Consistency of patient classification in orthodontic diagnosis and treatment planning

Larry S. Luke, DDS, MS; Kathryn A. Atchison, DDS, MPH; Stuart C. White, DDS, PhD

It is a common experience in postgraduate orthodontic programs for a student to approach several different instructors for their diagnosis and treatment plan for a particular patient. Invariably, the student will come away with several different treatment plans. As one instructor explains, "There are many roads to Rome." While this is undoubtedly true, one would hope that some of the roads are straighter, better paved, and more comfortable to travel on than others.

The discipline of orthodontics is unique in dentistry in that it is not usually concerned with the diagnosis or treatment of a disease. Rather, orthodontic problems often evolve from perceptions that variations from norms for growth and development of the face or occlusion are unacceptable either to the patient, the parent or guardian, or the clinician. Deciding how and when to treat is a complex process involving perceptions of outcomes. These include health risks and the likelihood of cooperation as perceived by the dentist, improvement of appearance and health versus discomfort and inconvenience for the patient, and financial costs for the payer. Bader and Shugars[1] outlined three phases of clinical decision-making:

- Diagnosing and detecting
- Deciding whether to intervene
- Selecting a treatment

Few have attempted to analyze the process by which clinicians diagnose and plan treatment for orthodontic problems. Weed[2] suggested the use of a problem-oriented record for use in medical records. Ackerman and Proffit,[3] building on the problem-oriented approach, suggested a system for orthodontic classification based on five major characteristics of malocclusion. They used a synthesis of the Angle[4] system and the Venn diagram to visualize interrelationships of alignment,

Abstract

The purpose of this study was to examine diagnosis and treatment planning categorizations used by experienced orthodontists. Thirty-nine clinicians were asked to evaluate six test cases and formulate a diagnosis and treatment plan for each. The information provided was categorized using a problem-oriented classification. The results indicate little agreement exists in diagnostic subcategories, such as molar relationship, degree of crowding, or the nature of skeletal discrepancies. There was also little agreement regarding some treatment strategies, such as extraction of teeth, the use of orthopedic appliances, or the use of surgery. A need exists for better definitions of diagnostic criteria and appropriate treatment options.

Key Words

Diagnosis • Decision-making • orthodontics

Submitted: October 1997 **Revised and accepted:** February 1998 Angle Orthod 1998;68(6):513-520.

the profile, and transverse, sagittal, and vertical deviations. Han et al.[5] analyzed the effect of diagnostic records on orthodontic treatment decisions and demonstrated the importance of study models in treatment planning. Atchison et al.[6,7] evaluated the impact of radiographs on orthodontic diagnosis and treatment planning and concluded that most of the diagnostic certainty could be attained before radiographs were examined. While there is a fair consensus on how to arrive at the diagnosis, it is not clear how uniformly clinicians agree on what they see or on what constitutes the best treatment.

The use of any classification scheme assumes that all clinicians agree on the definitions of the various categories used. Several studies of clinical decisions related to radiographic and restorative diagnosis and treatment planning have demonstrated large differences between practitioners.[8-10] Factors have been suggested that could account for such differences during diagnosis, such as carefulness or thoroughness of inspection, skill in examination and use of tools, and varying criteria for classification.[1] Differences during treatment planning may be caused by risk factors, perceptions of progression of the condition, varying treatment options, and various patient or payee related issues.

Baumrind et al.[11] investigated the agreement between five orthodontists for 148 subjects and found disagreements in the classifications of 29% of the adult subjects and 27% of the adolescents. In almost two-thirds of the subjects, all five examiners agreed either to extract or not extract teeth for treatment. Although the subjects had been preselected not to need surgery, 9% of the evaluations suggested that surgery was probably or definitely in order; one or more of the clinicians believed that surgery was probably or definitely appropriate for 29% of the adults and 23% of the adolescents.

The purpose of this study was to examine the categorization used by experienced orthodontists for orthodontic diagnosis and treatment planning and to determine the level of agreement in the use of the categories.

