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Research Article

Consistency and Validity of a Telediagnosis Method in Orthodontics

Chris Orloff*

Private Practice of Orthodontics in Perth, Australia

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***Corresponding author**: Chris Orloff, Private Practice of Orthodontics in Perth, Australia,
E-mail: orloff@westnet.com.au

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Abstract

The use of teledentistry in orthodontics has evolved in recent years, accelerated by the social distancing of the coronavirus pandemic, and now driven by the desire on the part of practitioners to improve the sustainability of the profession and by consumer demand to improve access to care and reduce the costs associated with access to specialist services. This is especially true of Western Australia which is a vast State with patchy access to specialist care. This article demonstrates that a physical examination of 46 patients attending a remote orthodontic clinic 600 km from the metropolitan centre of WA, and a review of clinical photographs of the same patient, can achieve an 80% concordance utilizing very simple tools such as a point-and-shoot camera.

Introduction

Teledentistry is a subset of telehealth and encompasses telediagnosis, the use of electronic medical records, Information and Communication Technology (ICT), digital imaging, and the internet to facilitate teleconsultation with specialists, supervision of collaborative distance practitioners, and continuing education [1]. These include, efficiency to reduce health, material, and financial cost. Extending the scope of health care beyond conventional boundaries, including geographical. Equity, to reduce the gap between access to quality healthcare between different socio-economic and geographical groups [2]. Australia has one of the healthiest populations in the world, however, it still has significant inequalities and challenges in healthcare due to its sheer geographical size and population distribution, amongst other things [3,4].

Orthodontics, a specialised field of dentistry, is no exception. In Western Australia, it has been found that there is inequality in access to government-subsidised orthodontic services due to geographical residence and socio-economic status (SES) [5]. These findings have been corroborated by studies in the UK and Jordan, also finding that lower SES [6] and rurality of residence is associated with lower access, and increased inequality in access to orthodontic services.

As with health care in general, e-health and telemedicine provide us with some possible solutions to inequality in access to orthodontic services. There have been numerous studies investigating the attitudes of general dentists and orthodontists, all indicating support for teledentistry, as it improves access to orthodontic services for dentists and patients. Putting these concepts into practice, Berdt, et al. [7] found that appropriately trained dentists, supported by orthodontists via teledentistry, was a viable approach to improving malocclusions in disadvantaged children where referral to an orthodontist was not feasible.

The aforementioned studies relied on synchronous (real-time) telecommunication. Another option for teledentistry is an asynchronous (store-and-forward) method [8]. This method relies on the collection of data, storage, and communication with an end user for assessment, the benefit of which is that it can be done at any time in any geographical location.

This study aims to assess the consistency and validity of distance diagnosis by practitioners, to enable the use of these

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methods in improving access to care for rural and remote dwellers.

Methods

This is an initial/pilot study comparing the results of direct clinical examination (face-to-face) by orthodontist 1 and distance examination (only using extra- and intra-oral photographs) by orthodontist 2. The consistency and reliability in results between the two methods of orthodontic assessment were evaluated.

This study was approved by the University of Western Australia Ethics Committee (RA/4/1/8702).

The study was conducted in specialist orthodontic clinics in Kalgoorlie and Perth, Western Australia. Participants (7 to 34 years old) were recruited by inviting new patients, (or their guardians if patients were underaged), to take part in the study, when they attended the practice for initial consultations. A staff member, using a predetermined script, informed the potential participants of the method and purpose of the study, and those who provided consent were recruited. A total of 46 participants took part in the study. The only inclusion criteria were that participants were between 7 - 34 years of age and had access to a smartphone. Standard clinical photographs were obtained, with routine clinical records taken at the initial consultation created solely for this purpose and accessed by the clinicians only. The sources were uploaded into Orthotrac software and saved with password protection. The photographic assessment was conducted for each participant by the "distance", second, orthodontist.

The direct clinical assessment was conducted at the time of initial consultation. The distant assessment was conducted a few weeks later. Both orthodontists completed the same assessment form, modified from Baume, et al. [9], and were precluded from discussing any of their assessments to reduce bias.

The results were collected in hard-copy printouts and stored in a secure place at the UWA facility. The concordance of the proposed treatment plan was assessed by the direct and distance orthodontist by agreement.

Statistical analysis

The Statistical analyses were obtained using the SPSS (Statistical Package of the Social Sciences) software version 25 (Chicago, IL, USA). SPSS was used to compute kappa statistics as a measure to determine the inter-rater and intra-rater reliability of the two examiners, using the Landis and Koch measurement [10] of rater agreement for categorical data. To test the intra-rater agreement between the two examiners, 10% of the records were scored again, some weeks after the first scoring.

