Research Article

Dental Laboratory Production of Prosthetic Restorations in a Population in Sofia, Bulgaria: A Descriptive Study

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Received 6 September 2010; Accepted 27 October 2010

1. Introduction

The demand for restorative treatment is generally triggered by various oral conditions that affect masticatory performance, appearance, and psychological comfort [1]. When tooth replacement is indicated, clinicians must decide which of the available prosthetic restorations will meet patients’ demands at best. These restorations are fixed and removable dental prostheses retained and supported by either natural teeth or dental implants. As dental implants are not affordable for a vast majority of patients, the choice is often limited to conventional tooth supported prostheses. In general, fixed dental prostheses are preferred as they offer better function and acceptance [2]. Nevertheless, when several teeth are missing and financial means are limited, removable partial dentures might be indicated. Thus, the decision-making process is usually based on numerous clinical, subjective, and economic considerations related to prevailing health care systems [3, 4].

In Bulgaria, the health care system suffers from considerable financial inadequacy with a total expenditure on health care of 4.3% of the gross domestic product (€132 per capita per year including dentistry) [5, 6]. Financial limitations in the health care system, together with other factors, are expected to have a negative impact on the oral health of the population. The scarce available data on the oral health of the Bulgarian population indicated high prevalence of missing permanent teeth ranging from 1.3 (20–24 years age group), through 5.3 (35–44 years age group), to 13 (55–64 years age group) [7]. Since the prevalence of missing teeth is substantial and (oral) health budget is restricted, it is crucial that viable and appropriate management strategies, such as the shortened dental arch concept, are utilized [8].

Being a minimal intervention approach, the shortened dental arch concept advocates for a “wait and see” period of monitoring function and stability of the dentition instead of immediate replacement of absent molars [9]. Replacement of absent molars with the sole purpose to restore dental
arch morphology irrespective of the degree of functional impairment may be considered overtreatment.

Data on the prevalence of missing teeth, that indicate the need for prosthodontic services, are generally available. The same is not true for data on the provision of prosthetic restorations. The latter can be used to appraise the effective demand for prosthodontic care and to determine utilizable treatment modalities. As part of a larger comprehensive epidemiological study on oral function in reduced dentitions and the feasibility of the shortened dental arch concept within the existing health care system in Bulgaria, the purpose of the present study was to explore prosthodontic production as delivered by dental laboratories.

2. Material and Methods

2.1. Laboratory Sample. Five commercial dental laboratories in the city of Sofia participated in the study. One of the laboratories was considered small (2 technicians) and four were of average size (4 to 10 technicians). Output from these laboratories was considered representative for Sofia because their clientele (10 to 40 dental practitioners per laboratory) practiced widely in the city. The chief dental technician of each laboratory was asked to record structured information regarding the status of teeth from gypsum casts and all restorations delivered during a two-week period. Additionally, age and gender of patients as reported by the dentists in charge and cost of each restoration, produced were recorded. The teeth of the gypsum casts were described as absent, present (including existing fixed replacements), crown preparation/abutment, or as tooth root. After accomplishment of the restoration the presence or absence of occlusal contact for each tooth was recorded, as well. For relating prosthetic restorations with dental arch and dentition conditions, only sets of complete upper and lower casts were considered. Dental arches (representing either mandible or maxilla) were classified as edentulous, interrupted (2 groups: interrupted/reduced and slightly interrupted), shortened, or complete based on number and type of teeth (Table 1). Dentitions (representing mandible plus maxilla) were classified as edentulous (2 groups: one jaw edentulous and both jaws edentulous), interrupted (2 groups: interrupted/reduced and slightly interrupted), shortened, or complete based on number and type of teeth, and occluding regions (Table 1). Complete sets of casts were assigned according to this classification before and after accomplishment of the restorations.

A total of 284 laboratory orders were received, of which 33 were excluded due to various reasons (e.g., incompletion of the registration form or no prosthodontic appliance requested, e.g., an orthodontic appliance or a diagnostic wax-up). The resulting laboratory orders represented prosthetic situations of 251 subjects (mean age 46 ± 14 years; 53% females).

2.2. Epidemiological Sample. To assess the representativeness of the laboratory sample, a subsample was extracted from a stratified cluster sample of a Bulgarian population in an ongoing epidemiological study (approved by the Medical University-Sofia Ethical Committee, decision no. 299). This subsample consisted of 325 subjects aged 20 years and over living in Sofia (mean age 36 ± 12 years; 34% females). Data on the state of the dentition including fixed and removable restorations were collected through dental examination after informed consent was obtained from each subject.

