

# Professional Variability in Decision Making in Modern Dentistry: A Pilot Study

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## Clinical Relevance

This pilot study highlights that a considerable proportion of variation in dental decision making is independently attributable to provider-specific factors. These results emphasize the continuing challenges of the limited availability of robust scientific evidence, limited implementation of and adherence to clinical guidelines, as well as habitually anchored rather than evidence-informed clinical decision-making routines.

## SUMMARY

**Dental treatment planning is usually expected to take account of the individual patient's clinical risks and benefits. Ideally, the therapeutic choice for each and every patient should be based on adequate clinical diagnostics and risk assessment that facilitates stabilization of the patient's clinical condition as well as prevents further oral impairment. However, identification of the most suitable approach tends to become more and more**

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**challenging as the number of therapeutic alternatives continues to increase due to medical innovation. In this study, the challenge of decision making in modern dentistry is illustrated using the example of bounded edentulous spaces. Many therapeutic alternatives exist for such clinical scenarios, including a noninvasive monitoring approach, minimally invasive tooth recontouring, orthodontic and prosthodontic treatment, and implant placement. The findings of this pilot study highlight the utmost relevance of incorporating individual patients' needs and risks into clinical treatment planning and providing appropriate guidelines.**

## INTRODUCTION

A widespread belief among patients is that treatment decisions first and foremost depend on the patient's disease. This perception seems to be based on the assumption that for each and every clinical condition there is unambiguous evidence about the effectiveness of alternative therapies and that this information is the most authoritative criterion when treatments are recommended and undertaken by

Table 1: Questionnaire Form

Treatment Recommendation for Bounded Edentulous Spaces (BES) Resulting From Missing Lower First Molars
<input type="checkbox"/> Orthodontic treatment to correct tipplings in the left side
<input type="checkbox"/> Orthodontic treatment to correct tipplings in the right side
<input type="checkbox"/> Orthodontic treatment to correct tipplings in both sides
<input type="checkbox"/> Tooth extraction(s) before orthodontic treatment. If any, please state where: _____
<input type="checkbox"/> Bridge-work in the left mandible
<input type="checkbox"/> Bridge-work in the right mandible
<input type="checkbox"/> Bridge-work in both sides of the mandible
<input type="checkbox"/> Implant in the left mandible
<input type="checkbox"/> Implant in the right mandible
<input type="checkbox"/> Implants in both sides of the mandible
<input type="checkbox"/> Closing the BES by means of tooth re-contouring in the left side
<input type="checkbox"/> Closing the BES by means of tooth re-contouring in the right side
<input type="checkbox"/> Closing the BES by means of tooth re-contouring in both sides
<input type="checkbox"/> Monitoring (no immediate treatment)
<input type="checkbox"/> Other suggestion(s); if any, please state: _____
<b>NB:</b> Form provided to respondents after description of the scenario; because different treatment alternatives can be combined into sequential treatment approaches, respondents could give multiple treatment recommendations.

medical providers. However, this may not always be the case in dentistry.

The supposed wonderland of perfect information may be obscured by the fact that available evidence about treatment alternatives is often very limited, and, thus, no clear treatment guidelines exist. One such clinical scenario refers to single posterior bounded edentulous spaces (BES). Such conditions do not just make up a few rare cases; their treatment has been reported to account for about 7% of annual dental expenses.<sup>1,2</sup> Treatment of BES is likely to be of continuing relevance as the population ages, and it has been suggested that despite a general decline in complete edentulism throughout the past decades, the frequency of partial edentulism has remained relatively stable.<sup>3</sup> In terms of treatment, it has often been argued that a missing tooth should be replaced to avoid arch collapse as a result of movement of adjacent and unopposed teeth.<sup>4,5</sup> However, a recent systematic review suggests that occlusal changes in BES after tooth loss are often limited; therefore, tooth replacement should not necessarily be regarded as the mainstay of therapy.<sup>6</sup> Given the absence of clear treatment guidelines for BES, however, dentists' recommendations may vary with respect to parameters that do not solely relate to patient characteristics.

