Speech Adaptation When Using Mouthguards

Research Protocol

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1. Introduction

Contact sports are defined as sports in which players interact with each other, trying to prevent the opposing team or player from winning (Barbic et al., 2005). Thus, participation in sports carries a considerable risk for dental injuries (Sane, 1998).) Due to the unavoidable repeated bodily contact, dental trauma highly prevalent among rugby players (Abdullah et al., 2015). The prevalence and severity of sport-related dental injuries varied, with an estimate between 0.2% and 33.5%, but is likely to be underreported (Cohenca et al., 2007). The risk of injuries increased with the age of the players, especially among those involved in long hours of training and compete professionally (Turbeville et al., 2003).

Dental trauma often involves injuries to the tooth structure, periodontal tissue, oral mucosa and temporomandibular joints (Feliciano, 2006). The vulnerable site is the upper jaw, particularly upper incisors (Glendor, 2008). These injuries often affect the appearance of the casualties, causing undue psychological stress (Berger, 2009). Furthermore restoring the injured teeth often requires extensive dental procedure with long-term follow-up at a high cost (Glendor, 2001). Thus, familiarity with the emergency procedure for dental trauma was essential for improving the condition of the affected tooth. However, knowledge of dental trauma prevention and management were generally insufficient, suggesting the need to educate and train the athletes (Abdullah et al., 2015).

Mouthguards are typically composed of a thermoplastic copolymer, designed to fit over the occlusal surfaces of the maxillary teeth and extending near to the vestibular reflection (Patrick et al., 2005). Several authors demonstrated that wearing a mouthguard during sport can reduce the occurrence and severity of dental trauma (Yesil et al., 2009). Therefore, some sports authorities mandate the use of mouthguard (Quarrie et al., 2005). The purpose of using a mouthguard is to act as a buffer from trauma and provide a degree of protection for both the mouth's soft tissues (lips, gums, tongue) and hard tissues (teeth and alveolar bone) as well as protection from brain injuries (Knapik et al.,2007). The ability to protect the mouth is highly dependent on the ability of the mouthguard in shock absorption and impact dissipation (Craig et al., 2002).

There are basically three types of mouthguards that are available in the market. Type I (stock) are sold to the public and are used without any modification. Type II ('boil and bite') mouthguards are the most commonly used mouthguards on the market and represent 90% of all mouthguards worn (Padilla et al., 1996). These are made of a thermoplastic material that is softened and then molded to the dental arch by the user. Type III (custom-made) are made by a dentist using a mold of the patient's dental arches (Barbic et al., 2005).

Rugby is contact sports that need good physical fitness skills and specific skills depending on the position played. The team that can quickly and coefficiently communicate during a rugby game has a clear advantage. Thus, building good on-field communication habits make much easier for rugby players to work together. However, if the communication fails during rugby games, the prospect of success in offense and defense during rugby games will be greatly decreased (Gordon, 2005). Among Malaysian university rugby players, those who discontinued using mouthguard complaint that general discomfort and speech disturbance are the main barriers to compliance (Liew et al., 2014). The nuisance is largely due to their use of poorly-fitted stock or boil-and-bite mouthguards (Liew et al., 2014). In comparison, custom-fitted mouthguards were considered the best choice because of its ability to maintaining oral moistness and adaptation, hence causing less interference with respiration and speech, while improving comfort and limiting nauseating effect (Duarte-Pereira et al., 2008). However, limited availability and higher prices hinder its widespread use (Guevara et al., 2001).

To date, the intensity and duration of oral discomfort caused by mouthguard remain unclear, with no published study to evaluate speech performance that employed acoustic analysis and sonography. Hence, the aim of this research is to evaluate the impact of wearing mouthguards on the speech performance of the athletes.

2. Problem Statement

Rugby exposes players to increased risk of dental trauma. Thus, mouthguard use is often recommended. However, a mouthguard can affect speech. It is unclear to what extent speech performance improve over time.

