Use of videoconferencing for consultation in dental prosthetics and oral rehabilitation

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Summary
We conducted a 13-month study to investigate whether videoconferencing could be used for diagnosis and for making treatment plans for patients requiring prosthetic or oral rehabilitation treatment. The consultations took place between a specialist dental treatment unit in a central hospital and general dental practitioners in seven regional health centres. Videoconferencing was conducted using standard commercial units via an IP network, at bandwidths of 762 kbit/s – 2 Mbit/s. In total, 24 patients and 25 professionals (18 dentists, 2 dental hygienists and 5 nurses) took part. There were no technical problems. In 24 out of 27 teleconsultations, a diagnosis or treatment plan could be made. All participating dentists were satisfied with the consultation process and indicated that the technology used was of sufficient quality for clinical purposes. A patient satisfaction questionnaire indicated that patients were also satisfied. Videoconsultation in dentistry has the potential to increase the total number of dental specialist services in sparsely populated areas, such as those in Finland.

Introduction
Videoconferencing offers potential benefits in a sparsely populated country such as Finland. Rural regions in particular could benefit from the use of teleconsultation, as travel time to health-care delivery locations could be reduced, potentially saving money and time for professionals and patients alike.1,2 Since there is a lack of dental specialists in Finland’s rural regions, teleconsultation might improve the availability of dental services.3 Videoconferencing has been used successfully for teleconsultation by orthodontists in Finland.4 However, it still remains relatively little used within dentistry in comparison to other medical specialities, where results have been good.5–8 Videoconferencing has been used for educational purposes in dentistry,1,4,9–11 but there have been few studies concerning clinical dental consultation.5,12,13–16

Our aim was to determine whether videoconferencing could be used for accurate diagnosis and for making treatment plans for patients requiring prosthetic or oral rehabilitation treatment. We also wanted to find out more about the videoconferencing process itself and how patients and professionals responded to teleconsultation.

Methods
The study was carried out in the hospital district of South Ostrobothnia, in south-west Finland. The region covers an area of nearly 14,000 km² and has a population of about 200,000 inhabitants. Primary health care is provided by 26 local health-care centres with 83 dentists. There are also some 44 private dental practitioners. There are five dental specialists in the hospital district, of whom two are specialists in prosthodontics. All inhabitants have access to the health-care centres for basic dental care. For specialist treatment, patients are referred to the regional central hospital responsible for secondary care, the Seinäjoki Central Hospital. The hospital’s department of oral and maxillofacial diseases received 1054 referrals in 2007 and there were 3748 outpatient visits to the department during 2007. The average wait for patients for non-urgent treatment was approximately three months.

Dentists in primary care in regional health centres were able to consult a specialist dentist at Seinäjoki Central Hospital during a weekly videoconferencing session. The consultation appointment times were pre-arranged. Patient data and background information were gathered by the health centre personnel prior to the teleconsultation. The information included the clinical history, and when needed, plaster cast models and dental X-rays. The health centres participating in the study chose which patients required teleconsultation. The choice was based on the need to hear a specialist’s opinion in reaching the correct
diagnosis and treatment planning. This decision was made by the health centre dentists. Without the availability of teleconsultation, the patients would have been referred to the central hospital. Patients gave written consent to participate and ethics permission for the study was not required.

During the teleconsultation, a dentist in the health-care centre could consult a specialist dentist on cases of congenital or acquired dental insufficiencies. Different treatment options were discussed during the teleconsultation session. The treatment location was decided, i.e. hospital or health-care centre, or possible referral to a more specialised university hospital. The teleconsultation provided an opportunity to question the patient by the specialist being consulted if this was deemed necessary or if it was wished by the patient. The patient was also able to question the specialist.

Seven health centres from the hospital district participated in the study (Ahtäri, Alavus, Jalasjärvi, Peräseinäjoki, Kurikka, Kauhajoki ja Teuva). Twenty-five dental professionals participated (18 dentists, 2 dental hygienists and 5 nurses). The specialist in prosthodontics in Seinäjoki Central Hospital acted as the primary referring consultant and a specialist in orthodontics in the hospital gave additional support when needed. In a few cases an oral and maxillofacial surgeon at the hospital was also consulted.

