

Trends in implant dentistry: Implant systems, complications and barriers in Riyadh, Saudi Arabia

Trendy w implantologii stomatologicznej – systemy implantologiczne, powikłania i ograniczenia w stolicy Arabii Saudyjskiej, Rijadzie

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D – writing the article; E – critical revision of the article; F – final approval of the article

Dental and Medical Problems, ISSN 1644-387X (print), ISSN 2300-9020 (online)

Dent Med Probl. 2019;56(3):223–230

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Funding sources

None declared

Conflict of interest

None declared

Acknowledgements

The authors would like to thank all the dentists/specialists who participated in the study.

Received on December 16, 2018

Reviewed on March 25, 2019

Accepted on April 19, 2019

Published online on September 30, 2019

Cite as

Albugami RA, Smith S, Hassan MA, Almas K. Trends in implant dentistry: Implant systems, complications and barriers in Riyadh, Saudi Arabia. *Dent Med Probl.* 2019;56(3):223–230. doi:10.17219/dmp/108659

DOI

10.17219/dmp/108659

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Abstract

Background. Patients who are partially dentate or edentulous can receive both conventional and implant-supported fixed prostheses, which leads to improvement in function, esthetics and self-esteem. Currently, implant dentistry is one of the fastest-growing disciplines in dentistry.

Objectives. The aim of the study was to assess the education and training of dentists practicing implant therapy in the Riyadh region of Saudi Arabia, including their preferred dental implant systems, the clinical complications experienced as well as the barriers to implant therapy they encounter.

Material and methods. A self-administered questionnaire was distributed among dentists in Riyadh performing dental implants in both the state and private sectors. The questionnaire included demographic data, such as nationality, the practitioner's affiliated specialist category and their respective qualifications. Other data included their main sources of education pertaining to implant dentistry, the most commonly used implant systems, common clinical complications, and barriers to implant therapy. A descriptive statistical analysis of the data was carried out.

Results. A significant majority of non-Saudi dental practitioners were employed in the private sector ($p = 0.001$), whereas a significant majority of Saudi dental practitioners were employed in the state sector ($p = 0.001$). The largest group of practitioners performing implants were general dentists (48.1%). The 3i™ implant system was the most widely utilized (35.4%). Failed osseointegration (12.6%) and peri-implantitis (12%) were the most common clinical complications. The biggest barrier to placing implants was the cost of implants to patients (59.1%).

Conclusions. Fundamental to implant practice is the clinical practitioner and patient selection. The utilization of implant systems should preferably be based on the chemical properties of implant surfaces which promote early osseointegration. Comparative studies investigating the reasons for failed osseointegration and other clinical complications are needed locally and internationally. Further research, together with advanced clinical specialist training, can lead to improvement in the quality of implant therapy for the benefit of patients.

Key words: implant practice survey, implant systems, implant complications, hydrophilic implants, hydrophobic implants

Słowa kluczowe: przegląd praktyk implantologicznych, systemy implantologiczne, powikłania implantologiczne, implanty hydrofilowe, implanty hydrofobowe

Introduction

The replacement of lost teeth is achievable by utilizing removable partial dentures, complete dentures, overdentures, and fixed partial prostheses. Expanded treatment options available to the general population suffering from tooth loss include implant therapy.¹ Partially dentate and edentulous patients may significantly benefit from the placement of implants in terms of both esthetics and function.²

Male patients in Saudi Arabia complained that tooth loss affected their profile as well as the chewing function.³ A study in Saudi Arabia reported that 61.5% of the participants believed that the utilization of dental implants was the best treatment option for replacing missing teeth.⁴ Another study in Riyadh revealed that 75.7% of the respondents would willingly undergo implant therapy again, and 79.3% would encourage others to consider implant treatment.⁵

In both Saudi Arabia and elsewhere, few studies regarding the practice of implant dentistry refer to the practitioners' level of education. There is every indication that the majority of oral surgeons perform implants, followed by periodontists and general dental practitioners (GDPs).⁶⁻⁸ Education and training in implant dentistry in different countries can also vary, including undergraduate and formal post-graduate training, fellowship/board training as well as the attendance of courses and/or seminars.⁸