Therefore, this project is intended to evaluate the impact of wearing mouthguards on the speech performance of the players. In addition, the effectiveness of custom-fitted mouthguards in the prevention of dental trauma could be evaluated.

3. Research Question

i. Is there any difference in speech performances before (at baseline), immediately after, one-week after, one-month after and six-month after wearing a custom-fitted mouthguard?

ii. Is there any difference in the level of oral impairment immediately after, one-week after, one-month after and six-month after wearing a custom-fitted mouthguard?

iii. What is the incidence of traumatic dental injury among rugby players during the six-month period of wearing a custom-fitted mouthguard?

4. Aim and Objectives

The aim of this study is to evaluate the effect of wearing custom-fitted mouthguards on the speech performance and oral impairment of the Malaysia national rugby players.

The specific objectives are :

i. To compare the speech performance before, immediately after, one-week after, one-month after and six-month after wearing custom-fitted mouthguard;

ii. To compare the level of oral impairment before, immediately after, one-week after, one-month after, and six-month after wearing custom-fitted mouthguard; and

iii. To estimate the incidence of traumatic dental injury within the six-month custom-fitted mouthguards use period.

5. Research hypotheses

The null hypotheses are :

i. Speech performance at various time points is not affected by wearing custom-fitted mouthguard;

ii. Level of oral impairment at various time points is not affected by wearing custom-fitted mouthguard; and

iii. No incidence of dental trauma occurs within the six-month custom-fitted mouthguards use period.

6. Methodology

An interventional study using single-arm pre- and post- design will be carried out at the National Sports Institute. All the national rugby players taking part in the Asia Rugby Championship Premier 2018 will be invited to participate in this study. The information sheet regarding the study will be given out while the objectives and conduct of the study will be explained to the players. All players who agreed to participate will need to provide written informed consent.

To be eligible for inclusion, the players must be:

a) Men aged between 18 and 35;
b) Actively playing rugby;
c) Currently playing in Malaysia Rugby Union;
d) Native speakers of Malay (national language), with the ability to read and write in Malay fluently; and
e) Without any history of either speech or hearing impairment.

The exclusion criteria are:

a) Retired players;
b) National players who did not play rugby within the last six months of the recruitment date; and
c) Players with cleft lip and/or cleft palate; and

d) Players with any history of either speech or hearing impairment.

The sample size was calculated using G*Power 3.1 software (available at http://www.gpower.hhu.de/). The assumptions was an effect size of 0.25 with a 5% margin of error. The power of the study 80% and there was a total of six repeated measurements. Correlation among the repeated measures was set at 0.5. This yielded a minimal sample size of 24. Considering that drop-outs are higher with long-term follow-up, the sample size was increased by 20% to n = 30.

Development of questionnaire to evaluate oral impairment

A questionnaire will be developed to evaluate any oral impairment that could be experienced by the subjects before and during the use of a mouthguard. The questionnaire will be divided into four parts: (i) demographic information such as gender, age, frequency and duration of playing, highest level of representation and experience wearing custom-fitted mouthguard, (ii) frequency of wearing mouthguard, (iii) problems arise during mouthguard use and (iv) general perception on mouthguard. All questions in part (ii), (iii) and (iv) will be formatted in a five-point Likert scale. The following ratings will be given for the different possible answers in part (ii) and part (iii) with a qualitatively ordinal character: “Never” = 1; “Rarely” = 2; “Sometimes” = 3; “Often” = 4; “Always” =5. For part (iv), the possible responses were: “Strongly disagree” = 1; “Disagree” = 2; “Neutral” = 3; “Agree” = 4; “Strongly agree” =5. The questionnaires will be printed in Malay, the national language of Malaysia.

This questionnaire set will be validated and pretested on 10 undergraduate dental students. The cognitive interview will be carried out while the students are completing the questionnaire. Face validity will be determined as the degree to which they agree that the items of the questionnaire are appropriate and adequate to measure pattern and problems of wearing the mouthguard, as well as the general perception on the mouthguard.

