A Pilot Survey on the Prevalence of Clinical Challenges to Identify and Restore Unknown Dental Implants

Robert Douglas Walter, DDS, MSD[1]*
Seth Wiafe, PhD, MPH[2]
Udochukwu Oyoyo, MPH[3]
Montry Selin Suprono, DDS, MSD[4]

INTRODUCTION

The identification of unknown dental implants has posed a challenge for dentists and patients alike.[1] If the dentist is not able to immediately recognize the implant system and patients do not have access to their dental records, subsequent treatment may have a sequela of events. For dentists, the implant identification process consumes time and, in some cases, multiple attempts. For patients, it not only requires extra time but may cause discomfort in obtaining the ideal radiographic image, plus increased risk of overexposure with multiple attempts to get an acceptable image. Incorrect implant components cannot be returned if opened, and ill-fitting implant parts may compromise the implant-restorative interface. Once the implant-restoration interface is damaged, further clinical complications with the definitive restoration may follow. As a result, when dental implants of unknown type are encountered, there is a risk of increased time and expense to both stakeholders.

To foster continuous development in dental education, the Commission on Dental Accreditation (CODA) states that dental schools must incorporate into their predoctoral curricula the treatment option of dental implant therapy to replace missing teeth.[2] To comply with CODA, many dental schools have revised, created, and expanded their curricula.[3] However, an important part of dental implant therapy is the identification of unknown dental implants that have succumbed to prosthetic failure. In addition, it is equally important to know when to refer a patient with an unknown implant. Only after the implant system is identified can appropriate prosthetic parts be ordered.

To identify unknown dental implants, Sahiwal et al reported on a technique that required expert analysis of radiographic images taken at ideal perpendicular angles and then manually compared to a database that contains known implant images.[4–6] This manual technique to compare unknown to known radiographic images of dental implants has become an accepted method for implant identification.[7–9] Although the manual technique works most of the time, the process is quite tedious.

To assist clinicians and expedite treatment, alternative methods have been proposed to identify dental implants. In 2006, Michelinakis et al[1] developed computer software to aid clinicians in the recognition process of unidentified dental implants. The software was named Implant Recognition Software (IRS).[1] Unfortunately, an ideal radiograph was still required, and the database was relatively modest in size.

Almost a decade later, Morais et al[10] revisited the concept of computer-aided recognition of dental implants through radiographic analysis. Although not commercially available, the software was able to recognize 91% of the tested implants ($n = 11$).[10] For implants that the software could not recognize, it narrowed the reference database to 5% of its original size ($n = 601$).[10]

In 2016, the global implant market was valued at $4468.1 million in US dollars and is forecasted to reach $8406.5 million by 2025, with a compound annual growth rate of 7.9%.[11] As the implant market continues to grow, the likelihood of encountering individuals with unknown dental implants is inevitable.[12] Another notion that adds to the chances of encountering unknown dental implants is the concept of "dental tourism."[11–13] A dental tourist is a person who travels outside of their country of origin for dental therapy.[11–13] Unfortunately, a dental tourist may have incomplete or unavailable dental implant records to aid future dentists when prosthetic restorations need repair.[14,15]

Educators need to identify future areas of need when developing curricula for implant education. To further help identify location-based attributes that comprise specific traits and influences of behaviors, geographic information systems (GIS) and geodemographic segmentation methodologies were used.[16,17] To date, the authors are not aware of a published article in the dental literature that uses GIS to obtain geographical information on the challenges dentists face when confronted with an unknown implant. Therefore, the purpose of this survey was to collect initial data on some challenges that dentists have when identifying manufacturer and model of dental implants in need of restorative intervention in patients without available records.

MATERIALS AND METHODS

This study was approved by the local institutional review board (Institutional Review Board #5170111) and was conducted in

[1] Division of General Dentistry, Loma Linda University School of Dentistry, Loma Linda, Calif
[2] Center for Leadership and Health Systems, Loma Linda University School of Public Health, Loma Linda, Calif
[3] Dental Education Services, Loma Linda Calif
[4] Center for Dental Research, Loma Linda, Calif
* *Corresponding author*, e-mail: rwalter@llu.edu
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1. Do you currently place or restore dental implants?
a) Yes
b) No

2. What is your current level of dental training?
a) General dentist
b) Periodontist
c) Oral surgeon
d) Endodontist
e) Prosthodontist

3. Have you experienced challenges with identifying the exact type and company of a dental implant that was placed at another dental clinic?
a) Yes
b) No