First, many dentists may believe they have no option but to abide by information that has been passed from colleague to colleague. And as dentists may specialize in one or another subdiscipline, each of which may favor different lines of action, treatment recommendations may vary considerably across disciplines. For example, this sort of variation has previously been reported for treatment of periodontally compromised teeth, and different dental practice scopes have frequently been observed to be associated with different treatment preferences.<sup>7-10</sup> Second, the active dental profession comprises recently graduated dentists and dentists with decades of treatment experience. Yet, depending on the level of knowledge and experience, treatment recommendations may vary. Differences in levels of competency may also vary between dental students at different stages of education.<sup>11-15</sup> Third, the settings within which dentists work may differ. Many providers are self-employed and bear the cost risk of a small or medium-sized business. Other providers are employed (eg, in public institutions like a university hospital). Previous evidence, for example, suggests that different reimbursement arrangements can influence treatment decisions.<sup>16-18</sup> This may be another reason why treatment recommendations may depend on factors that do not solely relate to a patient's clinical condition.

So far, little information exists about the extent to which such dentist-related factors influence treatment recommendations for BES. Therefore, the purpose of the present study was to explore the extent to which treatment recommendations vary among dentists with different levels of experience, different fields of specialization, and different work settings.

## METHODS

### Survey Design and Administration

Using a standardized questionnaire form (Table 1 and a clinical vignette case for characterizing a clinical decision scenario (described in the next section), an anonymous survey about treatment recommendations was conducted among dentists and students of the dental clinics at the University of Heidelberg and among dentists working in private practices in June and July 2010. After the clinical vignette was presented by one person in a standard slide-show format to all lecture-attending respondents, the form was completed by dentists affiliated with the departments of prosthodontics (n=24; response rate=100%), conservative dentist-

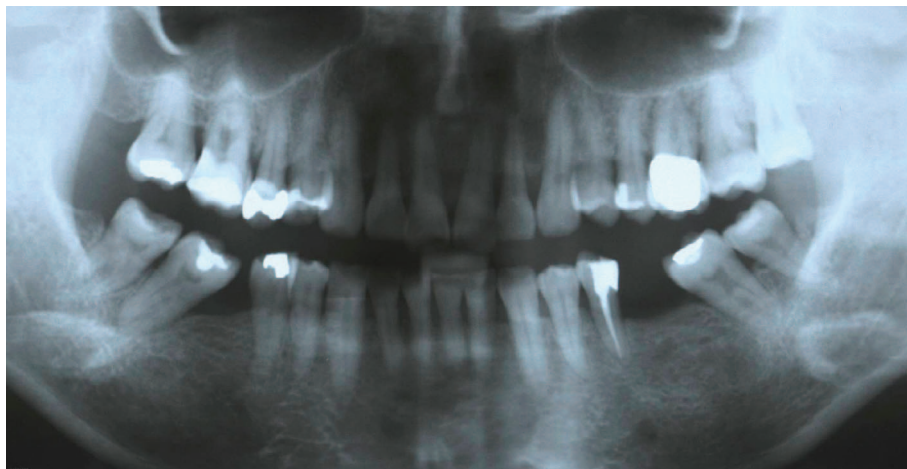


Figure 1. Orthopantomogram.

ry (n=20; response rate=91%), maxillofacial surgery (n=17; response rate=71%), and orthodontics (n=10; response rate=91%). The survey was also completed by students in the first (n=57; response rate=90%) and third year (n=31; response rate=84%) of clinical training who had already completed the preclinical years of education. The form was also completed by private practitioners who attended a lecture that was part of a training course for dentists specializing in endodontics (Gesellschaft für Endodontie Bonn e.V.) (n=55; response rate=92%). The survey was conducted anonymously by all respondents. No time limit was set for filling out the questionnaire.

### Clinical Vignette Case

The vignette described a previously reported case of a 59-year-old woman who is seeking advice regarding missing lower first molars in both sides of the lower jaw.<sup>19</sup> The patient has been missing these teeth since

childhood for reasons unknown, has no treatment preferences (neither for nor against tooth replacement nor any other type of therapy), and is willing to follow any recommendation given by the dentist. The dental condition has been stable for many years, and the patient has had no recent or current signs of discomfort; pain; or esthetic, functional, or other limitation. The patient is described as health conscious and very cooperative. An orthopantomogram, pictures of the clinical situation, and diagnostic plaster models were provided (Figures 1 through 6). The full description of the presented clinical vignette case is shown in Table 2.

### Statistical Analysis

For both sides of the lower jaw, the proportion of respondents recommending various treatment alternatives was computed. Response categories indi-



Figure 2. Clinical situation (overview).