Materials and methods

The design for this study has been previously described.[6] To summarize, the records of six patients (study models, photographs, radiographs, and examination information) were selected and duplicated from the records of patients seen for treatment at the University of California, Los Angeles, orthodontic clinic. Representative records of the six patients have previously been published.[7] The patients were chosen to represent varying ages, both sexes, and common malocclusion problems. Thirty-nine experienced orthodontists who were either members of the Pacific Coast Society of Orthodontists in southern California and/or faculty members at dental schools were interviewed by one of the authors. Each interview lasted approximately 2 hours.

A standardized interview format was used. The orthodontist was shown the patient's records except for radiographs and then asked, "What is your diagnosis of the problems?" The response was recorded. There was no effort by the interviewer to guide the response. The orthodontist was then asked, "What is your treatment plan after reviewing the clinical information?" and the response was recorded again. Again, no efforts were made to guide the response. The orthodontists were then allowed to select radiographs they desired to complete the records and were asked if they wished to change the diagnosis and/or treatment plan. All changes were recorded and a final diagnosis and treatment plan was obtained.

The diagnostic data were categorized using the five major malocclusion characteristics suggested by Ackerman and Proffit.[3] Subcategories were determined by the recorded responses from the orthodontists. Treatment responses were categorized according to extraction decision, headgear and/or functional appliance choice, and surgery decision. All the orthodontists used an edgewise appliance as their primary choice for comprehensive treatment in the permanent dentition.

Results

The responses by patient and category are shown in Table 1. For most categories, the most prevalent finding was "no response," since the responders were not guided to complete the categories. The "no response" could reflect that there was no problem, or that the orthodontist did not recognize that there was a problem, or that the orthodontist recognized a problem but chose not to report it. Most orthodontists were consistently brief in their responses, although one was unusually thorough. The "yes" responses do not necessarily indicate that the orthodontist saw a problem, only that he or she noted the category. For instance, if the orthodontist noted that the patient was caries-free, that would count as a "yes" response in the caries subcategory since it was noted in the diagnosis. Those subcategories with many "yes" responses were usually the ones the orthodontists identified as having the greatest degree of problem, or they

Table 1
Diagnostic categories determined by orthodontist responses

Category/Subcategory	Patient A (n=39) Y*	N**	Patient B (n=39) Y	N	Patient C (n=39) Y	N	Patient D (n=39) Y	N	Patient E (n=39) Y	N	Patient F (n=39) Y	N	Total n=234 Y%	N%
Sagittal														
Molar classification	31	8	36	3	36	3	30	9	21	18	33	6	80	20
Canine classification	11	28	3	36	0	39	2	37	7	32	0	39	10	90
Skeletal discrepancy	15	24	32	7	33	6	11	28	14	25	14	25	51	49
Overjet	21	18	19	20	15	24	4	35	2	37	6	33	29	71
Incisor angulation	20	19	24	15	25	14	0	39	3	36	15	24	37	63
Anterior crossbite	0	39	0	39	0	39	0	39	10	29	0	39	4	96
Transverse														
Posterior crossbite	0	39	0	39	0	39	22	17	28	11	26	13	32	68
Arch width	1	38	3	36	3	36	21	18	22	17	22	17	31	69
Asymmetry/functional shift	4	35	15	24	1	38	8	31	10	29	24	15	26	74
Midline	2	37	16	23	1	38	5	34	8	31	14	25	20	80
Vertical														
Overbite	31	8	28	11	17	22	36	3	15	24	22	17	64	36
Face type-length	17	22	13	26	10	29	31	8	11	28	16	23	42	58
Soft tissue problem	10	29	5	34	12	27	20	19	12	27	35	4	40	60
Alignment														
Crowding	26	13	34	5	23	16	30	9	32	7	29	10	74	26
Missing	1	38	0	39	9	30	0	39	18	21	21	18	21	79
Profile														
Profile	9	30	7	32	0	39	5	34	5	34	9	30	15	85
Oral health														
Periodontal	2	37	2	37	1	38	3	36	30	9	0	39	16	84
Caries	1	38	1	38	0	39	3	36	19	20	5	34	12	88
TM disorder	5	34	6	33	4	35	4	35	9	30	6	33	15	85

*Y = response; **N= no response

represented common measures for classifying malocclusion, e.g., molar classification or overbite.

