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ORIGINAL ARTICLE

The current considerations in the fabrication of implant prostheses and the state of prosthetic complications: A survey among the dental technicians

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Dental implants;
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Abstract *Purpose:* To investigate the current considerations in the fabrication of dental implant prostheses (DIP) and the state of prosthetic complications from the dental technicians (DT) perspective.

Methods: A self-designed pretested questionnaire and an informed consent were distributed to 150 certified DT working in dental laboratories of Riyadh, KSA. The demographic data, questions related to the implant fixed/removable prostheses and questions on the prosthetic complications related to the DIP were collected. Descriptive statistics and Chi-square test were used for statistical analysis, considering a P-value of <0.05 using SPSS.

Results: 130 responses (response rate 83.6%) were received. 53% (n = 69) of the DT received job orders for DIP from >20 dentists. 49% (n = 64) of dentists took the leading role in the treatment planning/designing. 48% (n = 62) and 52% (n = 68) of requests were for Cement and Screw retained DIP respectively. Custom abutments 37% (n = 49) choice of abutments. Porcelain fused to metal (PFM) 34% (n = 44) and PFM with metal occlusal surface 55% (n = 71) were material of choice. 49% (n = 64) designing of implant overdentures were according to the dentist's instructions

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with Ball and Socket 48% (n = 63) to be the most common attachment. DT regarded poor implant location/orientation 38% (n = 49) and inaccuracies in impression/bite-registration 40% (n = 52) as the obstacles to success. Half 50% (n = 65) of the repairs were for facing damage/chipping of ceramic. Fracture of the denture base/tooth detachment 50% (n = 65) was common with implant over dentures.

Conclusions: DT played a role and took decisions regarding the DIP. Frequent problems found by DT were poor implant location, discrepancies in impression/bite-registration, facing damage/chipping and damage/fracture of the denture base/prosthetic teeth. The frequency of these complications can be minimized by an increase in the prosthetic knowledge of the dentists and establishing clear protocols for communication between the dentist and the DT.

1. Introduction

The introduction of osseointegrated dental implants has dramatically enhanced the scope of prosthodontic treatment; it expanded the commercial world and the business of dentistry. The availability of stable anchorage for prosthetic tooth replacement has evidently expanded the scope for better treatment options. In the present scenario, the success of implants is an important landmark for dentists when reviewing the treatment outcome with patients. Literature search shows that there has been an increase in demand for dental implants, which is the core of dentistry in the 21st century (Bartlett, 2007; Taylor et al., 2005; Kawazoe, 2009).

When planning prosthetic rehabilitation, implant supported FDP or implant-supported single crown (SC) followed by conventional end-abutment tooth-supported fixed dental prosthesis (FDP) are the first treatment options. Cantilever tooth-supported FDP, combined tooth-implant-supported FDP or resin-bonded bridges are a second line of option (Pjetursson and Lang, 2008). Using dental implants in rehabilitating the partially edentulous patients is an accepted contemporary clinical method that is expected to have long-term success. Screw retention and cementation are two methods of retaining a fixed implant-supported restoration. The clinician's preference is initially the method chosen. The more popular screw-retained prosthesis traditionally simplified periodic retrieval of the superstructures and implants for repairs, hygiene and tightening of abutment screw (Nissan et al., 2011).

The success of an implant prosthesis depends on the combined efforts by the dentist and dental technician (DT). Both dentist and the DT should take responsibility to ensure best care for the patient. The working relationship of dentists with DT starts from the student days in the dental school. However, the absence of communication between dentist and DT has also been reported as a major problem in providing optimum patient services including the implant treatments (Pjetursson and Lang, 2008). Recognizing the significance of communication that is crucial for a properly executed prosthesis, the American Dental Association issued an updated guideline to improve the relationship between the dentist and DT. These guidelines will also increase the efficiency and the quality of care. The work authorization forms contain specific information requested by the laboratory so better communication can occur between the members of the team. The information requested generally include the patient's demographic details, important dates, description of the work necessary and a diagram of the design, materials to be used, shade of the prosthesis, information regarding customization, type of occlusal scheme, license number, signature and phone number of the dentist or specialist making the request (Afsharzand et al., 2006; Tulbah et al., 2017).