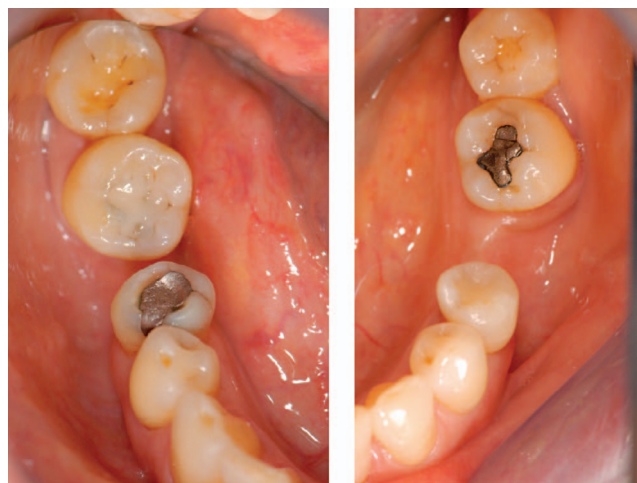


Figure 3. Close-up view of bounded edentulous spaces in both sides of the lower arch.

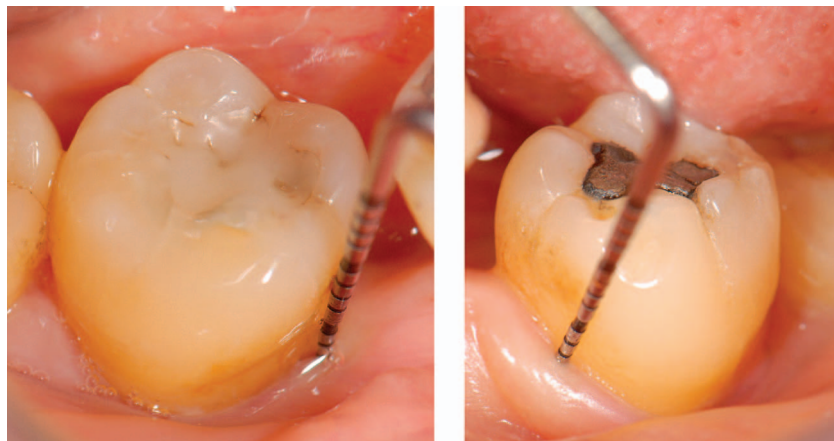


Figure 4. Close-up view of mesial pocket probing at the second lower right molar (left picture) and the second lower left molar (right picture).

cating identical treatment within both mandibular sides were recorded such that the according recommendation was imputed to the separate categories for both left and right side. We used  $\chi^2$  tests ( $p < 0.05$ ) to detect statistically significant differences in treatment recommendations between (1) University hospital dentists, dentists working in private practice, and students; (2) clinical practitioners within different university departments; and (3) students in different years of clinical education. Statistical analysis was performed by one scientist (SL) who was not involved in conceptualizing and carrying out the survey and was, thus, independent and blinded with respect to the data-generating process. All data analyses were carried out with the software package STATA/SE 12.0 (StataCorp, College Station, Texas).

## RESULTS

### Descriptive Statistics

Table 3 shows the frequency of different treatment approaches as recommended by clinical practition-

ers, private practitioners, and dental students. Bridgework (left) was most frequently recommended by students in their first year. Bridgework (right) was chosen most often by respondents from the prosthodontics department. Implant placement (left) was most frequently recommended by students in their first year. Implant placement (right) was chosen most often by respondents from the maxillo-facial department. Tooth recontouring (ie, direct composite buildups to close gaps)<sup>20</sup> was most frequently recommended by students in their first



Figure 5. Occluded models (anterior and lateral).

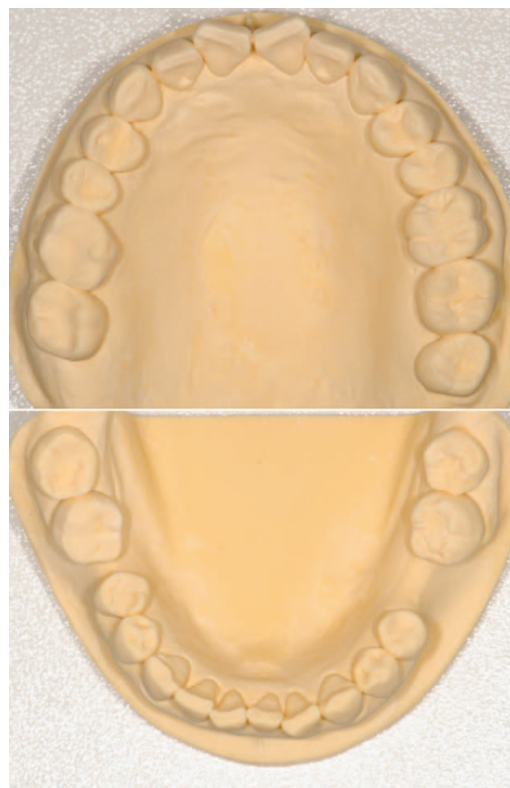


Figure 6. Occlusal view of models.

