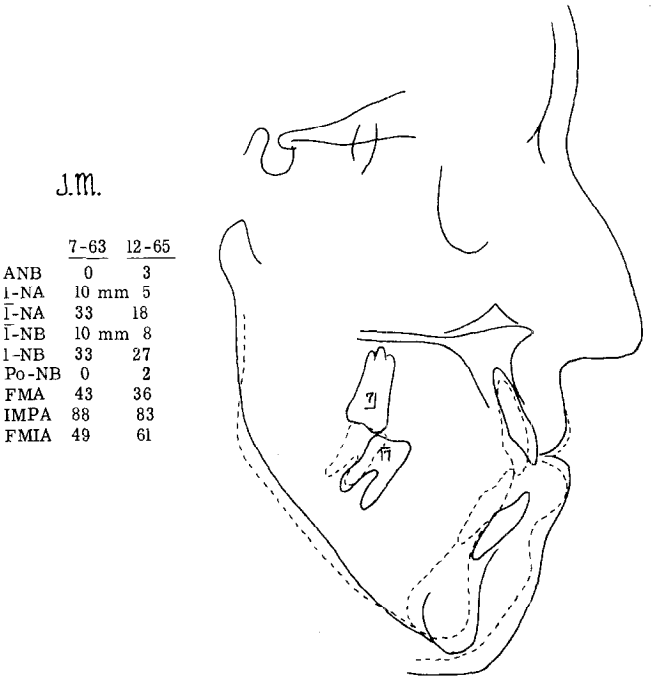
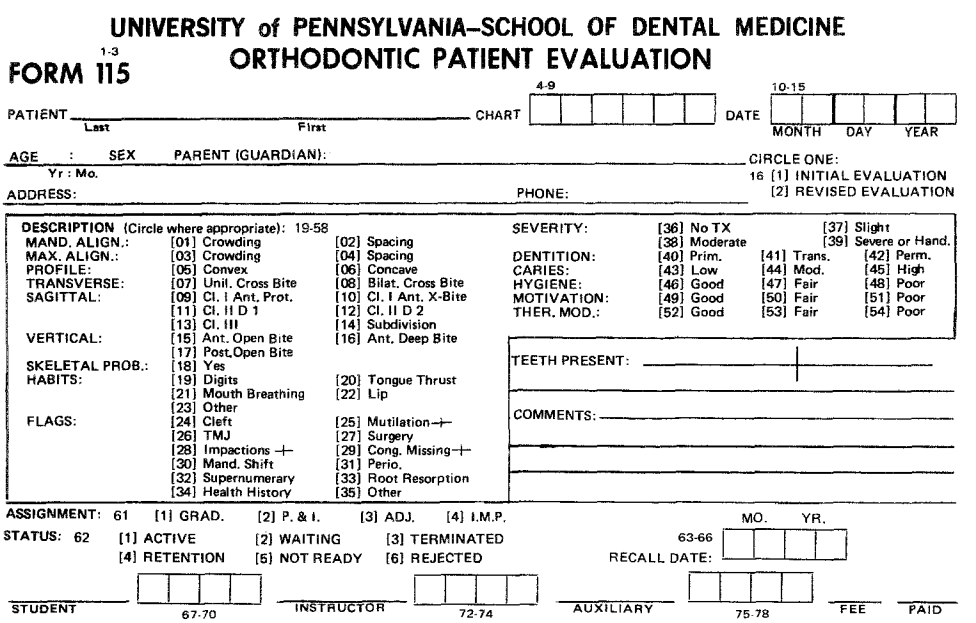


Fig. 7. Cephalometric tracings of Patient J. M.

through therapy by achieving the best balance between goals which may conflict. A sequence of steps in therapy to accomplish the desired objective can then be written, with contingencies accounted for if needed. It is obvious that a large number of syndromes and treatment plans defined in this manner exist, but the number is finite. The matching is among hundreds or thousands—but not millions—of possibilities. Such a situation lends itself to electronic data handling. A computer could calculate quickly the match between a syndrome and treatment sequences previously found to be effective in similar circumstances.

Placing information in computer-compatible form requires systematic data collection and organization. The organization of the data base, as described here, meets this requirement. Simple coded forms are now being used in university clinics to put patient data into a computer file, and the entire data base can easily be handled in this fashion. One such coded form (Fig. 8), which can be keypunched and used as a patient's master computer file, provides demographic data, descriptive and diagnostic data, and dispositional data which are used for administrative purposes. The descriptive data follow the format of the characteristics of malocclusion. At the present time the information is coded without a rating scale, but the rating scales can be added readily with this computer format.