Varieties of complications are associated with DIP. Although these complications hardly result in the total failure of treatment, the management can be unsatisfying, costly and time consuming for the clinician, patient and technician. Prosthodontic complications can be generally categorized as mechanical, biological and aesthetic. Mechanical complications affect the structural integrity of the abutment, implant or superstructure. Mechanical complications commonly reported include retention loss, fracture of the framework or veneering material, screw loosening and fracture, and implant fracture. The appearance of the restoration is affected by aesthetic complications and may be related with the DIP itself or the soft tissues surrounding it. Dentists as well as the DT who provides implant treatment should be mindful of these potential mechanical complications and the strategies by which they can be prevented and managed (Vere et al., 2012; Kreissl et al. (2007); Jung et al., 2008).

The aim of the current cross-sectional study was to investigate about the current considerations in the fabrication of DIP and the state of prosthetic complications from the DT perspective. The results helped in providing the current state of implant laboratory practice in xxx, xxx.

2. Materials and methods

This cross-sectional research study was reviewed and approved by the Ethical Committee of the College of Dentistry Research Center, xxxxx, xxx (CDRC Registration FR 0299). The study was conducted between March 2016 and September 2017.

A self-designed questionnaire with some parts adopted from previous studies to suit the requirements of the present study was used for collection of information. The questionnaire was pretested on site by the authors and in house DT. The questionnaire was distributed along with a cover letter stating the instructions, rationale and purpose of the survey as well as an informed consent to a conveniently selected sample of 150 certified DT working in the various dental laboratories of xxx, xxx. All the willing DT participated in the survey and completed the questionnaire by hand. The DT were helped in understanding questions and recording their responses.

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To facilitate the coverage of a broad range of topics the questionnaire was designed in four sections. The first section was used to collect the demographic data such as DT years of experience, job orders for implant prostheses received per week, and about who takes the lead role in designing of the DIP. The second and third section of the questionnaire targeted the questions related to the implant fixed and implant removable prostheses respectively. The last part of the questionnaire comprised of questions on the prosthetic complications related to the DIP.

2.1. Statistical analysis

Frequency analysis of the data collected was done using Statistical Package for Social Sciences (SPSS) version #21 (SPSS, Chicago, Illinois, USA). Descriptive statistics and Chi-square test were used for statistical analysis of the responses considering a P-value of <0.05 as the cut-off level for significance.

3. Results

One hundred thirty responses were completed out of the 150 hand distributed questionnaires (response rate 83.6%). A total of 130 complete responses were received, which were assessed. Among the total respondents, 12% (n = 16) had 1–3 years' dental technology experience, 58% (n = 75) had 4–6 years, 12% (n = 16) had 7–9 years and 18% (n = 23) had >10 years' experience (Table 1). Majority 53% (n = 69) of the participating DT received job orders for DIP from 20 or more dentists. According to the respondents almost half 49% (n = 64) of their customer dentists took the leading role in the treatment planning and designing of the DIP, while for only 12% (n = 16) of the job orders from the dentists the technicians were making the decision regarding the DIP. For around 39% (n = 50) of the job orders the decisions regarding the DIP were made by both DT and the dentists in collaboration with each other.

Table 1 Results from general questions section (N = 130).

Questions	Options	Frequency	Percentage (%)
Years of experience	1–3 Years	16	12
	4–6 Years	75	58
	7–9 Years	16	12
	10 and above	23	18
Job orders received from Dentists	1–9	24	19
	10–19	37	28
	20 and above	69	53
Leading role in treatment planning and prosthetic design of the Prostheses	Dentist	64	49
	Technician	16	12
	Dentist & Tech.	24	19
	Tech. & Dentist	26	20