The teleconsultation project finished in January 2008, after lasting for 13 months. User data and feedback was acquired during the project, and during a follow-up study in 2009. The first four months of the project were used for building up the network and training staff on the use of the teleconsultation equipment. A total of nine hours, during three days, were used for training. The first three hours were used for training on the use of videoconferencing equipment and the next three hours for clinical photographic techniques. The last three hours were lectures on photographic image processing. The aim was to give professionals enough guidance on technical aspects to make the consultation process run as smoothly as possible. In addition to training sessions, a total of 14 hours, during 9 days, were used for consultations.

A user satisfaction survey was carried out in which patients were asked to provide feedback immediately after each consultation. Dental professionals received user satisfaction questionnaires at the end of the study. The questionnaires were validated by performing a small-scale pilot survey to make certain that respondents understood the questions in the way they were intended to be understood. The survey results were also checked to make certain that all questions complied with the appropriate response scale.

Videoconferencing was used between the consultant specialist dentist and health centres. In addition, digital images, X-rays and images of dental casts or older dental X-rays could be shown. All dental units used a set-top type videoconferencing unit (Polycom VSX 7000) with a VGA interface unit (Polycom Visual Consert VSX). In addition to standard audiovisual equipment, laptop computers and digital cameras (Canon EOS 400D, Macro EF-S 60 mm, MR-14EX ring light) were also used (Figure 1). Dental cast study models were positioned on a rotating glass tray (a microwave-oven tray). Videoconferencing was conducted via an IP network (762 kbit/s – 2 Mbit/s). The security of sessions was ensured by use of a VPN (virtual private network).

Results

A total of 24 patients and 25 professionals (18 dentists, 2 dental hygienists and 5 nurses) participated in the study. There were 27 patient cases, consisting of 24 individual patients.

During the study the videoconferencing equipment functioned reliably, and none of the consultations suffered technical problems of any kind. The average time used for each consultation was 31 min. In 24 out of 27 cases a diagnosis or treatment plan was made during the consultation. Three cases could not be satisfactorily dealt with during the videoconference. In these cases the patients were referred to a specialist in oto-rhino-laryngology, to their general practitioner or to the hospital department of oral and maxillofacial diseases for further examination and treatment.

Both patients and professionals were relatively satisfied with the consultation process. Patients were asked to give a score between four (worst) and ten (best) for the consultation. A grade of 9 or 10 was given by 65% of the patients participating in the project (Table 1). As expected, patients that lived furthest from the central hospital gave the highest grades for the teleconsultation, and this result was significant ($P < 0.01$). Those patients whose residence was over 50 km away from the Central Hospital gave a grade of 9 or 10 (by 81%); those who lived over 65 km away were the most satisfied group (grade 9 or 10, by 100%). Patients who lived closest to the hospital (21–34 km) gave an average satisfaction score of 8 ($n = 4$).

Dental professionals gave an overall grade of 4.6 out of 5 for the overall suitability of videoconferencing for dental care.
consultation (Table 2). There were no major technical problems experienced during the study, and the professionals were relatively happy about the way the equipment functioned and gave an average score of 8.7 out of 10 for its overall functioning. This question dealt with the actual use and functioning of the various pieces of equipment related to the videoconsultation. The technology was judged to perform extremely well for conducting patient interviews, as all users gave a score of good or excellent, the average score being 4.9. The quality of digital radiographs displayed during consultation was deemed to be good, since 87% answered good or excellent. Similarly, the quality of digital photographs shown was judged to be good or excellent by 91%. The image quality of cast models displayed via videoconferencing was deemed good or excellent by 87%. There were no responses between the grades four to six.

During the project the referring dentist was able to participate in the consultation process and hence was able to learn from a more experienced specialist during the sessions. An average grade of 4.6 out of five was given by the professionals when asked to grade the consultation as a learning process.

Each videoconferencing system was leased for €197 per month (€1 ≈ £0.8). The IP network used was already in place, so no additional communication costs were incurred. The Seinäjoki Central Hospital charged the local authority from the referring region a set fee for each referred patient.

Table 1 Patient satisfaction with the teleconsultation process (n = 24).
Satisfaction was graded from 4 to 10 (4 = worst to 10 = best).

<table>
<thead>
<tr>
<th>Distance of patient residence from hospital (km)</th>
<th>Satisfaction score</th>
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<tbody>
<tr>
<td></td>
<td>4</td>
</tr>
<tr>
<td>21–34</td>
<td>0</td>
</tr>
<tr>
<td>35–49</td>
<td>0</td>
</tr>
<tr>
<td>50–64</td>
<td>0</td>
</tr>
<tr>
<td>&gt;64</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>0</td>
</tr>
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Table 2 User satisfaction for 23 dental professionals concerning the use of videoconferencing in dental teleconsultation. Satisfaction was graded from 1 to 5 (1 = very bad to 5 = very good), except for question 7 (scale 4–10, 4 = worst, 10 = best).