The choice of implant system utilized also varies between studies and is determined by different factors. Practicing dentists placing implants may be employed either in the private sector or in state institutions, where budget constraints may limit the choice of implant system to be used.⁸ Other factors may be the consideration of long-term implant success rates as well as the financial barriers experienced by patients.^{4,8} However, the cost of implants has been given the lowest priority by practicing dentists when choosing an implant system, especially in the private sector.⁹

Implant therapy complications resulting in the loss or failure of implants are attributed to inaccurate treatment planning, surgical mistakes or improper prosthodontic restoration.⁹ The reported complications include dehiscence/fenestration, gingival inflammation and fistulae. Surgical complications such as hemorrhage and neurosensory disturbances have also been reported.¹⁰ The prevalence of peri-implantitis as a complication varies from study to study.^{8,11,12} This may be due to the inconsistencies in the precise diagnoses of peri-implantitis and peri-implant mucositis in different clinical settings.⁸ Implant placement location, poor oral hygiene, the patient's medical condition, and patient noncompliance are also reasons that may underlie implant therapy complications.^{7,8,13}

A recent study in the Eastern Province of Saudi Arabia indicated that far more non-Saudis than Saudis practiced implant dentistry.⁸ This was attributed to the

recruitment of a large number of non-Saudi dentists into the private sector due to an increased demand for implant therapy. The study reported that the largest proportion of dentists performing implants were oral surgeons (44.7%), followed by GDPs (21.1%), periodontists (18.4%), and prosthodontists (13.2%).⁸ It was therefore the purpose of the present study to assess the education and training of dentists practicing implant therapy in the Riyadh region of Saudi Arabia, including their preferred dental implant systems, the clinical complications experienced and the barriers to implant therapy they encounter. This would allow us to compare the practice of implant therapy in the Riyadh region to that in the Eastern Province of Saudi Arabia.

Material and methods

The study was conducted between May 2017 and March 2018. A self-administered English-language questionnaire was distributed among practicing dental practitioners currently placing dental implants. The practitioners were working in state hospitals, and in various private centers in and around the city of Riyadh. Access and permission to distribute the questionnaires was obtained from both the state and private institutions.

The questionnaire included demographic data to ascertain the total number of practicing dentists performing both stage 1 and stage 2 of implant surgery. Their respective qualifications including their specialist category were also noted. Saudi and non-Saudi practitioners were differentiated, as were state and private sectors.

The questionnaire also referred to the practitioners' main source of education pertaining to implant dentistry as well as the most commonly used implant systems. The most common clinical complications experienced by practitioners were investigated as well as the barriers to implant therapy they encountered. A descriptive statistical analysis was carried out using IBM SPSS Statistics for Windows, v. 22.0. (IBM Corp., Armonk, USA). Statistical significance was set at 0.05.

Results

Out of a total of 248 questionnaires, 192 were completed, signifying a response rate of 77.4%. The majority of the respondents were male ($n = 127$; 66.1%). Non-Saudi dental practitioners were in the majority (56.6%), with a significant proportion employed in the private sector (89.2%; $p = 0.001$). A significant majority of Saudi dental practitioners, however, were employed in the state sector (82.14%; $p = 0.001$).

Formal education regarding implant placement was reported to consist mostly of post-graduate training during the acquisition of a Master's degree (43.2%), followed by

the attendance of courses and/or seminars (30.7%), undergraduate training (13%), fellowship/board training (9.9%), and doctoral studies (8.3%).

Of a total of 192 respondents placing implants, 48.1% were GDPs, 30.8% periodontists, 11.9% oral surgeons, 5.4% prosthodontists, and 3.8% restorative specialists. The percentage distribution of the qualifications held by the listed proportions of the practitioners is depicted in Fig. 1. The highest qualification held by the majority of GDPs was a Bachelor's degree (90.9%), that held by the majority of periodontists and oral surgeons was a Master's degree (57.9% and 61.9%, respectively), and that held by the largest number of prosthodontists was a fellowship (50%). The largest number of restorative specialists held either a Master's degree (42.86%) or a fellowship (42.86%).

Regarding the dental implant systems being used, it was found that the 3i™ system was the most commonly used (35.4%), followed by Astra Tech™ (22.4%), Osstem® (10.4%), Noble Biocare™ (9.4%), Straumann® (7.8%), and Zimmer® (5.2%) (Fig. 2).