Out of four questions with multiple options in relation to implant fixed prostheses; responses of participants were significantly different $p < 0.05$ for three questions (Table 2). With regards to retention 48% (n = 62) and 52% (n = 68) of the job order requests were for Cement retained and Screw retained implant fixed prostheses respectively. In relation to the most commonly used abutment with cement retained prostheses, custom abutments 37% (n = 49) were the choice of abutments followed by Titanium abutments 34% (n = 45) and Zirconium abutments 21% (n = 27). Porcelain fused to metal 34% (n = 44) and All Ceramic Zirconia 14% (n = 19) were the choice of materials for the anterior regions of the mouth. While for the posterior regions, porcelain fused to metal with metal occlusal surface 55% (n = 71) was equally considered in comparison to all ceramic zirconia crowns 14% (n = 18). Only few 8% (n = 10) of participants also considered all metal crowns for the posterior regions of the mouth (see Tables 3 and 4).

The majority of total respondents 49% (n = 64) mentioned that decisions regarding the designing of implant overdentures were made according to the dentist's instructions and only 12% (n = 16) of the respondents reported that the designing of implant overdentures were left to the technicians. The most common attachment type with implant overdentures was the Ball and Socket 48% (n = 63) type of attachment followed by Magnets 28% (n = 37).

Of the problems encountered by the DT in the laboratory, aesthetic 37% (n = 48) and occlusal 35% (n = 46) related issues were almost the same, while compatibility precision 28% (n = 36) related issues were slightly lesser than the other two. Comparing these results in connection with the laboratory fabrication challenges faced by the DT reveals that the DT regard poor implant location and orientation 38% (n = 49) followed by the defects and inaccuracies in impression taking and bite registration 40% (n = 52) as the obstacles to success. In relation to the complications related to the implant superstructures, half 50% (n = 65) of all the requests were for facing damage and chipping of ceramic. Several creative steps taken by the DT to prevent veneer chipping and fractures, based on laboratory considerations were revealed in the survey. Metal including zirconia coping designs 19% (n = 24), indirect composite resins 12% (n = 16) and metal coping designs 30% (n = 39) were some steps adopted by the DT. Fracturing of the denture base or denture tooth detachment 50% (n = 65) was the most common complications reported with implant over dentures. This was followed by the reconstruction of the occlusion related to wear or attrition of the acrylic teeth 29% (n = 38).

4. Discussion

The study presents a unique data on amount of specialized and high precision laboratory procedures employed by DT at specialized fabrication laboratories with regards to DIP. There certainly are clinical cases in which the DT takes the initiative with regards to designing of the DIP and the clinicians do not guide the technician about it. The intention of the current survey was to explore the practices in DIP designing from the DT perspective. This helped in evaluating and identifying the current trends and problems from the standpoint of DT.

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Table 2 Questions and responses regarding implant fixed prostheses (N = 130).

S. No.	Questions	Options	Frequency	Percentage (%)	P-value
1	According to you, which implant fixed prostheses, is in demand?	Cement retained	62	48	0.599
		Screw retained	68	52	
2	Which is the most used abutment with cement-retained prostheses?	Titanium	45	34	0.000
		Zirconium	27	21	
		Custom abutments	49	37	
		Other	9	7	
3	What types of materials (i.e. veneer, coping) are used to make implant prostheses in the anterior region?	Porcelain fused to metal crown	44	34	0.000
		All ceramic crown (zirconia)	37	28	
		All ceramic crown (other materials)	19	14	
		Indirect composites (facing crown)	22	17	
		Indirect composites (jacket crown)	8	6	
4	What types of implant fixed prostheses are used in the posterior region?	Porcelain fused to metal crown (full bake)	53	41	0.000
		Porcelain fused to metal crown (metal occlusal)	18	14	
		All Ceramic crown (Zirconia)	18	14	
		Indirect composite veneer crown (full bake)	16	12	
		Indirect composite veneer crown (Metal occlusal)	15	11	
		Metal crown	10	8	

Table 3 Questions and responses regarding implant overdentures (N = 130).