Fabrication of mouthguards

Dental impressions of the upper-jaw of all of the subjects will be taken using alginate impression material and rigid perforated stainless-steel trays. The impressions will be rinsed under running tap water before spraying with disinfectant. The impressions will be transported in sealed and labeled zip-lock bags. The impressions will be cast within the same day using Type II dental stone. After the model hardens, usually about 45 minutes, the highest margins of the vestibular border will be marked with a pencil for reference during trimming. At the model trimmer, the excess stone will be carefully removed.

Pressure dual laminated technique will be used by technicians to fabricate the mouthguards. Ethylene-vinyl acetate (EVA) thermoplastic sheets of 3 mm in thickness with 125 mm diameter (Dentsply International Raintree Essix, Court East Sarasota, USA) will be used. The first layer of white EVA sheet will be adapted on the model and heated under pressure in the thermo-pressure machine (Erkopress 300 Tp by Erkodent, Germany). The first layer will be allowed to cool down at room temperature for a minimum of 10 to 15 minutes and excess material will be trimmed. The second layer of black EVA sheet will then be adapted on top of the first layer using the thermo-pressure machine. The mouthguard will further be trimmed and smoothened to the desired thickness. Two 3 mm sheets laminated together should form an even thickness of 4 mm mouthguard. An Iwanson spring wax calipers crown gauge measuring 1-10 mm calibrated scale will be used to ensure all mouthguards constructed had uniform 4 mm thickness at occlusal, buccal and palatal surfaces. The design of the mouthguards takes into consideration of the following limits: (i) the labial borders of the mouthguard were extended to within 2 mm of the vestibular reflection, (ii) the palatal margins were trimmed to the cervical area of the palatal surface of the upper teeth, (iii) enclosing the maxillary teeth to the distal surface of the first molars. The adaptation, stability, and retention of the mouthguards will be checked when it is delivered to the players. Adjustments will be performed when necessary. Any complaint of sharp edges will be handled. The players will be instructed on the use and care of the mouthguards.

Speech performance measurement

Prior to the fitting of the mouthguard, speech samples will be recorded from each participant. These speech samples were used as control (T_0). The recording of speech samples will be performed using the Sony IC Recorder (ICD-SX700/SX800, San Diego, USA) in a quiet room to minimize background sound. The recorder will be placed 15 cm away from the player's lips and each player will be asked to read loudly a list of selected Malay words (*paku* for phoneme */p/, bola* for phoneme */b/, tatu* for phoneme */t/*, and *dadu* for phoneme */d/*), as the words are shown one after another on the computer screen. Each session will take about 10-20 minutes to complete. Three recordings will be obtained for each word. The mouthguard will then be fitted for each player. The recording of speech samples will be repeated immediately following wear (T_1), and at the following intervals: one-week after (T_2), one-month after (T_3) and six-month after wear (T_4).

Evaluation of oral impairment and compliance

Before the mouthguard is fitted, all participants will be asked to fill up the questionnaires (at T_0). They will also be requested to fill up the same questionnaire at the same time points prior to the recording of the speech samples at T_1, T_2, T_3, and T_4.

Compliance and injury monitoring

Throughout the six-month period, the compliance of wearing mouthguards and the occurrence of dental trauma during training will be monitored on-site by the researcher or if not available, an assigned coach. A 24-hour helpline will be provided as a surveillance tool to monitor problems with mouthguards and dental trauma. Besides, replacement mouthguard will be provided for only once, if the players damage or misplace the mouthguard. However, if the players damage or misplace the mouthguard more than two times, they will be withdrawn from the research.

Data analysis

Data collected from the questionnaires will be analyzed using SPSS version 23.0 (IBM Corporation, Armonk, NY, USA). Descriptive analysis will be performed for demographic data to have an overview of the participants' age, frequency, and duration of playing and experience of wearing a custom-fitted mouthguard.