The category with the largest number of subcategories was the sagittal, followed by the transverse. The subcategories showing the largest number of "yes" responses were: molar classification (80%), crowding (74%), overbite (64%) and skeletal discrepancy (51%). The remaining subcategories were used for less than 50% of the opportunities. However, for individual patients whose problems were uniquely in one or more subcategory, "yes" responses dominated.

Table 2 shows the variety of "yes" responses for the four subcategories used more than 50% of the time. There was considerable disagreement in classifying the patients' problems within each subcategory.

Table 3 shows how many orthodontists decided to treat each patient and the methods they would use, and how many wanted to obtain additional data. Considerable variety is apparent in the decision of which teeth to extract. Some orthodontists chose first premolars and others second premolars or some combination for the same patient. Likewise, some orthodontists favored extracting third molars and others second molars to relieve posterior crowding. The full edgewise appliance was favored by all the orthodontists for final treatment in the permanent dentition. Other appliances frequently selected included lower lingual holding arches and rapid palatal expanders.

Discussion

Diagnosis

Responses generally fit into the categories suggested by Ackerman and Proffit,[3] as expected. Almost all orthodontic programs teach this approach to diagnosis. What was surprising was that there was so little agreement within several of the major subcategories (Table 2). Orthodontists approach molar classification (as suggested

Table 2
Responses for four commonly used subcategories

Patient A	#	Patient B	#	Patient C	#	Patient D	#	Patient E	#	Patient F	#
Molar classification											
Class I	15	Class II	20	Class II	22	Class I	15	Class II	21	Class II	21
(borderline)	(2)	Class II	16	Class II	14	Class III	7			(Mild)	(5)
Class II	11	subdiv. right		severe		Class III	7			(Severe)	(7)
(borderline)	(5)					subdiv. right				Class I	7
Class II	5					Class II	1			(Class II tendency)	(1)
Subdiv. left										Class II	5
										Subdiv. right	
Crowding or spacing											
Spacing–maxilla	3	Undefined crowding	12	Undefined crowding	10	Undefined crowding	16	Undefined crowding	20	Undefined crowding	11
Mild crowding–mandible	4	Undefined crowding–mandible	10	Undefined crowding–mandible	8	Undefined crowding (impacted third molar)	6	Undefined crowding–mandible	5	Moderate crowding–maxilla	3
Posterior crowding	6	Moderate crowding–mandible	5	Severe crowding–mandible	3	Severe crowding–mandible (impacted third molar)	3	Moderate crowding–maxilla & mandible	2	Severe crowding–maxilla	3
Second molar crowded–maxilla	4	Posterior crowding	3	Moderate crowding–maxilla & mandible	1	Moderate crowding–maxilla & mandible	1	Moderate crowding–mandible	3	Mild crowding–maxilla & mandible	2
No deficiency–maxilla, second molar crowding & undefined–mandible	2	Undefined crowding–maxilla & mandible	1	Mild-moderate crowding–mandible	1	Undefined crowding–maxilla	1	Mild-moderate crowding–maxilla & mandible	3	Mild crowding–mandible	3
Mild crowding–maxilla & mandible	1	Undefined spacing–maxilla & mandible	1			Severe crowding–maxilla & mandible	1	Severe crowding–mandible	1	Mild crowding–maxilla	2
Spacing–maxilla, mild crowding–mandible	2	Moderate crowding–mandible, Spacing–maxilla, posterior crowding	1			Undefined crowding–mandible	1			Undefined crowding–maxilla	2
Mild crowding–mandible (posterior)	1	No serious discrepancy	1			Impacted third molars	1			Undefined crowding–mandible	2
Undefined crowding–mandible, second molar crowding–maxilla	1									Moderate crowding–maxilla & mandible	1
Overbite or openbite											
Severe overbite	24	Severe overbite	26	Severe overbite	12	Openbite	35	Mild overbite	12	Openbite	21
Closed bite	2	Closed bite	2	Openbite	3	Severe overbite	1	Openbite	3	Mild overbite	1
Moderate overbite	2			Moderate overbite	2						
Mild overbite	1										
Increased overbite	1										
Undefined overbite	1										
Skeletal discrepancy											
Protrusion-maxilla & mandible	5	Protrusion-maxilla & mandible	13	Retrusion-mandible	18	Class III	6	Class I	8	Protrusion-maxilla & mandible	7
Class II	4	Protrusion-maxilla	8	Protrusion-maxilla	3	Class I	3	Class II	2	Class II	2
Protrusion–maxilla	2	Class II, bimaxillary protrusion	3	Class II	5	Retrusion-maxilla	2	Maxilla retrusion, mandible protrusion	1	Retrusion-mandible	1
Retrusion–mandible	1	Class II	3	Protrusion-maxilla, retrusion-mandible	5			Mandible protrusion	1	Class II, retrusion-mandible	1
Protrusion–maxilla, retrusion–mandible	1	Protrusion-maxilla, retrusion-mandible	2	Class II, retrusion-mandible	2			Class III	1	Retrusion-maxilla & mandible	1
Uncertain length–mandible	1	Class II, protrusion-maxilla, retrusion-mandible	1					Uncertain	1	Retrusion-maxilla	1
Class I	1	Retrusion-mandible	1							Protrusion-maxilla	1
		Protrusion	1								