S. No.	Questions	Options	Frequency	Percentage (%)	P-value
1	The design of the implant overdenture	Decision made according to instructions of Dentist	67	51	0.000
		Work is left to technicians	19	14	
		Decided upon through consultation with each other	44	34	
2	What are the proportions of attachment types is used with IODs?	Magnet	37	28	0.000
		Ball and socket	63	48	
		Locator	14	11	
		ERA	2	1	
		Other	14	11	

The response rate was 87% for hand delivered questionnaires was found to be satisfactory. Electronic questionnaires were not adopted because of inability of accessing the emails of the DT and not all of the DT were involved in fabrication of DIP. Only those DT who were involved in fabrication of DIP were requested to participate in the survey. Participation of majority of the DT having four or more years of experience in fabrication/handling of DIP and receiving job orders from 20 or more dentists, allowed an effective comparison of data sets. The laboratory work related to the DIP consists of complex processes, handling numerous devices and materials. The personnel practicing these procedures on daily bases in the dental laboratories can be considered proficient and they differ from the past generations of DT who mainly practiced the craftsmanship.

During the treatment planning and designing of the DIP the importance of the dentist's role cannot be overemphasized. According to the respondents of the current study

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Table 4 Questions and responses regarding prosthetic complications. (N = 000).

S. No.	Questions	Options	Frequency	Percentage (%)	P-value
1	Main issues generally encountered?	Compatibility precision issues	36	28	0.385
		Aesthetic issues	48	37	
		Occlusal issues	46	35	
2	Fabrication challenges faced?	Poor implant location and orientation	49	38	0.000
		Inadequate consideration of occlusion	15	11	
		Defects and inaccuracies in impression and bite registration	52	40	
		Defective or unreasonable prosthesis design	8	6	
		Other	6	5	
3	Frequently received repairs requests involving implant fixed prostheses?	Facing damage and chipping	65	50	0.000
		Facing discoloration and wear (indirect composite veneer crowns)	16	12	
		Bridge connector fracture	21	16	
		Design changes and modification associated with additional implants	24	19	
		Other	4	3	
4	Creative steps taken in order to prevent veneer fracture and chipping in the molar region?	Use of metal occlusal designs	26	20	0.003
		Use of indirect composite resin material	33	25	
		Devise metal coping designs	39	30	
		Cover the distal-most part with metal	18	14	
		Nothing in particular	14	11	
5	Frequently received repair requests for Implant Over Dentures?	Fracturing of the denture base or denture tooth detachment/fracture	65	50	0.000
		Mesostructured (attachment) damage	14	11	
		Occlusal reconstruction due to denture wear or attrition	38	29	
		Replacement of the attachment system (transition to another system)	11	9	
		Other	2	1	

almost half of the dentists (49%) were leading the role in this regard, while around one fourth of the dentists were making the decisions primarily by themselves but with consultation of the DT. This indicated a positive attitude from the dentists where around three fourth of the dentists were leading the role in treatment planning and designing of the DIP. This finding of the study is slightly better than reported in 2015 by Yoshiyuki et al. in which only 39% of the dentists were leading the role in treatment planning and designing. However, the DT were still making the decisions in 12% of the cases themselves and in 20% of the cases they were leading the role in the decisions making along the consultation of the dentist. The prosthetic complications occurring later after using the DIP is a result of repercussions of this important issue.

The screw- and cemented-retained implant restorations shown in long-term clinical prospective studies reported similar results in terms of patient- and clinician-assessed success parameters (DaSilva et al., 2014; Chaar et al., 2011). In the current study the percentage of dentists demanding screw retained implant fixed prostheses were marginally high (52%) compared to the cement retained fixed prostheses (48%). The excellent marginal integrity and retrievability are the main advantages of screw-retained restorations but have disadvantages such as open screw access holes and need for optimal implant positioning which have been proposed to stabilize veneering material and compromise occlusion. The total cost of implant treatment increases due to the sophisticated clinical and laboratory procedures of screw-retained restorations (Vohra and Habib, 2014; Millen et al., 2015; Wittneben et al., 2014). Although there is no absolute way of restoring the implant, screw retention still has many attributes and, when possible, should be considered the optimal solution (Assaf and Gharbyeh, 2014).