Regarding the criteria for selection when considering a specific implant system, 18.3% of the respondents reported that the particular implant system was chosen by the administration of their hospital and/or clinic, followed by the popularity of the system (15.7%), easy handling (7.3%) and the long-term prognosis (5.7%).

The consideration of costs (1.04%) and esthetics (1.04%) were given the lowest priority by the practitioners (Table 1).

Of the respondents, both state and private employees, who reported performing implants every month (Fig. 3):

- 25.5% stated that they placed an average of 1–5 implants/month;
- 31.2% – 6–10 implants/month;
- 17.1% – 11–15 implants/month;
- 10.4% – 16–20 implants/month;
- 14.3% – >20 implants/month.

The most common clinical situation for the placement of implants was single posterior tooth loss (89%), followed by single anterior tooth loss (71%), edentulous

Table 1. Implant system selection criteria in terms of the percentage of practicing dentists

Implant system selection criteria	Percentage of practicing dentists [%]
Hospital/clinic administration	18.3
Popularity of the system	15.7
Easy handling	7.3
Long-term prognosis	5.7
Cost	1.04
Esthetics	1.04

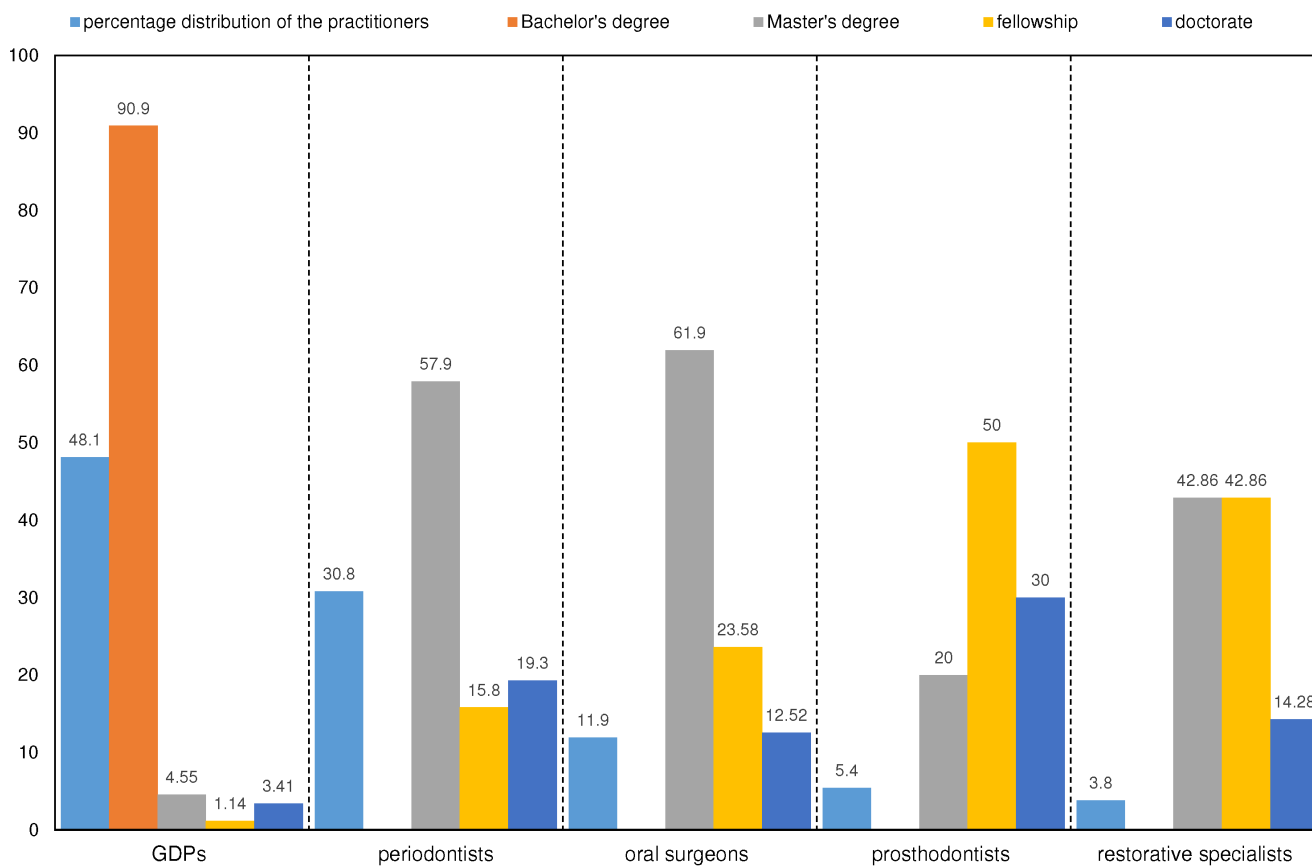


Fig. 1. Percentage distribution of qualifications held by the percentage proportions of practitioners
GDP – general dental practitioner.