4. Have you experienced ordering the wrong implant component(s) when restoring a dental implant that was placed at another dental clinic?
a) Yes
b) No

5. Please enter the zip code of where you practice dentistry.
(Text box)

FIGURE 1. Survey to dental alumni regarding challenges with dental implants.

full accordance with the World Medical Association's Declaration of Helsinki. A five-item survey was created by the authors and administered online, via e-mail, using a web-based survey tool (Qualtrics, Qualtrics International, Inc, Provo, Utah; Figure 1). The survey was limited to practicing dentists, specifically dental alumni of a dental school in the United States. The survey was sent to 4569 dental alumni between June and July 2017. Digital communication was chosen because it is a common mode of communication and has resulted in high response rates.[18] Two weeks before the survey was released, a notification e-mail was disseminated to describe the purpose of the study. Following the notification e-mail, a cover letter and invitation to participate was electronically distributed. To be a participant, subjects were expected to read the cover letter and click on the survey link to give consent to participate. Subjects were given 2 weeks to participate; for those who did not participate in the first round, a reminder e-mail was sent. The survey was closed after an additional 2 weeks. All responses were anonymous and answering each question was optional.

GIS and geodemographic segmentation technologies were used to analyze the survey results. GIS have been successfully applied in the field of marketing and in businesses to identify community-based traits that influence health-related behaviors.[16] GIS technology includes computer software that allows data analysis and visualization of the distribution of spatial pattern of events. Geodemographic segmentation data comprises categorized neighborhoods according to their sociocultural, demographic, economic compositions, and consumer spending patterns. The data used cluster analysis of more than 60 demographic and socioeconomic variables in conjunction with data-mining techniques to classify US neighborhoods into one of the 67 primary lifestyle segments comprised of 12 life mode groups and six urbanization groups.[17] The underlying premise was that individuals of similar demographic, sociocultural, educational, and economic background seek each other out and influence each other's behaviors. Thus, persons residing in a neighborhood unit or segment tend to share similar interests, behave in similar manners, and can be influenced by similar approaches. The data then provided detailed descriptions of communities in terms of neighborhood portraits. GIS and statistical analyses were performed with software (ArcGIS for Desktop 10.6.1 and IBM SPSS v 25). The methodology and results were reviewed by an independent statistician.

RESULTS

Of the 4569 dental alumni, 339 completed the survey. Figure 2 shows the locations of the participants. All six US urbanization groups are represented. Tables 1 and 2 provide general characterizing information collected in reference to placement or restoring dental implants and the current level of dental training. Of those who participated, 77% reported that they either restore or surgically place dental implants (n = 261). The top five (5) disciplines that participated in descending order of frequency were general dentists (78.96%; n = 259), prosthodontists (9.45%; n =31), periodontists (4.88%; n = 16), oral surgeons (3.96%; n = 13), and endodontists (2.74%; n =9).

Figure 3 provides a graphical representation of survey questions 3 and 4 for the respondents. When it came to challenges with identifying unknown dental implants, 79.82% of 332 clinicians who work with dental implants have had difficulty with implant system identification. The proportion of clinicians who reported difficulty identifying the manufacturer of the dental implant are as follows; prosthodontists (100%; n = 31), oral surgeons (92.3%; n = 12), periodontists (81.3%; n = 13), general dentists (79.9%; n = 207), and endodontists (28.6%; n = 2). Geodemographic segmentation analysis showed urbanization groups to report "yes" to the survey question in descending order (percentage; sample size). The Rural Urbanization Group reported yes 89.5% (n = 19), followed by in descending order Principal Urban Center Group 81.3% (n = 16), Urban Periphery Group 81.1% (n = 74), Suburban Periphery Group 80.3% (n = 157), Semirural Group 77.8% (n = 18), and Metro Cities Group 73.2% (n = 41). See Table 3.

When it came to the prevalence of ordering incorrect implant components, 40.73% (n = 143) reported to have ordered the wrong part(s). Interestingly, when it was reported by discipline, 74.2% (n = 23) of the prosthodontists have had the most challenges. The dominant urbanization group reported "yes" to having experienced ordering the wrong implant component(s) was the Semirural Group (61.1%; n = 18). The Semirural Group was followed by the Rural Group with 50% reporting "yes" (n = 18). The Metro Cities Group had the least challenges with ordering parts with only 37.5% reporting "yes" to the question in the survey (n = 40). Table 4 has the frequency of ordering incorrect implant components by urbanization group.