**Table 2: Case Characteristics of the Clinical Vignette**

- Both lower first molars have been missing since childhood for reasons unknown
- Dental condition has been stable for many years
- No recent or current discomfort/pain
- No aesthetic, functional, or other limitations
- No hereditary disposition known for diseases of the oral cavity
- Regular intake of medication against hypertension; no other acute/chronic systemic diseases
- Patient is a non-smoker
- Social anamnesis: the patient is married and homemaker
- No financial or time constraints for treatment
- The patient brushes her teeth 2-3 time per day using a fluoridated toothpaste; interdental cleaning includes tooth floss and individually adjusted interdental brushes; for cooking, she uses fluoridated salt
- No complications during or in response to earlier endodontic, periodontal and restorative dental treatment
- No pathologic abnormalities detectable, neither within nor outside the oral cavity
- Complete dentition with missing upper right wisdom tooth and missing lower first molars
- No carious lesions detectable; normal signs of erosion, abrasion, and attrition; no traumatic abnormalities
- Sufficient direct and indirect dental restorations
- Endodontically treated lower left second premolar; all other teeth exhibit positive vitality
- No discoloration or excessive movability of teeth
- All teeth respond negative to percussion
- No current periodontal treatment need (pocket probing depths of 1-3 mm in general; no bleeding on probing; previously treated and stable furcation involvement (grade 2) at both upper first molars; gingival recessions at some teeth, particularly at the upper right first molar
- Myofunctional examination revealed no need for according therapy
- Both remaining lower second molars are tipped into mesial direction, particularly on the right side
- Mesio-distal extension of the mesial BES is ca 7 mm on the left side and ca. 2 mm on the right side; only slight elongation of upper first molars with no indication of deficient contacts with antagonizing teeth
- Neutral to slightly distal tothing in the left canine and premolar region; distal tothing in the right canine and premolar region in the extent of about one premolar; mesial shift of the dental midline in the lower jaw; crossbite between lower right wisdom tooth and second upper right molar

clinical year. Orthodontic treatment was suggested most often by respondents from the maxillofacial department. Among University hospital dentists, a monitoring-only approach was most frequently recommended by dentists from the conservative dentistry department, followed by dentists from the

prosthodontics, orthodontics, and maxillofacial departments (see Figure 7).

**Testing for Statistical Significance**

Table 4 shows  $\chi^2$  statistics from tests for differences in treatment recommendations among hos-

**Table 3: Frequency (Standard Error) of Treatment Recommendations for Bounded Edentulous Spaces**

	University Hospital				Private Practice	Dental Students	
	Conservative	Prosthodontics	Surgery	Orthodontics		First Year	Third Year
Bridgework left	0.00 (0.00)	0.04 (0.04)	0.06 (0.06)	0.20 (0.13)	0.20 (0.05)	0.28 (0.06)	0.26 (0.08)
Bridgework right	0.00 (0.00)	0.04 (0.04)	0.00 (0.00)	0.00 (0.00)	0.05 (0.03)	0.04 (0.02)	0.00 (0.00)
Implant left	0.30 (0.11)	0.38 (0.10)	0.82 (0.10)	0.30 (0.15)	0.31 (0.06)	0.89 (0.04)	0.52 (0.09)
Implant right	0.00 (0.00)	0.00 (0.00)	0.24 (0.11)	0.00 (0.00)	0.02 (0.02)	0.11 (0.04)	0.03 (0.03)
Recontouring left	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.04 (0.02)	0.00 (0.00)
Recontouring right	0.30 (0.11)	0.21 (0.08)	0.29 (0.11)	0.60 (0.16)	0.18 (0.05)	0.79 (0.05)	0.52 (0.09)
Orthodontic left	0.00 (0.00)	0.00 (0.00)	0.24 (0.11)	0.10 (0.10)	0.04 (0.03)	0.21 (0.05)	0.03 (0.03)
Orthodontic right	0.00 (0.00)	0.00 (0.00)	0.29 (0.11)	0.00 (0.00)	0.07 (0.03)	0.14 (0.05)	0.10 (0.05)
Monitoring only	0.65 (0.11)	0.46 (0.10)	0.18 (0.10)	0.30 (0.15)	0.35 (0.07)	0.00 (0.00)	0.29 (0.08)
n	20	24	17	10	54	57	31