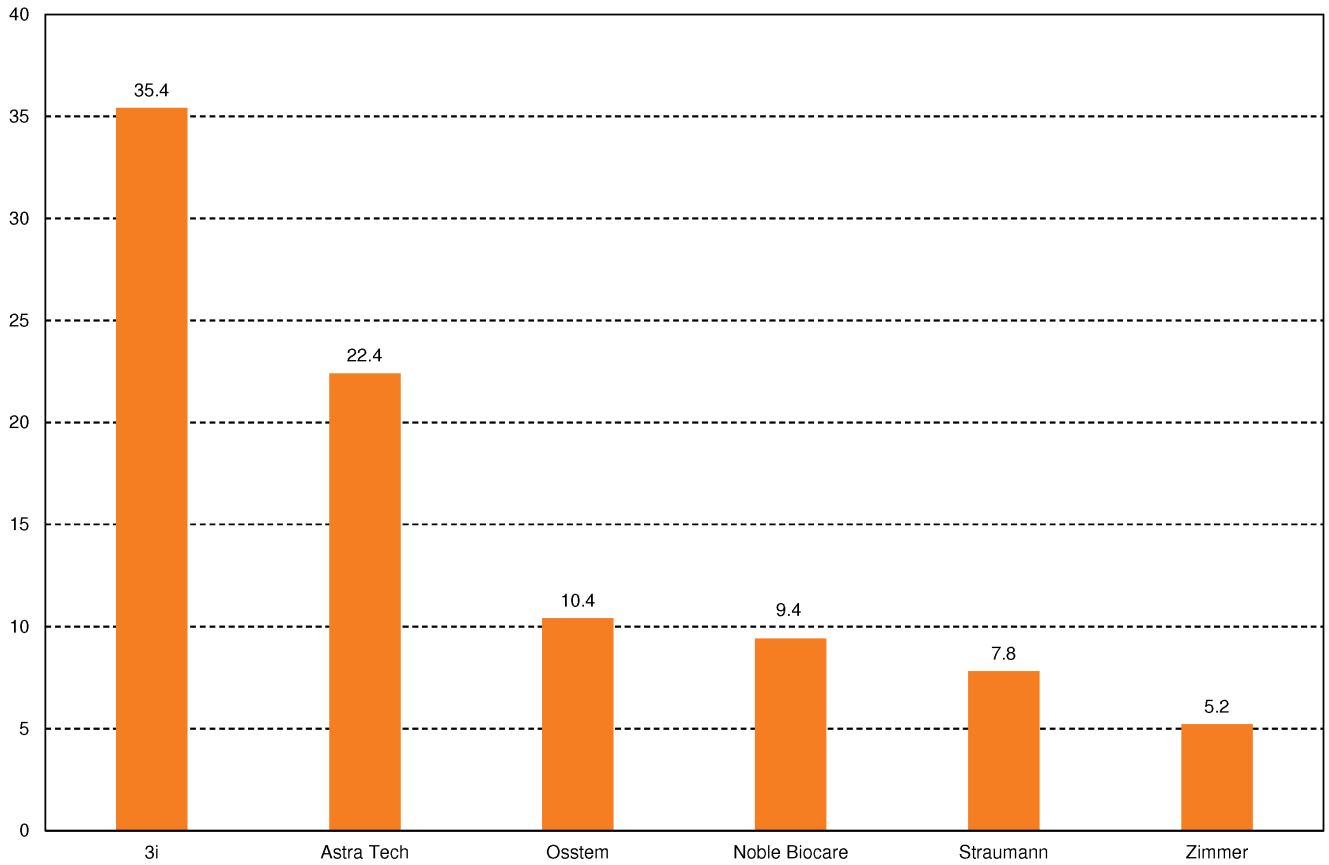


Fig. 2. Percentage distribution of the implant systems used

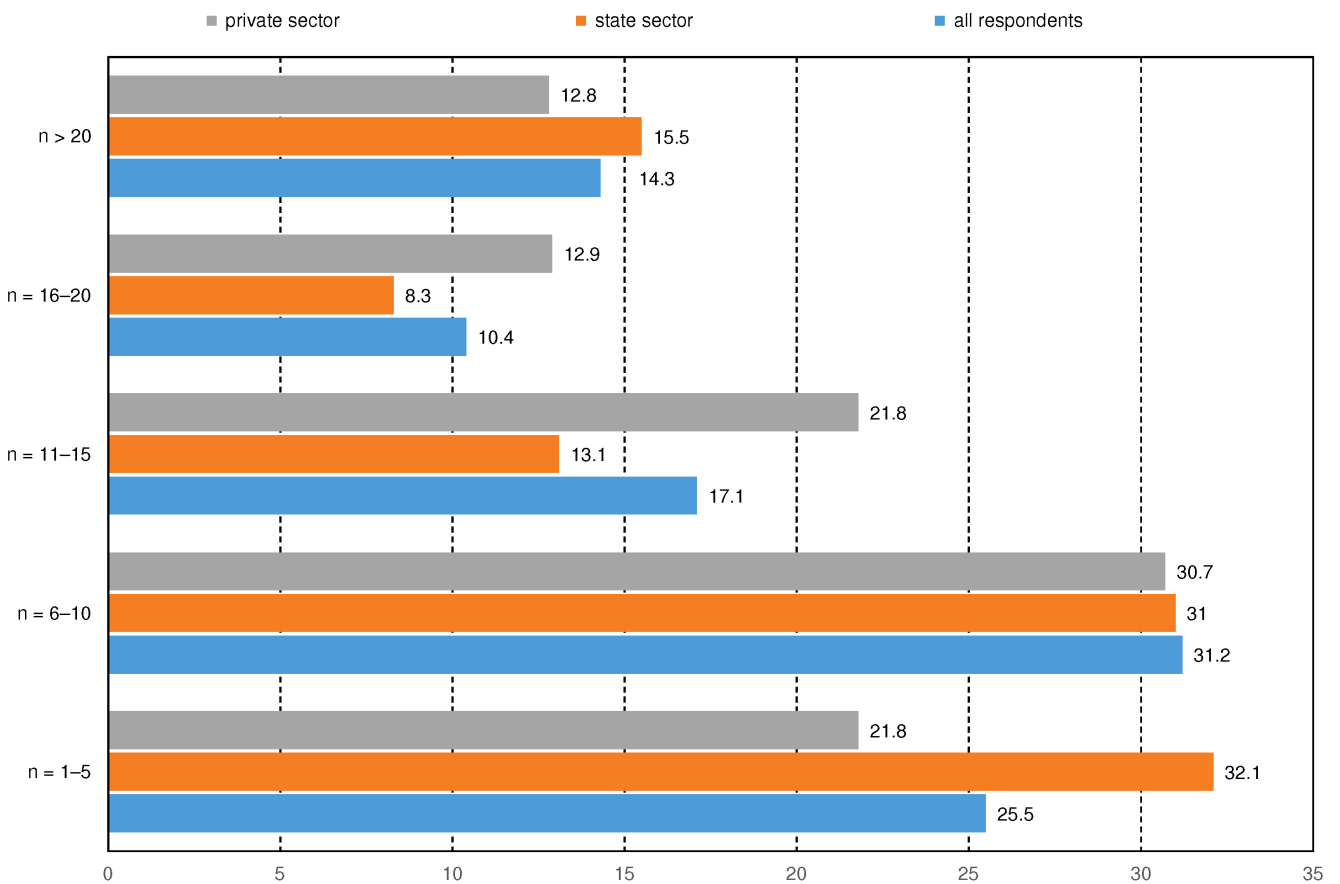


Fig. 3. Percentage distribution of respondents placing n number of implants per month

cases (56.5%), free-end saddles (42.4%), multiple tooth loss (39.8%), and abutments for either fixed partial dentures (FPDs) or overdentures (26.9%) (Table 2). In this study, the lower first molar was the most common posterior tooth to be replaced with an implant. The recommendation of substituting missing teeth with implants as the first choice of treatment was reported by 87.8% of the respondents, in contrast to utilizing FPDs or removable dentures.