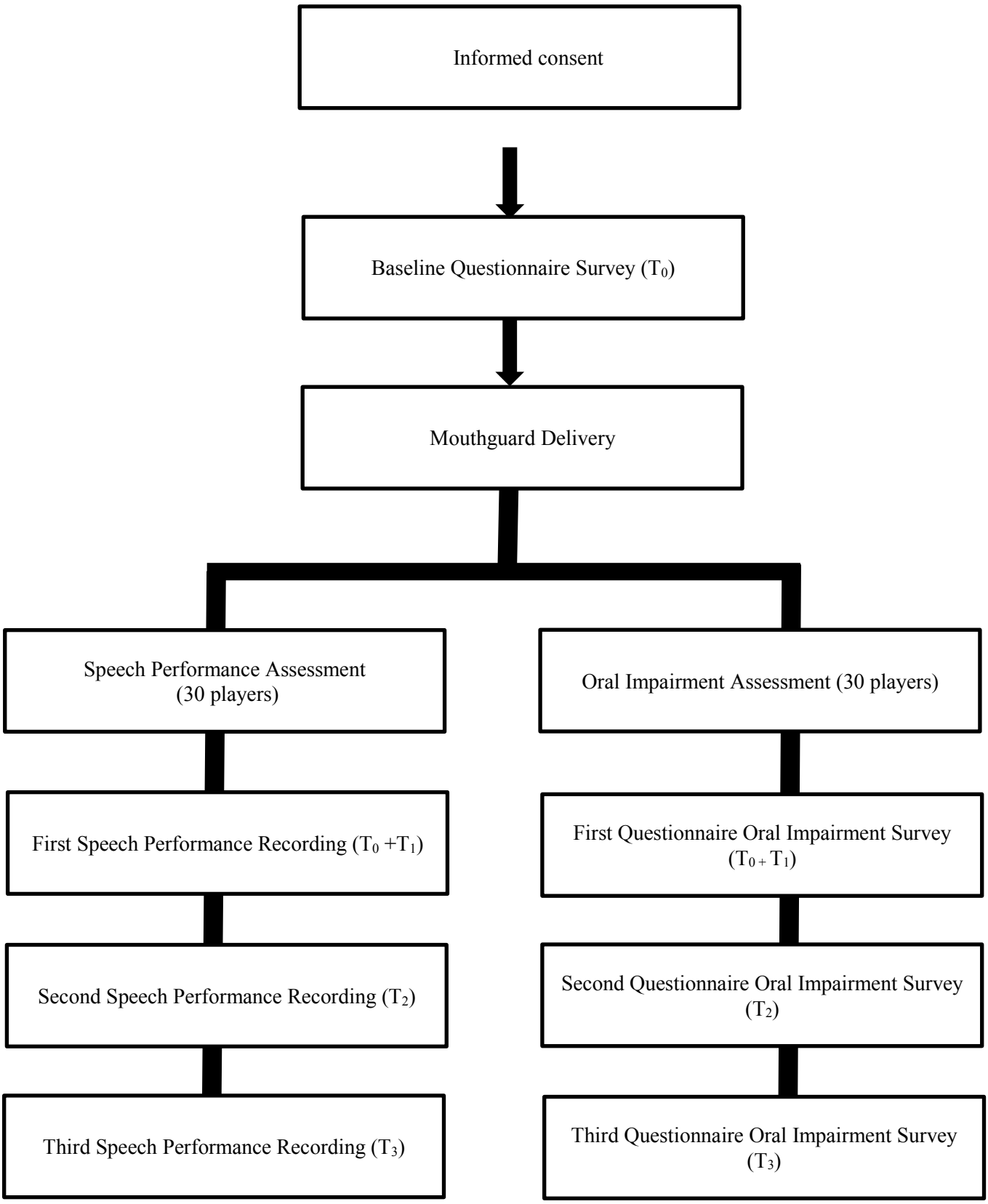
For the self-assessment questionnaire of oral impairment, Friedman's test will be used to test for differences between groups because the dependent variable being measured is ordinal. Statistical significance is set at $\alpha = 0.05$. Subsequently, the Wilcoxon signed-rank test will be used for pairwise comparison. Bonferroni adjustment will be done to correct for multiple testing. For part (ii) self-reported frequency of wearing custom-fitted mouthguards, comparisons will be made between T_2, T_3, and T_4. Hence, the adjusted level of statistical significance is set at $\alpha = 0.05/3 = 0.017$. For (iii) problems arise during mouthguard use, and (iv) general perception on a mouthguard, the level of statistical significance is adjusted to $\alpha = 0.05/6 = 0.008$ because of multiple testing between T_1, T_2, T_3, and T_4.