For each sample, proportions of crowned teeth and proportions of replaced teeth in one dental region (a, p, m) were calculated relative to the other two regions, that is, a/p + m, p/a + m, and m/a + p, where a, p, and m are the number of crowned or replaced teeth in anterior, premolar, and molar region, respectively. Finally, the proportions for the two samples were compared and tested for significant differences using chi-square tests.

3. Results

The two-week output of the 5 laboratories consisted of 243 crowns on natural teeth and implants, 16 post and cores, 18 complete dentures, and 23 removable and 82 fixed partial dentures (Table 2). The mean laboratory prices for a single crown, a three-unit fixed dental prosthesis, and an acrylic removable partial denture were €22, €75, and €30, respectively. Approximately half of the restorations were produced on 134 partial casts, while 203 dental restorations were produced on 115 complete casts (69 upper and 46 lower). The latter were related to the dental arch groups (Table 3). Altogether 382 teeth were replaced (167 with fixed dental prostheses and 215 with removable dentures including complete dentures) and 540 teeth received a single crown or served as a retainer. The majority of fixed dental restorations produced on partial and complete casts restored maxillary teeth.

Two-thirds of the fixed dental prostheses (n = 62; 71%) in both upper and lower casts replaced posterior teeth only (Table 3). The majority of removable partial dentures delivered was acrylics (n = 18; 78%); 5 (22%) were metal frames. Most replacements were in the maxillary premolar region and in the mandibular molar region. There was no case of removable partial denture replacing only anterior teeth. For the slightly interrupted dental arch group, only fixed dental prostheses were produced (Table 3). All casts representing edentulous jaws received complete dentures (n = 18).

Before delivery of the requested restoration, 19 sets of casts (33%) represented interrupted/reduced dentitions, 25 (43%) were slightly interrupted, and 14 (24%) were recognized as shortened dental arch conditions (Table 4). After delivery, only 19 (33%) out of 58 incomplete dentitions were restored to the level of completeness (Table 4). The majority of the incomplete dentitions resulted in slightly interrupted (n = 15; 26%) or shortened dentitions (n = 24; 41%), including 10 cases (4 shortened dentitions and 6 slightly interrupted dentitions) for which only crowns and no replacements were requested.

In the epidemiological subsample, a total of 428 missing teeth appeared to be replaced (222 with fixed dental
Table 1: Dental arch groups and dentition groups of the complete sets of casts according to the number of teeth present and group characteristics.

<table>
<thead>
<tr>
<th>Dental arch Group No. of teeth</th>
<th>Characteristics</th>
<th>Dentition Group No. of teeth</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Edentulous</td>
<td>0</td>
<td>(i) no teeth</td>
<td>Edentulous</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interrupted/reduced</td>
<td>≤10</td>
<td>(i) open space(s)*/anterior reduction</td>
<td>Interrupted/reduced</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slightly interrupted</td>
<td>≥11</td>
<td>(i) open space(s)*</td>
<td>Slightly interrupted</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shortened</td>
<td>≥6</td>
<td>(i) anterior region intact</td>
<td>Shortened</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(ii) posterior absent teeth</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(iii) no open space(s)*</td>
<td></td>
</tr>
<tr>
<td>Complete</td>
<td>≥14</td>
<td>(i) with or without 3rd</td>
<td>Complete</td>
</tr>
<tr>
<td></td>
<td></td>
<td>molars</td>
<td></td>
</tr>
</tbody>
</table>

* An open space is defined as tooth-bounded edentulous area.

Table 2: Number (%) of prostheses delivered by the dental laboratories during the two-week recording.

<table>
<thead>
<tr>
<th>Prostheses</th>
<th>Dental laboratory</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Fixed dental prosthesis</td>
<td>30 (18)</td>
</tr>
<tr>
<td>Removable partial denture</td>
<td>11 (7)</td>
</tr>
<tr>
<td>Crown</td>
<td>108 (65)</td>
</tr>
<tr>
<td>Implant retained crown</td>
<td>5 (3)</td>
</tr>
<tr>
<td>Post &amp; core</td>
<td>8 (5)</td>
</tr>
<tr>
<td>Complete denture</td>
<td>3 (2)</td>
</tr>
<tr>
<td>Total</td>
<td>165 (100)</td>
</tr>
</tbody>
</table>

* Does not provide this service.