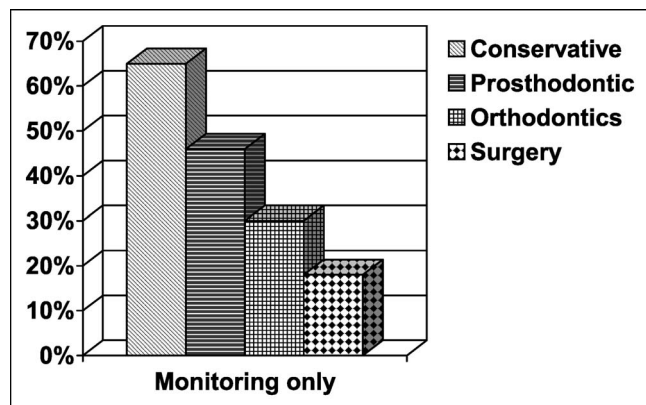


Figure 7. Proportion of University hospital dentists recommending a monitoring approach for the described clinical scenario of bounded edentulous spaces.

hospital practitioners, private practitioners, and students. When comparing University hospital dentists with students, treatment with bridgework (left), implant placement (left), and recontouring (right) were found to be recommended significantly more often by students, whereas a monitoring approach was recommended significantly more often by dentists working in the clinics. When comparing dentists working in the clinics with private practitioners, treatment with bridgework (left) was recommended significantly more often by private practitioners. When comparing private practitioners with students, treatment with implant placement (left), recontouring (right), and orthodontic treatment (left) were recommended significantly more often by students, whereas a monitoring approach was recommended significantly more often by private practitioners.

Table 5 shows  $\chi^2$  statistics from tests for differences in treatment recommendations among dentists from different departments within the university hospital. No significant difference was found between the conservative dentistry and the prosthodontics departments. When comparing dentists working in the conservative dentistry department with their colleagues working in the maxillofacial department, implant placement and orthodontic treatment were recommended significantly more often in the maxillofacial department, whereas a monitoring approach was recommended significantly more often in the conservative dentistry department. When comparing dentists working in the conservative dentistry department with their colleagues working in the orthodontics department, bridgework (left) was recommended significantly more often by the orthodontists. When comparing dentists working in the prosthodontics department with their colleagues working in the maxillofacial department, implant placement and orthodontic treatment were recommended significantly more often in the maxillofacial department, whereas a monitoring approach was recommended significantly more often in the conservative dentistry department. When comparing dentists working in the prosthodontics department with their colleagues working in the orthodontics department, recontouring (right) was recommended significantly more often by the orthodontists. When comparing dentists working in the maxillofacial department with their colleagues working in the orthodontics department, implant placement (left) was recommended significantly less often by the orthodontists.

Table 4: The  $\chi^2$  Statistics From Tests for Differences in Treatment Recommendations Between Dentists in University Hospital, Dentists in Private Practice, and Dental Students

	Clinics vs Students	Clinics vs Private Practice	Private Practice vs Students
Bridgework left	12.68 <sup>a,b</sup>	6.10 <sup>a,c</sup>	0.97
Bridgework right	0.16	1.65	1.02
Implant left	16.14 <sup>a,b</sup>	2.62	28.57 <sup>a,d</sup>
Implant right	0.33	1.18	2.41
Recontouring left	1.63	Not applicable	1.27
Recontouring right	23.14 <sup>a,b</sup>	2.68	35.40 <sup>a,d</sup>
Orthodontic left	2.34	0.69	4.47 <sup>a,d</sup>
Orthodontic right	1.29	0.00	0.99
Monitoring only	22.01 <sup>a,e</sup>	0.98	28.57 <sup>a,f</sup>

<sup>a</sup> Italic values indicate statistically significant difference at the 5% level.  
<sup>b</sup> Treatment was recommended significantly more often by students than by dentists.  
<sup>c</sup> Treatment was recommended significantly more often by private practice than university hospital.  
<sup>d</sup> Treatment was recommended significantly more often by students than by dentists.  
<sup>e</sup> Treatment was recommended significantly more often by dentists than by students.  
<sup>f</sup> Treatment was recommended significantly more often by private practice.