Common challenges encountered before the surgical placement of implants were reported to be low sinus levels (38.4%), smoking (15.6%), the patient's medical condition (15.1%), the severity of bone loss (11.9%), the presence of gingivitis/periodontal disease (7.8%), and a high caries risk (6.2%) (Table 2).

The biggest barrier to performing implant surgery was the cost of implants to the patient, reported by 59.1% of the respondents, followed by the patient's fear (9.9%), a shortage of equipment (6.8%), and a lack of time reported by the patient (1.6%). (Table 2).

The clinical complications most frequently encountered after implant surgery were reported to be failed osseointegration (12.6%), peri-implantitis (12%) and peri-implant mucositis (9.3%). This was followed by dehiscence/fenestration (7.3%) and local infection (6.7%). The underlying reasons for these clinical complications as perceived by the respondents were patient noncompliance, poor oral hygiene and smoking (24.5%). Other indicated reasons

were periodontal diseases and infection (22.9%), followed by improper implant placement and the practitioner's inexperience (20.8%).

Regarding the referral of patients for the management of unexpected complications, 74.3% of all respondents reported that they referred their patients for the appropriate treatment of any clinical complications. Of these, the highest referral rate (91%) was reported among GDPs, followed by restorative specialists (85.7%), oral surgeons (63.6%) and periodontists (56.3%). Prosthodontists had the lowest referral rate (40%).

Discussion

The population of Saudi Arabia was estimated to be 33.5 million in 2018. The demand for implant therapy has been increasing in the Saudi population.⁴ Al-Houtan et al. in their study investigated implant therapy practices in the Eastern Province of Saudi Arabia, which is the largest administrative area in the country.⁸ The Eastern Province has an estimated population of 4.6 million, distributed over 5 cities in the region. The total number of dentists placing implants in the Eastern Province is estimated to be 55. The survey-based study in the Eastern Province had a response rate of 69% (n = 38), which was regarded as weak.⁸ On the other hand, the city of Riyadh – the capital and the largest city in the country, situated in the central part of Saudi Arabia – alone has an estimated population of 4.21 million.¹⁴ The total number of dentists placing implants in Riyadh is estimated to be 248. The response rate in the present study was 77.4% (n = 192). Although the response rates in these 2 studies may seem to be comparable, the number of respondents in the present study is considered more acceptable.

The prevalence of clinical complications may vary between studies, both on a local and international basis. In the present study, failed osseointegration was the most commonly reported complication, along with peri-implantitis. The Eastern Province study also reported peri-implantitis as the main clinical complication.⁸ Other studies with larger population samples did not, however, uphold this tendency.^{11,12,15} Patient noncompliance and poor oral hygiene were identified as the main reasons underlying these clinical complications in both of the Saudi Arabian studies as well as in a study conducted in Sweden.⁷ Also, in the present study, periodontal diseases, infection, improper implant placement, and the inexperience of practitioners were highlighted as causes of complications.

In this study, a high referral rate was reported by GDPs for the treatment of the complications they encountered. A more thorough understanding and knowledge of potential clinical complications is needed, which means that further research regarding implant practices and complications, with larger sample sizes, both regionally and in-

Table 2. Clinical indications, pre-surgical challenges and barriers encountered in terms of the percentage of practicing dentists

Clinical indications, pre-surgical challenges and barriers	Percentage of practicing dentists [%]
Clinical indications	
Single posterior tooth loss	89.0
Single anterior tooth loss	71.0
Edentulism	56.5
Free-end saddle	42.4
Multiple tooth loss	39.8
Abutment for FPD/overdenture	26.9
Pre-surgical challenges	
Low sinus levels	38.4
Smoking	15.6
Patient's medical condition	15.1
Severity of bone loss	11.9
Gingivitis/periodontal disease	7.8
High caries risk	6.2
Barriers	
Cost of implants to the patient	59.1
Patient's fear	9.9
Shortage of equipment	6.8
Lack of time for the patient	1.6

FPD – fixed partial denture.

ternationally, should be conducted. Furthermore, from an educational perspective, in both the present study and the Eastern Province study, the attendance of courses and/or seminars was listed by a large proportion of the respondents as part of their training in implant placement. The increased popularity of such courses was described in another study.¹⁶ However, as the Eastern Province study pointed out, the ideal practitioner to place implants is a surgically trained periodontist or oral surgeon.⁸ Therefore, it should be reiterated that such courses and seminars should concentrate on considering the complexity of the various aspects of implant planning and surgical placement as well as the involved difficulties. This would allow the future development of complications and compromises in the quality of implant therapy to be avoided to a larger extent.⁸