Table 3
Treatment decisions

	Patient A	#	Patient B	#	Patient C	#	Patient D	#	Patient E	#	Patient F	#
Decision to treat	Yes – treat	32	Yes – treat	36	Yes – treat	37	Yes - treat	36	Yes - treat	26	Yes - treat	36
	Wait for eruption	5	TMJ consult	2	Perio eval.	1	Perio eval.	1	Dx Setup	3	Wait for eruption	2
	Bolton analysis	2	Resolve TMJ	1	Erupt maxillary second molars	1	Ent - surg. consult	1	Perio and/or restorative	7	Hx of trauma?	1
							Informed consent - root resorpt.	1	Bolton analysis	1		
									Blood analysis	1		
									More TMJ films	1		
Extract teeth	Second or third molars	6	First or second premolars and third molars	19	Primary canines and first molars	9	Premolars and third molars	19	Mandible incisor	11	Primary teeth or serial extraction	14
	First or second premolars	3			Primary teeth and premolars	4	Third molars	4	Mandible premolars	9	Other	6
	Other	6	First or second premolars only	10	Premolars only	2	Premolars	8	Mandible premolars and maxilla molars	6		
			Other	8	Other	3	Other	4	Other	4		
Headgear	Cervical	18	Cervical	10	Cervical	11	Hi-pull	3	Combi	1	Hi-pull	12
	Undisclosed	7	Hi-pull	10	Hi-pull	3			Undisclosed	1	Combi	2
	Combi	4	Combi	5	Undisclosed	3					Uncertain	3
	J-hook	3	Undisclosed	2	Combi	1						
	Hi-pull	1	Unilateral	1								
	Kloehn	1	Hi-pull and Combi together	1								
Functional	Bionator	1			Bionator	13					Bionator	2
	Teuscher	1			Herbst	3					Uncertain	1
					Unknown	3						
					Frankel	1						
					Herbst & bionator	1						
					Orthopedic corrector and bionator	1						
Surgery			Mandible adv., Genioplasty	2	Possibly later	8	Maxilla impact and/ or expand	17	Maxilla expansion	18		
			Le Fort setback, chin implant	1	Mandible advancement	2	Maxilla & mandible (undefined)	5				
					Maxilla expansion and mandible advancement	1	Possible later	2				

by Angle[3]) as if the classes are reliably categorized, yet some of these cases demonstrated considerable variation. In patient A, the molars and canines on one side were clearly Class I, while those on the other side, especially the canines, tended toward Class II. The orthodontists who were more discriminating described the difference, while others took their choice of which to describe. One respondent was quite verbose in describing the patients, and the others were remarkably brief, which may have reduced the discrimination and thus amplified the disagreements. These results are in agreement with those of Baumrind et al.,[11] who also found disagreement regarding Angle classification.