With regard to the types of abutments used with the cement retained prostheses, CAD/CAM abutments accounted for more than half of the total (Zirconium = 21%; Titanium = 34%). This percentage of CAD/CAM abutments is high compared to one third reported by Yoshiyuki et al. (2015) in a study in Japan. Customized abutments using precious metal alloys accounted for 37% of the cases. The advantages of custom abutments that make an excellent option for implant treatment include patient-specific soft tissue management during the healing phase and final restorations that adhere precisely to the patient's gingival architecture. But many clinicians are uncertain to change to custom components

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because of ease of fabrication and cost in CAD/CAM abutments (Gowda et al., 2016).

Concerning the types of prostheses used in the anterior and posterior regions the collected data indicated a trend towards selection of almost the same materials with PFM to be the choice of material in majority of cases. The use of Zirconia was next after the PFM and its percentage of usage in the anterior region (28%) was obviously higher compared to posterior regions (14%) because of esthetic reasons. These results indicate that majority of the prosthetic components of the implants are still made from conventional alloys as reported by Saini et al. (2015).

The results revealed that in only 14% of cases for implant overdenture required decisions to be taken by the technicians, while in 51% of the cases the dentists themselves or in 34% of cases with consultation of the technicians the decisions were made. The attachments most commonly used available commercially include bar, stud, magnetic and telescopic attachments. These types has advantages, disadvantages, and special requirements to be used efficiently (Trakas et al., 2006; Krennmair et al., 2006). The simplest stud attachment widely used is the ball attachment due to its ease of handling, its low-cost, minimal chair side time requirement and their possible applications with both implant and root supported prostheses (Ahmed and Kaddah, 2016; Kim et al., 2012). Another popular method of attaching removable prosthesis to osseo integrated implants is the magnetic retention. However, prosthetic maintenance and complications most commonly occurred in the magnet groups (Trakas et al., 2006; Krennmair et al., 2006; Ahmed and Kaddah, 2016; Kim et al., 2012). These could possibly be the reasons because of which a high percentage of clinicians chose the ball and socket (48%) and magnetic attachments (28%) in the current study.

Caldron et al. (2014) reported that the mechanical is the most common complications that occur during the treatments involving implants. The outcome of the prosthesis is influenced by the design characteristics of the prostheses, the type of material used and biomechanical issues. Additionally, the frequency of prostheses repairs and its related costs are also important from economic point (Carr, 1998). According to the results of the study the main issues encountered in a dental laboratory, compatibility, aesthetic and occlusion related issues each encountered for almost one third of the total responses. From the DT point of view, poor implant location and orientation (38%) and defects and inaccuracies in impression and bite registration (40%) were the obstacles to success. Dentists can prevent these complications by proper preoperative examination and treatment planning using surgical templates or cone beam scans. Half of the issues reported regarding frequently received repairs requests were for facing damage and chipping. Similar reports in the literature (Papaspyridakos et al., 2012), can be found for this high rates of facing/chipping repairs. It was an interesting revelation in the survey that the DT take creative steps using a combination of materials to prevent this facing/chipping related complications. With regards to implant overdentures more than half all the requests involved issues related to the denture itself like fracturing of the denture base or teeth (50%) and occlusal reconstruction due to the denture wear (29%). Surprisingly issues related to the attachments systems like damage (11%) and replacement (9%) were much lower compared to the denture base issues. Similar issues have been reported in the literature (Goodacre et al., 2003; Andreiotelli et al., 2010) regarding these issues.

5. Conclusion

Considering the sample evaluated, we may conclude that DT played a role and took decisions regarding the DIP. The problems that the DT faced frequently were poor implant location, discrepancies in impression/bite registration, facing damage/chipping and damage/fracture of the denture base and prosthetic teeth. The results suggested that in order to minimize the frequency of the complications in DIP, the dentists should increase their prosthetic knowledge and clear protocols should be established for communication between the dentist and the dental laboratory technicians.

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Conflict of interest

The authors have no conflict of interest to declare.

Ethical statement

The study protocol was approved by the Research and Ethics Committee at the College of Dentistry, King Saud University (FR-0299).

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