Further comparisons between the present study in Riyadh with the Eastern Province study reveal certain major differences (Table 3). The predominant gender practicing implant dentistry in both studies was male; however, a larger pro rata percentage of males is evident in the Eastern Province (81.6%).⁸ This may be attributed retrospectively to a larger number of dental schools in Riyadh, qualifying more female students. These Riyadh schools have been open significantly longer than dental schools in the Eastern Province. Only recently have female students been graduating from schools in the Eastern Province. It may also be postulated that more male dentists are recruited into the private sector in the Eastern Province.

Of all practicing dentists in Riyadh, a smaller percentage were in private practice (54.8%) as compared to the Eastern Province (65.8%). However, due to the sample sizes in the 2 studies ($n = 192$ and $n = 38$, respectively), there was a much larger number of private practitioners in Riyadh. This may possibly be ascribed to the Riyadh region being more affluent than the Eastern Province.

The Riyadh region had a larger proportion of Saudi nationals practicing implant dentistry as compared to the Eastern Province. However, there is still a slightly higher proportion of non-Saudis practicing implant dentistry, albeit fewer than in the Eastern Province. Riyadh has a larger population, with more state and private teaching dental hospitals than the Eastern Province. It is under-

standable that Saudis who are permanently resident and educated in Riyadh would prefer to remain and practice in Riyadh.

A larger number of implants were being placed in Riyadh as compared to the Eastern Province. Riyadh has a far greater population than any of the 5 cities in the Eastern Province, along with a larger number of practicing dentists placing implants. The demand for implant therapy is therefore expected to be higher. A survey conducted in Riyadh indicated the increased popularity of implants as a treatment option, with wide acceptance and a high level of satisfaction expressed after placement.⁴

The present study found that the majority of practitioners placing implants in Riyadh were GDPs, whereas in the Eastern Province, implants are mostly placed by oral surgeons. The reasons for this tendency may be twofold. Firstly, there is a greater number of both state and private dental schools in the Riyadh region as compared to the Eastern Province, so by implication, more Saudi GDPs are being qualified. Secondly, this study showed that a significant majority of non-Saudi dental practitioners were employed in the private sector (89.2%), and the majority of GDPs in Riyadh are non-Saudis. This may be ascribed to a higher number of non-Saudi GDPs being recruited to the private sector in Riyadh as compared to the Eastern Province.

Both locally and internationally, the factors influencing the choice of implant system may vary. A greater proportion of practicing dentists in Riyadh utilize the 3i system, whereas in the Eastern Province, the Straumann system is more frequently used. The reasons for different implant systems being preferred in these 2 regions in the same country are not clear. In this study, the popularity of the system, easy handling in use and the long-term prognosis were among the reasons for the choice of implant system. A limitation of this study regarding the choice of implant system is the absence of any investigation of whether the preferred use was based on published scientific literature that included clinical data. Studies in other countries also indicated the preferential use of particular implant systems, such as Noble Biocare and Straumann.^{17,18} The use of a particular implant system during the practitioner's specialist training, the influence of aggressive commer-

Table 3. Comparison of implant practices between Riyadh and the Eastern Province of Saudi Arabia

Difference	Riyadh	Eastern Province of Saudi Arabia
Predominant gender of the practitioners placing implants	male (67.2%)	male (81.6%)
Employment sector	private (54.8%)	private (65.8%)
Percentage of non-Saudi practitioners	56.6%	68.4%
Number of practitioners placing 6–10 implants per month	57 (342–570 implants)	13 (78–130 implants)
Practitioners placing the most implants	GDPs (48.1%)	oral surgeons (44.7%)
Implant system mostly used	3i (35.4%)	Straumann (34.2%)
Clinical complication encountered most frequently	failed osseointegration (12.6%)	peri-implantitis (23.7%)