Descriptions of crowding and spacing also lack clear classifications. Some orthodontists described the crowding of anteriors visible on the models, while others described the crowding of molars visible on the radiographs. Some appeared to give just their impressions of the overall problem, such as crowded or spaced, even when both conditions existed in different arches or within the same arch. It would appear that a better method for communicating the conditions of crowding and spacing is needed.

The description of overbite also showed remarkable discrepancies. Patient C had a short lower face height and a severely deep bite. However, some orthodontists described the patient as demonstrating an openbite because the mandibular incisors do not touch the palate. Again, a better method for describing the condition of incisor overlap needs to be devised that accounts for a deep overbite with lack of contact between the tissues.

The lack of agreement in describing skeletal discrepancy stems from a lack of agreement in defining it. Some rely on the appearance of the face in profile, especially the lips and cheeks relative to the eye, nose, and chin. Others rely on various measurements from lateral cephalometric radiographs. Many orthodontists base their treatment plan on what they perceive the skeletal problem in the sagittal plane of space to be. The diversity of treatment approaches for these patients may reflect the amazing lack of agreement as to what the underlying problems are, even though the same patient records were used. Presumably some of the orthodontists were mistaken in their diagnosis and therefore their treatment would be incorrect or not as effective. But determining who was right requires a more reliable way of defining skeletal discrepancies and evaluating treatment approaches for the defined problems.

Decision to treat

For five of the patients, the orthodontists were generally ready to treat based on the records and data given them. The lone exception was patient E, an adult female with gingival dehiscence involving several teeth. She also exhibited caries and missing maxillary first premolars. The problem list was extensive and several of the orthodontists wanted periodontal and restorative problems to be treated before becoming involved in a case that many thought might require surgery as well as full edgewise therapy. A few also wanted a diagnostic setup to visualize the final occlusal options.

Treatment planning

All six patients were evaluated as needing extractions by some of the orthodontists, but the decision was not unanimous for any of the patients. Since second or third molar impaction or crowding was detected in at least three patients, second or third molar extractions were a frequent recommendation. Premolar extraction was recommended by at least one orthodontist for each patient, and a majority of orthodontists suggested extracting premolars in patients B and D. There was no clear-cut preference for extracting first or second premolars, and several orthodontists selected different teeth in different quadrants. Patient E was the only one for whom a mandibular incisor extraction was recommended. Since she was already missing the maxillary premolars, the extraction of mandibular premolars or an incisor was the choice of most of the orthodontists. While the incidence of premolar extraction is thought to be declining, it was still a popular solution for these orthodontists.

Baumrind et al.[11] found reasonably high agreement between clinicians as to whether to extract or not extract teeth. Clinicians disagreed about whether to extract in 34% of the cases in their study, and they were in complete agreement to extract in 40% and complete agreement not to extract in 26%. Those results were much higher than the results of this study and may reflect the similarity in training received by clinicians in the earlier study, where 11 of the 14 clinicians had

studied at the same specialty program. The 39 orthodontists in this study represented much more diverse backgrounds, with no more than five from the same program.

Headgear and functional appliance therapy were popular treatment forms for growing patients. For patients with short lower face height, low-pull headgear was the most popular choice. For one patient with a long lower face height (patient F), high-pull headgear was the most popular choice. For patient C, who was thought by several to exhibit maxillary protrusion and/or mandibular retrusion, the functional appliance was a popular choice, especially the Bionator. Functional appliances, however, were not recommended by a majority of clinicians for any patient.

Surgery was recommended for four patients, but it was a majority choice for only one (patient D). The two patients who were clearly adults (patients D and E) caused more orthodontists to select surgery as an option.

The primary finding of this portion of the study was that the 39 orthodontists recommended 39 different treatment plans. While many methods of treatment were selected, all might be expected to result in a successful outcome, since these were well-qualified and experienced orthodontists. Also, after obtaining their orthopedic effects with different appliances, all relied on full edgewise appliances to complete and finish the treatment. There is obviously room for research as to which treatments are the most efficacious given a specific set of problems for a specific patient. There are presently no standards for when to extract and when to provide orthopedic correction or surgery. Neither are there clear-cut choices among the various methods available for orthopedic correction.