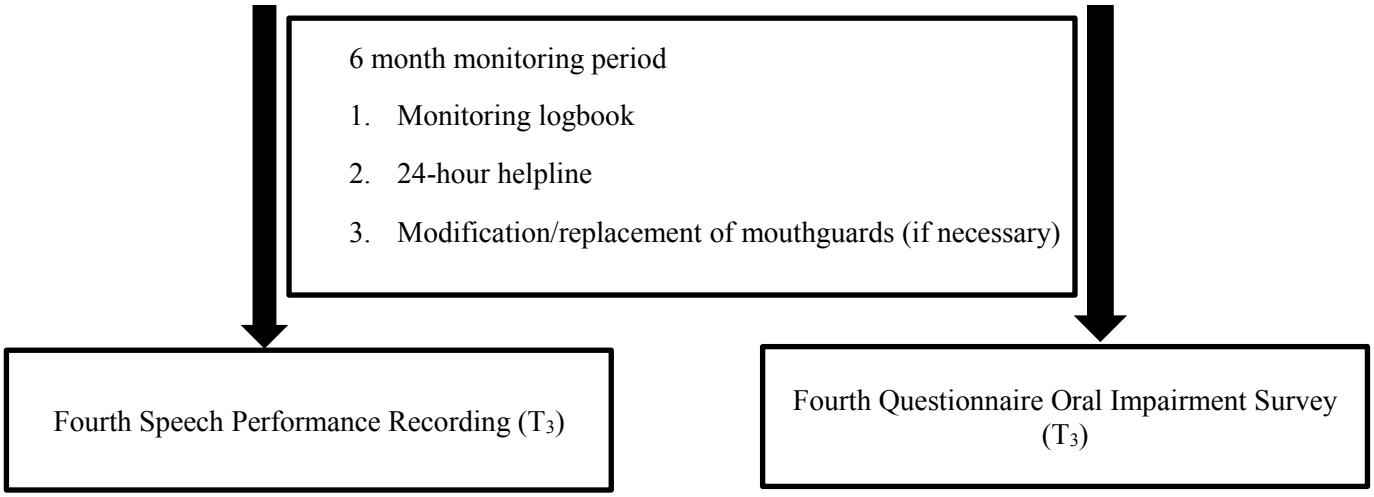
All the recorded speech waveforms will be digitized (at a sampling rate of 22 kHz and 32-bit resolution) and stored on a compact disk. The speech samples collected will be transcribed into the PRAAT software version to assess the acoustic characteristics of the sound via spectrographic analysis. Each speech sample file was given a number which referred to a participant's profile to blind the assessor.

By using spectrogram analysis, mean voice onset time (VOT) values for all phonemes */p b t d /* will be measured in a millisecond. The measurements will be done by manually positioning two cursors in the display of the waveform/spectrogram in the sample file. The beginning and end of a particular measurement of a sound will be judged from both the waveform and spectrogram. The average mean VOT values and voicing duration from the three readings will be obtained for each phoneme.

One-way repeated-measures analysis of variance (ANOVA) will be used to compare the VOT of each phoneme at different time intervals (T_0, T_1, T_2, T_3, T_4). Statistical significance is set at $\alpha = 0.05$.

7. Flowchart of the study




6 month monitoring period
1. Monitoring logbook
2. 24-hour helpline
3. Modification/replacement of mouthguards (if necessary)
Fourth Speech Performance Recording (T_3)
Fourth Questionnaire Oral Impairment Survey (T_3)

8. References

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