Table 5: The  $\chi^2$  Statistics From Tests for Differences in Treatment Recommendations Among Dentists From Different Departments Within the University Hospital

	Conservative vs Prosthodontics	Conservative vs Surgery	Conservative vs Orthodontics	Prosthodontics vs Surgery	Prosthodontics vs Orthodontics	Surgery vs Orthodontics
Bridgework left	0.85	1.21	4.29 <sup>a,b</sup>	0.06	2.20	1.27
Bridgework right	0.85	—	—	0.73	0.43	—
Implant left	0.27	10.14 <sup>a,c</sup>	0.00	8.13 <sup>a,d</sup>	0.17	7.0 <sup>a,e</sup>
Implant right	—	5.28 <sup>a,c</sup>	—	6.26 <sup>a,d</sup>	—	2.76
Recontouring left	—	—	—	—	—	—
Recontouring right	0.49	0.00	2.50	0.40	4.95 <sup>a,f</sup>	2.44
Orthodontic left	—	5.28 <sup>a,c</sup>	2.07	6.26 <sup>a,d</sup>	2.47	0.76
Orthodontic right	—	6.80 <sup>a,c</sup>	—	8.04 <sup>a,d</sup>	—	3.61
Monitoring only	0.10	7.69 <sup>a,g</sup>	0.71	6.87 <sup>a,h</sup>	0.38	2.44

<sup>a</sup> *Italic values indicate statistically significant difference at the 5% level.*  
<sup>b</sup> *Treatment was recommended significantly more often in the orthodontics department than the surgery departments.*  
<sup>c</sup> *Treatment was recommended significantly more often in the surgery department than the conservative dentistry department.*  
<sup>d</sup> *Treatment was recommended significantly more often in the surgery department than the prosthodontics department.*  
<sup>e</sup> *Treatment was recommended significantly more often in the surgery department than the orthodontics department.*  
<sup>f</sup> *Treatment was recommended significantly more often in the orthodontics department than the prosthodontics department.*  
<sup>g</sup> *Treatment was recommended significantly more often in the conservative dentistry department than the surgery department.*  
<sup>h</sup> *Treatment was recommended significantly more often in the prosthodontics department than the surgery department.*

As shown in Table 6, implant placement (left), recontouring (right), and orthodontic treatment (left) were recommended significantly more often by students in their first clinical year, whereas a monitoring approach was recommended significantly more often by students in their third clinical year.

## DISCUSSION

The present study revealed substantial variability regarding treatment recommendations with respect to dentists' level of experience, area of specialization, and institutional setting in which they work. First, our findings appear to give evidence for a tendency toward

less invasive treatment being recommended with increasing level of treatment experience. Dental students were more likely to recommend implant placement (left) and recontouring (right) than practicing dentists. Students were also more likely to recommend bridgework than clinical practitioners and more likely to recommend orthodontic treatment than private practitioners (left). Dentists were more likely to recommend monitoring than students. Among students, implant placement (left), recontouring (right), and orthodontic treatment (left) were recommended more often by students in their first year, whereas monitoring was recommended more often by students in their third year. It should be noted tooth recontouring is a specific component of the first-year curriculum.

Second, it seems that the area of dentists' specialization also has a considerable impact on the type of recommended treatment. Although no differences were detected between the conservative dentistry and prosthodontics department, dentists in the maxillofacial department were more likely to recommend implant and orthodontic treatment but less likely to recommend monitoring compared with colleagues from the prosthodontics and conservative dentistry departments. Orthodontists were more likely to recommend bridgework (left) than conservative dentists, more likely to recommend recontouring (right) than prosthodontists, and less likely to recommend implants (left) than colleagues from the maxillofacial department.