cial marketing, lower costs as well as personal preferences for specific implant systems, for example due to restorative convenience, may underlie this tendency. Globally, implant manufacturers profess that their various implant systems have ‘the best’ physicochemical, biological and clinical properties.¹⁹ However, the current basis for implant treatment protocols is early osseointegration, which comprises the immediate and early loading of implants.¹⁹ The enhancement of the bone-to-implant contact (BIC) interface is an important parameter affecting the speed of osseointegration.²⁰ The modification of the topographical features of dental implant surfaces at the micro- and nanoscale can significantly improve BIC and bone anchorage at the early stages of osseointegration.¹⁹ Hydrophilicity has been shown to positively affect the initial stages of wound healing during osseointegration, whereby the adsorption of plasma proteins essential for the initial osteogenic interaction is accomplished.²¹ This leads to beneficial gene expression, intense and rapid osteogenesis, bone mineralization, and early osseointegration.^{19,22} Various studies compared hydrophobic and hydrophilic implant surfaces having the same microtopography. These studies concluded that osseointegration was enhanced by super-hydrophilic surfaces, demonstrating a stronger bone response in comparison with hydrophobic surfaces with the same topographical features.^{20,23}

Surface chemistry that promotes hydrophilicity, and not micro-surface topography, has been shown to accelerate implant osseointegration and increase BIC.^{19,20,23} Surface chemistry potentially alters ionic interactions, protein adsorption and cellular activity at the implant surface.²⁴ Protein adsorption at the implant surface influences the attachment and migration of cells. A higher affinity to individual protein molecules, which influences the bonding strength and maintains the conformation, orientation and function of these proteins, is exerted on hydrophilic surfaces than on hydrophobic ones.^{25,26} This is of considerable importance, since initial protein interactions with the implant surface largely mediate the impact of hydrophilicity on cellular and tissue reactions toward biomaterials.²⁵ This includes biological signals activating and expressing the receptors located on the membranes of cells, subsequently determining initial cellular attachment as well as cell proliferation and differentiation.²⁵ Hydrophobic surfaces, however, may induce the denaturation of proteins by bringing about conformational changes.^{27,28}

Various studies found that hydrophilic surfaces enhance the early stages of cell adhesion, proliferation and differentiation as well as bone mineralization as compared to hydrophobic surfaces.²⁹ This includes promoting the differentiation and maturation of osteoblasts, thereby contributing to accelerated osseointegration, as well as initializing the earlier onset of secondary implant stability.^{28,30} Furthermore, other studies described a significantly lower overall early failure rate of hydrophilic implants as compared to hydrophobic ones.³¹ The majority of implant

surfaces currently being utilized in clinical practice are hydrophobic.^{25,32,33} The examples of hydrophobic implants are 3i, Astra Tech, Straumann, and Dentsply Friadent; the examples of hydrophilic implants are Astra Tech, Osstem, Nobel Biocare, and Straumann.²⁵

Lastly, in the present study, failed osseointegration was recorded as the most common clinical complication (12.6%), as compared to the Eastern Province study, which reported peri-implantitis to be more common. However, due to the larger total number of implants placed in Riyadh (between 342 and 570 per month), along with the similar reported prevalence of peri-implantitis (12%) among the Riyadh patients, failed osseointegration may be ascribed to poor patient compliance, smoking and bad oral hygiene, as reported in this study.

Conclusions

The majority of practitioners placing implants in Riyadh were GDPs. Failed osseointegration and peri-implantitis were the most common clinical complications. The cost of implants to patients was the biggest barrier to placing implants.


The practice of implant placement can differ from one region to another, both locally and internationally. However, what is fundamental is the choice of implant system. It should be based on factors that promote early osseointegration for the purpose of the immediate and early loading of implants. Therefore, consideration should be given to the advantages of chemically modified surfaces that promote hydrophilicity, rather than to the topographical features alone. Implant placement, as practiced by various qualified clinicians, also involves the aspects of patient selection and clinical complications. Studies with larger sample sizes are needed to ascertain and compare the demand and practice of implant placement in other regions of Saudi Arabia.


Additional comparative research should be undertaken on a local as well as international basis. The research should incorporate patient selection, restorative planning and the surgical placement of implants as well as the prevalence and reasons for implant complications and failures. Appropriate patient selection for implant therapy cannot be overemphasized. By this means, additional knowledge, insight and expertise regarding proficiency in clinical therapeutic guidelines may be further developed. This knowledge, in addition to advanced clinical specialist training, will inevitably lead to the improvement in the quality of implant therapy for the benefit of patients.

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