Conclusions

The diagnosis of six patients by 39 orthodontists demonstrated that the data are generally organized into categories based on planes of space, as suggested by Ackerman and Proffit.[2] However, classifications are either so poorly defined or so unreliably used by orthodontists that the meaning of the classification is blurred. Different orthodontists looking at the same records and using the same classification instruments produced different interpretations. Likewise, different orthodontists arrived at uniquely different plans for each patient. There was little consistency regarding the appropriateness of extraction of premolars or molars for crowding, the use of headgear and/or functional appliances for skeletal discrepancy, or the use of surgery. There was unanimity that the full edgewise banded and bonded appliance is the appliance of choice to complete treatment in the permanent dentition. The consistency of the orthodontists' decisions over time was not evaluated but would be a useful question for future study.

Considerable research needs to be done to refine the classification of orthodontic problems and the appropriateness of treatment regimens. The American Association of Orthodontists has recently approved clinical practice guidelines for orthodontics and dentofacial orthopedics.[12] These recommend diagnosis based on the size of the maxilla and mandible, available arch length, abnormalities of tooth number, morphology and eruption patterns, functional abnormalities (habits), and craniofacial anomalies. Treatment options are suggested that may be appropriate for each diagnostic category. While these represent a step toward classification, they remain very general and all-encompassing. What appears to be needed are better definitions regarding diagnostic criteria so that the actual problems our patients present with can be accurately communicated. Likewise, a consensus as to the appropriate treatment options for these problems would benefit their efficient resolution. In particular, research directed toward treatment outcomes for extraction, orthopedic force, and surgery options are required to demonstrate which is the better "road to Rome."

Author Address

Dr. Larry S. Luke
UCLA School of Dentistry
Rm. 23-020A, CHS
Box 951668
Los Angeles, CA 90095-1668
E-mail: larryl@dent.ucla.edu

Larry S. Luke, clinical professor, UCLA School of Dentistry.

Kathryn A. Atchison, professor, UCLA School of Dentistry.

Stuart C. White, professor, UCLA School of Dentistry.

References

1. Bader JD, Shugar DA. Variation, treatment outcomes and practice guidelines in dental practice. J Dent Educ 1995; 59: 61- 95.
2. Weed LL. Medical records, medical education and patient care: The problem-oriented record as a basic tool. Cleveland, Ohio: Case Western Reserve Press, 1969.
3. Ackerman JL, Proffit WR. The characteristics of malocclusion: A modern approach to classification and diagnosis. Am J Orthod 1969; 56:443-454.
4. Angle EH. Classification of malocclusion. Dental Cosmos. 1899; 41: 248-264, 350-357.
5. Han UK, Vig KWL, Weintaub JA, Vig PS, Kowalski CJ. Consistency of orthodontic treatment decisions relative to diagnostic records. Am J Orthod Dentofac Orthop 1991; 100:212-219.
6. Atchison KA, Luke LS, White SC. Contribution of pretreatment radiographs to the orthodontist's decision making. Oral Surg Oral Med Oral Pathol 1991; 71:238-245.
7. Atchison KA, Luke LS, White SC. An Algorithm for ordering pretreatment orthodontic radiographs. Am J Orthod Dentofac Orthop 1992;102:29-44.
8. Noar SJ, Smith BGN. Diagnosis of caries and treatment decisions in approximal surfaces of posterior teeth in vitro. J Oral Rehab 1990; 17: 209-218.
9. Mileman P, Purdell-Lewis DJ, Dummer P, van der Weele L. Diagnosis and treatment decisions when using bitewing radiographs: A comparison between two dental schools. J Dent 1985; 13: 140-151.
10. Bader JD, Shugars DA. Agreement among dentists' recommendations for restorative treatment. J Dent Res 1993; 72:891-896.
11. Baumrind S, Korn EL, Boyd RL, Maxwell R. The decision to extract: Part 1- Interclinician agreement. Am J Orthod Dentofac Orthop 1996;109:297-309.
12. American Association of Orthodontists. Clinical practice guidelines for orthodontics and dentofacial orthopedics. St. Louis: American Association of Orthodontists, 1996.