Third, our findings also hint at the relevance of settings in which dentists work. In particular,

Table 6: The  $\chi^2$  Statistics From Tests for Differences in Treatment Recommendations Between Students in Different Years of Clinical Coursework

	Third-Year Students vs First-Year Students
Bridgework left	0.05
Bridgework right	1.11
Implant left	15.84 <sup>a,b</sup>
Implant right	1.46
Recontouring left	1.11
Recontouring right	7.05 <sup>a,b</sup>
Orthodontic left	5.07 <sup>a,b</sup>
Orthodontic right	0.35
Monitoring only	20.28 <sup>a,c</sup>

<sup>a</sup> *Italic values indicate statistically significant difference at the 5% level.*  
<sup>b</sup> *Treatment was recommended significantly more often by first-year students than by third-year students.*  
<sup>c</sup> *Treatment was recommended significantly more often by third-year students than by first-year students.*

bridgework (left) was recommended more often by dentists working in private practice than by University hospital dentists. It may be tempting to speculate whether such a difference in treatment recommendations may be attributable to different financial incentives for private and clinical practitioners, yet identification of such a link was outside the scope of the present study.

Given that, to date, treatment guidelines for BES are not fully conclusive; the observed variations may not appear completely unexpected.<sup>21</sup> Nevertheless, the extent of differences among various groups of respondents seems remarkable. As there was also great variation within different groups of respondents, this may hint at further uncertainties about which treatment approach would be the most adequate for BES. Unquestionably, the currently existing knowledge regarding clinical management of BES is insufficient to judge any of the proposed treatment approaches as entirely right or wrong. However, for clinical scenarios characterized by stable BES without any limitations perceived by the patient, previous evidence suggests that it is unlikely that the patient will incur a high risk of adverse health consequences if a monitoring approach is taken rather than immediate tooth replacement.<sup>6</sup> In order to establish more differentiated treatment guidelines for BES that facilitate more patient-centered treatment decisions in the future, however, more research is needed that examines the potential of monitoring approaches. Moreover, there is a need for better understanding about how dental professionals change their clinical practice and about reviewing dental education programs because reviewing clinical guidelines alone may not necessarily lead to rapid implementation of altered therapeutic approaches.<sup>22</sup>

As with any other pilot study, the present investigation has its limitations. First, no tailored sample-size planning or other specific sampling procedures could be applied. Some of the variation in the reported results could have been influenced by an unfitted sample size or by sample selection bias. Second, the present study could not control for other potentially relevant covariates, such as, for example, a different age composition of self-employed dentists and their colleagues working in hospital. This could be relevant because it may complicate the distinction between age-related effects of experience and effects of different practice settings (private practice vs hospital). Third, the sample for private practitioners was recruited from dentists having a specific interest in endodontics

and thus may not be considered representative of the entire professional community.

Nevertheless, the findings of the present study uniquely quantify the extent of intraprofessional variability in treatment recommendations as regards BES. The fact that the treatment patients receive seems to be strongly influenced by provider characteristics that do not directly relate to the patients' clinical condition may be a challenge. Patients usually seek treatment advice from dentists because of their supposed expert knowledge with regard to the necessity of clinical intervention and which treatment approach, if any, is the most clinically adequate. However, if the existing clinical evidence about therapeutic alternatives is unclear, it seems not unlikely that dentists seek to justify treatment approaches in the way in which they are most comfortable. This is not to say that dentists would only act in their own interest and would not respect the patient preferences, but if it is impossible to differentiate between the clinical appropriateness of two therapeutic alternatives and, thus, both are clinically justifiable, it seems plausible that providers prefer the one that best accommodates their own skill. Based on the supposed expert advice, patients may then shape their treatment preferences accordingly. Ultimately, however, this implies that one specific treatment is chosen over several others despite no evidence of better clinical effectiveness. This may not only raise concerns of inefficient resource use (if providers prefer more expensive treatments) but also of inconsistencies within the dental profession (if patients with identical clinical conditions receive largely different treatment recommendations).

All in all, the present study gives novel evidence for considerable intraprofessional variability in dental treatment recommendations for BES with respect to dentists' level of experience, area of specialization, and institutional setting in which they work. The extent of the observed variations seems highly remarkable. Treatment guidelines and dental education programs should thus be reviewed. Moreover, future randomized controlled clinical research examining the effectiveness of monitoring approaches will be helpful to further the development of more differentiated treatment guidelines for BES. In addition, more detailed investigations of factors relevant for dentists when making clinical decisions could take particular advantage of state-of-the-art experimental techniques used in the behavioral sciences, such as discrete choice experiments.



### Disclaimer

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### Regulatory Statement

This study was conducted in accordance with all the provisions of the local human subjects oversight committee guidelines and policies of Heidelberg University. The approval code for this study is 07/07/2011.

### Conflict of Interest

The authors of this manuscript certify that they have no proprietary, financial, or other personal interest of any nature or kind in any product, service, and/or company that is presented in this article.

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