Until it is possible to evaluate etiologic factors in malocclusion more thoroughly than at present, even the best treatment plan contains significant uncertainties. These relate to varying degrees of morphologic and psychologic patient responses to treatment. We have previously discussed treatment response as an important element in treatment planning.[11] Obviously, a treatment plan



UNIVERSITY of PENNSYLVANIA–SCHOOL OF DENTAL MEDICINE

FORM 115 (1-3) ORTHODONTIC PATIENT EVALUATION

PATIENT Last First CHART (4-9) DATE (10-15) MONTH DAY YEAR

AGE Yr : Mo. : SEX PARENT (GUARDIAN): CIRCLE ONE: 16 [1] INITIAL EVALUATION [2] REVISED EVALUATION

ADDRESS: PHONE:

DESCRIPTION (Circle where appropriate): 19-58

MAND. ALIGN.:	[01] Crowding	[02] Spacing
MAX. ALIGN.:	[03] Crowding	[04] Spacing
PROFILE:	[05] Convex	[06] Concave
TRANSVERSE:	[07] Unil. Cross Bite	[08] Bilat. Cross Bite
SAGITTAL:	[09] Cl. I Ant. Prot.	[10] Cl. I Ant. X-Bite
	[11] Cl. II D 1	[12] Cl. II D 2
	[13] Cl. III	[14] Subdivision
VERTICAL:	[15] Ant. Open Bite	[16] Ant. Deep Bite
	[17] Post.Open Bite	
SKELETAL PROB.:	[18] Yes	
HABITS:	[19] Digits	[20] Tongue Thrust
	[21] Mouth Breathing	[22] Lip
	[23] Other	
FLAGS:	[24] Cleft	[25] Mutilation–+
	[26] TMJ	[27] Surgery
	[28] Impactions –+	[29] Cong. Missing–+
	[30] Mand. Shift	[31] Perio.
	[32] Supernumerary	[33] Root Resorption
	[34] Health History	[35] Other

SEVERITY:	[36] No TX	[37] Slight	
	[38] Moderate	[39] Severe or Hand.	
DENTITION:	[40] Prim.	[41] Trans.	[42] Perm.
CARIES:	[43] Low	[44] Mod.	[45] High
HYGIENE:	[46] Good	[47] Fair	[48] Poor
MOTIVATION:	[49] Good	[50] Fair	[51] Poor
THER. MOD.:	[52] Good	[53] Fair	[54] Poor

TEETH PRESENT:

COMMENTS:

ASSIGNMENT: 61 [1] GRAD. [2] P. & I. [3] ADJ. [4] I.M.P.

STATUS: 62 [1] ACTIVE [2] WAITING [3] TERMINATED [4] RETENTION [5] NOT READY [6] REJECTED

MO. YR. 63-66 RECALL DATE:

STUDENT (67-70) INSTRUCTOR (72-74) AUXILIARY (75-78) FEE PAID

Fig. 8. Coding form for computer handling of data base.

that is not working must be altered. Systematic review of treatment response and utilization of this information are not emphasized in most discussions of computerized treatment planning. If updated information on patients is provided on a regular basis, the superior data-processing capabilities of the computer can be used to provide better feedback about treatment response. This feature should be part of future computerized treatment planning services. Routine submission of treatment progress data, using forms coded in the office or clinic in the same way that charts are written now, will permit treatment planning feedback along with other desired practice-control features.

Summary and conclusions

An adequate data base for orthodontic classification, diagnosis, and treatment planning contains a history of medico-dental, social, and behavioral items, including an evaluation of the patient's self-image; findings from oral examination (including functional analysis of mastication, swallowing, speech) and other pertinent information; and a systematic description of the malocclusion, such as that provided by the Ackerman-Proffit group classification with quantitative rating scales. This produces an individualized problem list for the patient.

Careful production of the data base and generation of a list of specific problems related to it are particularly important when complex cases are being evaluated. Optimum occlusion, esthetics, and stability may be incompatible goals in such cases. Interaction among possible solutions to specific problems is likely, so that solving one problem may make another worse. The best procedure is to list individual solutions to individual problems, producing a tentative treatment plan. Judgments about compromises between conflicting treatment objec-

tives, therapeutic modifiability of conditions, and type of mechanotherapy are made as a final treatment plan is written.

The data base should be organized in a fashion that lends itself to electronic data handling.

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There is one other thing which seems to me to be of importance, and that is the establishment of a definite method for educating the profession in orthodontia, and educating the laity in the care of children. Certainly the profession in orthodontia, and educating the the privilege of attending the orthodontia meetings and to come in almost daily contact with the orthodontists. There is little provision whereby the laity may become acquainted with the needs of their children. (Castro, F. M.: President's Address, Transactions of the Ninth Annual Meeting of the American Society of Orthodontists, Cleveland, Ohio, Oct. 4-6, 1909.)