Results

The results of the distance photographic assessments were compared to direct clinical assessment. The results of statistical analysis showed significant agreement in 33 out of 44 cases (Chi-square, $p < 0.05$). The intra-rater reliability for both examiners was assessed and ranged from moderate (examiner 1, kappa = 0.60) to substantial (examiner, 2 kappa = 0.78). Inter-rater reliability was substantial (Kappa = 0.65). Patient analysis as part of the diagnostic process in orthodontics is well established [11] and is directed towards establishing a prioritized problem list. The information that is assimilated to create the problem list constitutes the Database, with this data distilled from questionnaires and patient interviews, clinical examination of the patient along data from diagnostic records. The diagnostic records collected for each patient will vary with the complexity of the orthodontic problem. Intra-oral and extra-oral photographs and screening panoramic radiographs would be the minimal records collected, with addition of study casts and lateral cephalogram routinely added to the database for patients undergoing comprehensive treatment. Additional information from volumetric radiographs, MRI, and other special tests may also be obtained.

Discussion

Information regarding the relative contribution of the different diagnostic records toward making an orthodontic diagnosis and establishing a treatment plan is limited, with no defined minimum set of records determined [12]. Orthodontic study casts were the traditional mainstay of diagnosis and treatment planning and were judged alone to provide adequate information for treatment planning [13].

Clinical photography has been associated with dentistry since 1840 when the first dental school opened and the world's first photographic gallery was opened and operated by a dentist turned photographer [14]. Since that time photography has been an integral part of a patient's clinical record, with the specialty of orthodontics leading the way in this model of recording patient data.

Diagnosis of oral conditions from clinical photographs has been shown to be valid. No significant statistical difference was shown to exist between a clinical assessment for dental caries, and an examination using an intra-oral camera in the diagnosis of early childhood caries [15]. Similar results have shown the efficacy of distance diagnosis via photography in the fields of Oral Medicine [16], Oral Surgery [17], and Endodontics [18].

In orthodontics, various authors [19-20] have examined the role of teledentistry in the referral of patients. Mandall's [21] study of 40 potential patients referred for orthodontic assessment whose colour slides were mounted on a lightbox and assessed by eight orthodontists showed low reliability between consultants, although intra-examiner reliability was generally better.

The current study demonstrates an agreement between the treatment recommendation between the direct clinical assessment and the distance orthodontist in 33 out of a total of 41 sets of patient clinical photographs (80% agreement). The direct clinical assessment doctor is Australian trained with 18

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years of experience as an Orthodontist, and the distance doctor is trained at a different Australian institution with five years clinical experience as an Orthodontist. These two Orthodontists generally do not work together in clinical situations and no clinical training nor discussion took place in an attempt to standardize clinical care. Therefore, the recommendations for proposed action in the 43 test cases represent real-world clinical variation.

The agreement between the two orthodontists in 80% of the treatment recommendations compares favorably when compared with the intra-examiner consistency in one study which showed 56-73% reliability over a 4-6 week time period, whilst another study showed only moderate inter-examiner agreement when eight orthodontists stated whether they agreed with a series of 40 treatment plans [22]. A study of extraction decisions in the treatment planning of 60 orthodontic cases showed moderate to good intra-operator reliability, although multi-examiner agreement ranged from K = 0.38 (fair) to K = 0.11 (poor) [23]. In only 13 of 60 cases was there a total agreement for the extraction/non-extraction decision.

Essentially, the current study shows comparatively good agreement between the direct orthodontic assessment, and the remote assessment from digital photos, despite the current study using an Olympus Axis Stylus SH-1 camera, which is best described as a point-and-shoot digital camera, rather than a 35mm SLR with ring flash. The point-and-shoot style of the camera better represents the quality of photography typically available to a distance clinician in a real-life tele-dentistry assessment. Potentially, agreement between these two examiners would be better with a more sophisticated clinical dental 35mm SLR with an appropriate focal length macro lens and a ring flash, however, such photographic equipment is expensive and cumbersome and is likely to be replaced by smartphone cameras and applicable Apps [24].

Recently, mass-produced intra-oral lip retractors have become available. These devices are matched to smartphones and allow AI-assisted programmes to evaluate dental conditions and assess the progress of ongoing orthodontic treatment [25]. Future study direction intends to assess the validity of such teledentistry interfaces and to determine if routine remote orthodontic monitoring is valued by the orthodontic patient [26], as well as reducing the time and cost of attending in-office appointments. Such innovation if validated will increase the sustainability of orthodontic care [27].

Conclusion

A physical examination of 46 orthodontic patients by one experienced orthodontist, and an examination of clinical photographs of the same patients by a second experienced orthodontist, resulted in the same treatment recommendation in 80% of the cases. This result was achieved using a simple point-and-shoot digital camera to represent real-life teledentistry and without any treatment planning discussion taking place between the two doctors. The use of clinical photographs to establish a provisional orthodontic diagnosis is a valid exercise.

Future research will be directed to determine if the recent development of smartphone applications to remotely assess patients have a similar utility, and if so will improve access to specialist care by patients disadvantaged by distance or socio-economic status. Additionally, future research will elucidate whether teledentistry has a part to play in improving the sustainability of orthodontic treatment.

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