Table 3: Number of delivered crowns (C), post and cores (P&C), fixed dental prostheses (FDP), removable partial dentures (RPD), and complete dentures (CD) according to the dental arch groups before replacement.

<table>
<thead>
<tr>
<th>Dental arch group (n)</th>
<th>C</th>
<th>P&amp;C</th>
<th>FDP Anterior only</th>
<th>FDP Posterior only</th>
<th>RPD Anterior only</th>
<th>RPD Posterior only</th>
<th>CD</th>
<th>Total production</th>
</tr>
</thead>
<tbody>
<tr>
<td>Edentulous (18)</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>18</td>
<td>18</td>
</tr>
<tr>
<td>Interrupted/reduced (31)</td>
<td>15</td>
<td>2</td>
<td>6</td>
<td>7</td>
<td>6</td>
<td>5</td>
<td>10</td>
<td>51</td>
</tr>
<tr>
<td>Slightly interrupted (26)</td>
<td>16</td>
<td>2</td>
<td>6</td>
<td>16</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>38</td>
</tr>
<tr>
<td>Shortened (14)</td>
<td>24</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>8</td>
<td>*</td>
<td>34</td>
</tr>
<tr>
<td>Complete (26)</td>
<td>62</td>
<td>0</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>62</td>
</tr>
<tr>
<td>Not assigned (i) partial casts (134)</td>
<td>126</td>
<td>12</td>
<td>2</td>
<td>37</td>
<td>2</td>
<td>*</td>
<td>*</td>
<td>179</td>
</tr>
<tr>
<td>Total production</td>
<td>243 (64)</td>
<td>16</td>
<td>11 (3)</td>
<td>62 (16)</td>
<td>9 (2)</td>
<td>13 (3)</td>
<td>18 (5)</td>
<td>382 (100)</td>
</tr>
</tbody>
</table>

* Not applicable.
restoration is a di
tinction situations before and after insertion of the produced
as noted from the dental casts. Relating production to den-
troduction to dental regions, dental arches, and dentitions
by 5 dental laboratories in a 14-day period and related this
This study investigated prosthodontic restorations produced
output of the dental laboratories involved was considered
participate influenced the results in this study. However, the
reason for this was the recording of information on con-
secutive work orders together with information on cost of
the appliance, which provoked owners of dental laboratories
to view this investigation with suspicion. It is not known
what extent the inclusion only of laboratories willing to
participate influenced the results in this study. However, the
output of the dental laboratories involved was considered
representative for Sofia as their clientele was well known for
practicing widely in the city.

The laboratory sample represented a patient population
and cannot be considered representative for the nonpatient
population. The mean age and the prevalence of females
in the laboratory sample were higher compared to the
Sofia population sample. Higher mean age in the laboratory
sample can be partly attributed to 18 subjects of 66 to 85
years of age requiring removable dentures, while the Sofia
sample consisted of a working population between 20 and 65
years of age. Moreover, it has been shown that prosthodontic
restorations are more common in older ages [10]. The same
is true for females who seek dental treatment more often
than males [11, 12]. This difference in age and gender
distribution did not allow comparison of subjects, dental
arches, and dentitions between the two samples. However,
the Sofia population sample comprised both patient as
well as nonpatient individuals. Therefore, it was considered
appropriate to compare the proportions of crowned and
replaced teeth per dental region in the two samples in order
to verify whether number, type, and location of the produced
restorations are reflected in the population.

The distributions of crowned teeth in the two sam-
ple differed significantly. In contrast, the distributions
of replaced teeth over the dental regions were similar in both
samples. It can be therefore concluded that the tooth replace-
ments as produced in the laboratories were sufficiently
reflected in the Sofia population sample. More than half of
the incomplete dentitions in the laboratory sample of this
study were restored to the level of shortened dentitions or did
not receive any replacement. In a recent similar laboratory
study in a southern region of Vietnam, it was concluded that
dental practitioners tend to provide complete dental arches
by tooth replacements, predominantly acrylic removable
partial dentures [13]. In contrast, dental practitioners in
Sofia seem to direct more e-
sorts towards preservation of
sufficient oral function [ 14–

4. Discussion

This study investigated prosthodontic restorations produced
by 5 dental laboratories in a 14-day period and related this
production to dental regions, dental arches, and dentitions
as noted from the dental casts. Relating production to den-
tition situations before and after insertion of the produced
restoration is a different approach to describe provision of
prosthetic restorations that emphasise the importance of
the treatment outcome rather than the production of a
certain type of restoration alone. Approximately half of the
laboratory production in this study, however, was produced
on partial casts and a relatively small number of prosthetic
restorations produced on complete casts was related to
dentition situations. This diminished the sample size and
therefore the findings of this study must be viewed with
cautions.