<table>
<thead>
<tr>
<th>Question</th>
<th>Mean score</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Suitability of videoconferencing technology for consultations?</td>
<td>4.6</td>
<td>0.63</td>
</tr>
<tr>
<td>2. Quality of dental X-ray images shown via videoconferencing?</td>
<td>4.4</td>
<td>0.81</td>
</tr>
<tr>
<td>3. Suitability of videoconferencing for showing dental castor models?</td>
<td>4.2</td>
<td>0.76</td>
</tr>
<tr>
<td>4. Suitability of videoconferencing for showing oral photographs?</td>
<td>4.6</td>
<td>0.77</td>
</tr>
<tr>
<td>5. Suitability of videoconferencing for conducting patient interviews?</td>
<td>4.9</td>
<td>0.73</td>
</tr>
<tr>
<td>6. How did teleconsultation session function as a learning process?</td>
<td>4.6</td>
<td>0.90</td>
</tr>
<tr>
<td>7. Overall functioning of videoconferencing (scale 4–10)?</td>
<td>8.7</td>
<td>0.86</td>
</tr>
</tbody>
</table>

In 2007 the average fee per patient visit to the department of oral and maxillofacial diseases was €207. Other costs incurred were the referring dental professionals’ wages.

Discussion

Since it was the first time that most of the dental professionals had used videoconferencing or other teledentistry equipment, it was clear that initial problems due to inexperience were bound to occur. However, partly because of the training provided, the performance of the IT devices used was rated as adequate and both patients and professionals were satisfied with the technology.

Dentistry has traditionally been a technical field of medicine, and so dentists are used to adopting new methods and technologies. The regional dental clinics which participated in the study were small units where opportunities to consult a more senior or experienced clinician were very rare. Consequently, the consultation possibilities offered by the project were enthusiastically received by the staff.

Broadband connections are becoming more readily available in remote regions in Finland. Although relatively high speed connectivity was available for the project, it would be feasible to use slower connection speeds. According to previous experience, connection speeds of 284 kbit/s are sufficient for good quality audio and image transmission.11 Also, older networking techniques such as ISDN connections can be used.13 Newer high definition videoconferencing technologies offer even better image quality than was used in the present study, but require relatively high connection speeds, and may not be easy to employ for teledentistry at the moment.

Teleconsultation can be a teaching process that can serve to maintain or improve medical proficiency.17,18 In one recent study, general dentists under supervision via teleconsultation improved their proficiency by 35%, as measured by the peer assessment rating index.19 Our results support this finding. The use of teleconsultation also resulted in a greater interactivity between specialist and general practitioners, so most of the consultations can be seen as a learning experience.4,9,10

A major challenge in teledental consultation is to set up the service in such a way that it is cost-effective. One way to achieve this is to train nursing staff so that they can be the participating party in the consultation process in the dental clinic, freeing the dentist to perform other duties. The dentist’s working time that would be taken up by the consultation can thus be avoided or saved.20,21 Consultations that do not require the physical presence of the patient, i.e. those that can be performed by using dental X-rays and dental casts, can be relatively rapid, thus lowering costs. There were also working time savings for dental professionals, as in most cases the consultation reduced the need for follow-up visits to the referring dental clinic.
It is relatively common for dentists to visit specialist dental clinics for consultations based on dental X-rays and dental cast models. This practice remains popular, especially in orthodontics and when making diagnosis and treatment plans. Teleconsultation, however, saves travel time and costs. This can be significant in countries such as Finland with long travel distances.

The present work showed that videoconferencing can be used for diagnosis and treatment planning for patients requiring prosthetic or oral rehabilitation treatment with demanding problems. Telemedical applications of this type are especially well suited to regions with long distances and sparse populations. Telemedicine also makes it possible to share expertise more broadly than at present, for instance between countries or continents. For instance, developing countries could access lectures from universities and dental clinics. The investments in technology required for this may be relatively modest.

Within the limitations of the present study, videoconferencing thus seems suitable for long distance consultation in dentistry. It has the potential to increase the total number of dental specialist services in sparsely populated areas in Finland.

References
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