DISCUSSION

Manual recognition of unknown dental implants is prevalent, and the findings of the current study agree with Barrowman et al[14] and Mattheos et al.[15] Geodemographic segmentation analysis also confirmed that all six US Urbanization Groups recognized implant identification challenges. However, when it came to encountering errors in implant identification and ordering wrong component(s), the only group to report a dominant problem were the prosthodontists. One might speculate that prosthodontists may be the one discipline in

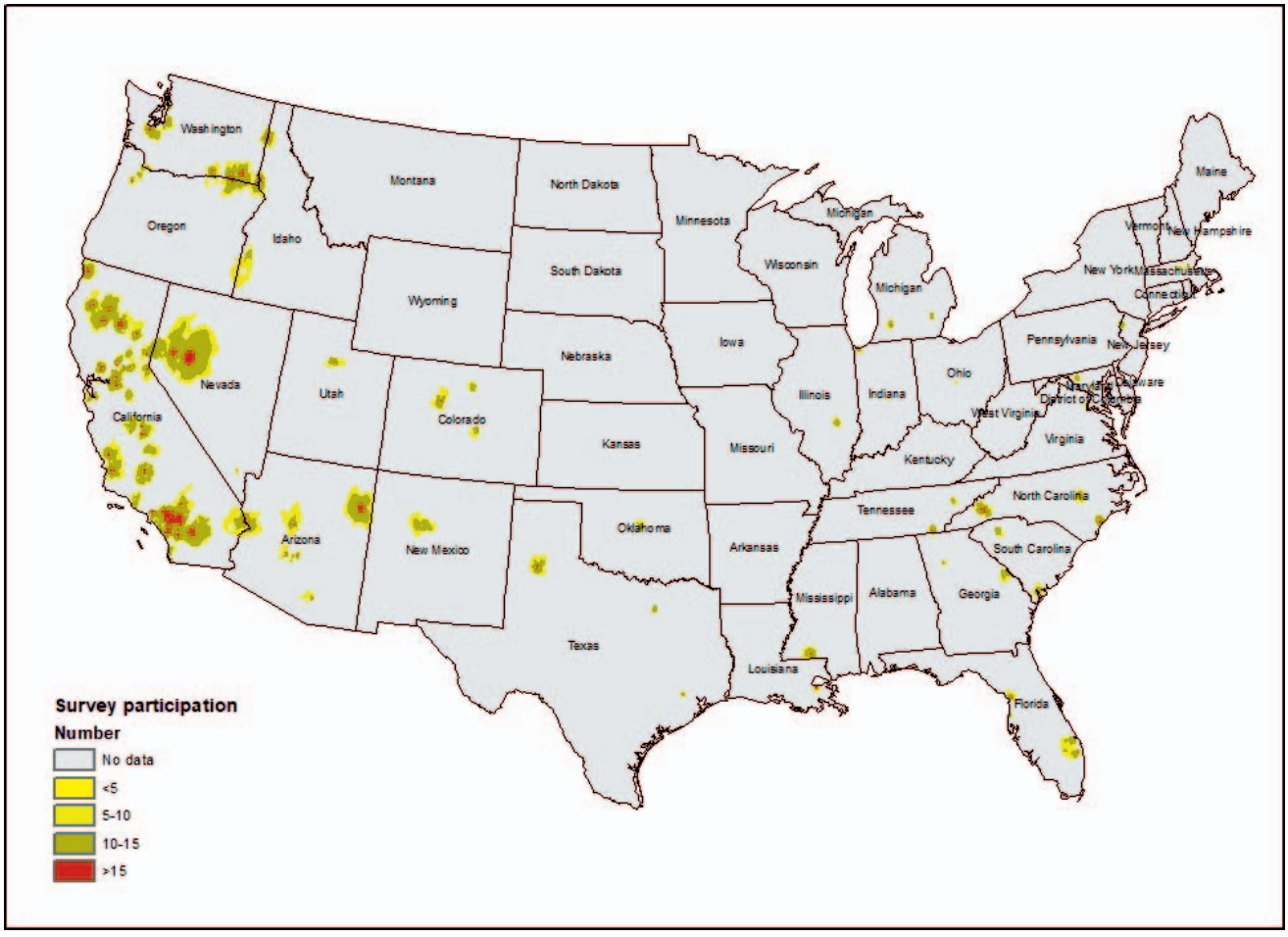

Figure 2. Distribution map of surveyed participants.

dentistry with the greatest opportunity in treating patients who have dental implant complications. When dental specialties were adjusted, 79.82% of the clinicians reported to have challenges with identifying unknown dental implants. Additionally, when urbanization groups were evaluated, dentists in Semirural and Rural Groups reported having the most challenges with ordering incorrect implant parts. The fact that the Semirural and Rural Groups had a greater rate of errors in ordering implant parts may parallel issues with access to care as well as dental tourism.