Another limitation of this study is the convenient sam-
ping of the dental laboratories. Although a random selection
of laboratories would have been preferable for obtaining
an unbiased estimate of prosthodontic production in Sofia,
a truly representative sampling was not feasible. The main
reason for this was the recording of information on con-
secutive work orders together with information on cost of
the appliance, which provoked owners of dental laboratories
to view this investigation with suspicion. It is not known
to what extent the inclusion only of laboratories willing to
participate influenced the results in this study. However, the
output of the dental laboratories involved was considered

<table>
<thead>
<tr>
<th>Dentition group before delivery</th>
<th>Prevalence N (%)</th>
<th>Type of replacement</th>
<th>Dentition group after delivery</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>FDP</td>
<td>RPD</td>
</tr>
<tr>
<td>Interrupted/reduced</td>
<td>19 (33)</td>
<td>16</td>
<td>10</td>
</tr>
<tr>
<td>Slightly interrupted</td>
<td>25 (43)</td>
<td>19</td>
<td>0</td>
</tr>
<tr>
<td>Shortened</td>
<td>14 (24)</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Total</td>
<td>58 (100%)</td>
<td>40 (71%)</td>
<td>16 (29%)</td>
</tr>
</tbody>
</table>

Table 4: Denition groups before and after delivery and type of appliance in case of replacement.
In this study, production of both fixed and removable prostheses was investigated, and results from the insertion of produced restorations were appraised on dentition level. In contrast, other studies on prosthodontic production investigated production of either fixed or removable dental prostheses, focusing on the number and the distribution of produced restorations on dental arch level (upper or lower), number and type of teeth most commonly crowned or replaced, or different technical aspects of the production process, for example, design, material or quality of the restorations [18–22]. Therefore, comparison of the present material with results of the few available studies on prosthodontic production cannot be conclusive.

The total output of the laboratories was rather small, although the number of the laboratories and the observation period are consistent with previous surveys [13, 18, 19]. This may be a result of the limited access of the Sofia population to dental care due to financial restrictions, particularly with respect to prosthodontic treatment which is not covered at all by the national health insurance fund in Bulgaria. In 2007, the average monthly salary of employees under labor contract in Sofia city was 590 leva or approximately €300 [23]. This is four times the mean laboratory price of a three-unit FDP (not including the dentists’ fees). It is assumed that out-of-pocket payment for a fixed dental prosthesis is a substantial effort for considerable part of the population. Despite the high costs, the production of fixed dental prostheses noticeably outnumbered the production of removable dentures. The low cost of acrylic removable partial dentures apparently did not lead to effective demand for this type of appliances.

5. Conclusions

Within the limitations of this study, it can be concluded that dentists in Sofia predominantly decide to provide fixed restorations. The majority of prosthetic restoration requests were not aiming at restoring incomplete dentitions to the level of completeness. Shortened and slightly interrupted dentitions appear to be acceptable treatment goals for the restoration of mutilated dentitions. Further investigation is recommended to address this topic.

Table 5: Proportions of crowned teeth and replaced teeth in anterior, premolar, or molar regions relative to the other two regions in upper and in lower cast/jaw of the laboratory sample (Lab) and of the epidemiological sample (Epi).

<table>
<thead>
<tr>
<th>Region</th>
<th>Upper cast/jaw</th>
<th>Lower cast/jaw</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lab</td>
<td>Epi</td>
</tr>
<tr>
<td>Crowned teeth</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anterior</td>
<td>175/186</td>
<td>134/244</td>
</tr>
<tr>
<td>Premolar</td>
<td>87/274</td>
<td>139/239</td>
</tr>
<tr>
<td>Molar</td>
<td>99/262</td>
<td>105/273</td>
</tr>
<tr>
<td>Replaced teeth</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anterior</td>
<td>61/173</td>
<td>72/169</td>
</tr>
<tr>
<td>Premolar</td>
<td>96/138</td>
<td>96/145</td>
</tr>
<tr>
<td>Molar</td>
<td>77/157</td>
<td>73/168</td>
</tr>
</tbody>
</table>

Acknowledgment

Part of this study was supported by Grant no. JI-1507/2005, issued by Bulgarian Ministry of Education and Science.

References