Through CODA's guidance, dental school graduates must be competent in providing and/or recognizing dental implant therapy as a mode to replace missing teeth within the scope of general dentistry as defined by the school.[2] Dental schools may find it valuable to introduce techniques on how to manually identify unknown implant systems in their curriculum in an effort to minimize future complications with failed prosthodontic components. Furthermore, emphasis on providing implant information to patients after implant placement should be presented in their curriculum.

Table 1

Frequency of responses to survey question number 1: Do you currently place or restore dental implants?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	262	74.6	77.1	77.1
	No	78	22.2	22.9	100.0
	Total	340	96.9	100.0	
Missing	System	11	3.1		
Total		351	100.0		

Table 2

Frequency of responses to survey question number 2: What is your current level of dental training?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	General dentist	260	74.1	79.0	79.0
	Periodontist	16	4.6	4.9	83.9
	Oral surgeon	13	3.7	4.0	87.8
	Endodontist	9	2.6	2.7	90.6
	Prosthodontist	31	8.8	9.4	100.0
	Total	329	93.7	100.0	
Missing	System	22	6.3		
Total		351	100.0		

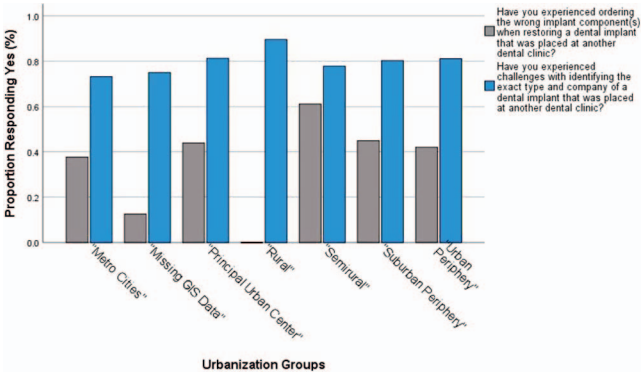

Figure 3. Responses of urbanization groups for survey questions 3 and 4.

The limitations of this study pertain to the limited sample size and the diversity of participants (sampled population). As a result, the sample is bias because it did not include alumni from other dental schools. Therefore, the results do not reflect the same experiences and challenges of dentists who have completed their training from other dental programs. As a pilot survey with its limitations, the sample population does have a distribution across the United States, as shown in Figure 2.

To date, the authors are not aware of any published surveys that have evaluated the challenges that dentists face with dental implants. The addition of GIS tapestry (using geodemographic intelligence) was used as a new method for dentistry and will be useful in future studies to understand lifestyle choices and influences of behaviors toward dental implants, as well aspects of dentistry. Furthermore, a larger sample size and a more diversified sample population to further evaluate trends observed in this current research are needed. Expansion of the survey to identify more specific information regarding the challenges that dentists face, estimated time spent on deciphering the unknown dental implant would also be valuable. Though this study has its limitations, the preliminary results suggest that dentists face challenges with implant identification and that this topic may need to be addressed in dental implant curriculum.

Table 3

Responses of urbanization groups for survey question number 3: Have you experienced challenges with identifying the exact type and company of a dental implant that was placed at another dental clinic?

	Responses		
Urbanization Groups	Yes	No	Total
Metro Cities	30	11	41
Principal Urban Center	13	3	16
Rural	17	2	19
Semirural	14	4	18
Suburban Periphery	126	31	157
Urban Periphery	60	14	74
Missing GIS Data	6	2	8
Total	266	67	333

Table 4

Responses of urbanization groups for survey question number 4: Have you experienced ordering the wrong implant component(s) when restoring a dental implant that was placed at another dental clinic?

	Responses		
Urbanization Groups	Yes	No	Total
Metro Cities	15	25	40
Principal Urban Center	7	9	16
Rural	0	9	18
Semirural	11	7	18
Suburban Periphery	69	85	154
Urban Periphery	31	43	74
Missing GIS Data	1	7	8
Total	143	185	328

Abbreviations

CODA: Commission on Dental Accreditation
GIS: geographic information system
IRS: Implant Recognition Software

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