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Effect of mobile phone use on shear bond strength of brackets in fixed orthodontics - An in-vitro study

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Abstract

The aim of the study was to evaluate the effect of mobile phone radiation on shear bond strength of orthodontic bracket and the study sample consisted of 200 human maxillary premolar that were extracted for orthodontic treatment. The Samples were collected and stored in distilled water at room temperature in a plastic container. Teeth were randomly divided two groups of hundred teeth each. Huawei MT 7 mobile phone set at 700mG frequency is made available beside the phantom head in such a fashion a person holding the phone while in conversation. A call was made to the phone 20 minutes continuously changing the phone position to the other side at the end of 10 minutes and is continued for 5 days for one group and the other group was un-exposed to mobile phone radiation. The shear bond strength was

calculated using a universal testing machine. The unpaired t test to done to analyze the difference of mean shear bond strength among group gave 2.1 as value. Test of significance gave statistically significant p value of 0.03. The study concluded that the radiation emitted from mobile phone in close proximity while in us reduces the shear bond strength of brackets.

Keywords: Mobile phones, orthodontic bracket radiofrequency electromagnetic radiation, shear bond strength

Introduction

Orthodontics since it emergence as a specialty in the last century, has witnessed enormous development. A search into the history of the origins of orthodontic appliances indicates that revolutionary advances in material sciences have contributed in a big way and has helped in improving the standards of treatment. Orthodontic treatment mainly involves use of brackets wires for correcting malocclusion. There are several types of orthodontic braces available commercially including the more traditional metal bracket to coloured ceramic or plastic brackets. Brackets are used to correct various malocclusions such as over bites, cross bites and open bites, and other flaws of teeth and Jaws[1].

Material science related to orthodontics has witnessed immense changes in the last few decades, the introduction of the acid etching technique by Buonocore and the development of quality adhesive materials has to lead to significant advancement in the field of dentistry and orthodontics. The advent of acid etch technique has revolutionized the field with increased patient comfort, elimination of tooth separation, decreased gingival irritation, better oral hygiene maintenance, improved aesthetics, ease of proper bracket placement and reduced chair side time. This technique has been widely accepted by orthodontist throughout the world[1]

In 1965 Newman[3] introduced resins into orthodontics. This innovation replaced the old band based fixed orthodontic treatment to a new direct attachment on enamel by using adhesives. Composite resins are one of the most commonly used adhesives in orthodontic bonding. Bonding with composite adhesives is a technique sensitive procedure. They provide sufficient bone strength and are easy to handle. Resin modified glass ionomer cements as a last generation of glass ionomer cement with improved properties possess some of the good qualities of composite resin as well as some characteristic that make them very desirable for orthodontic bonding like fluoride release properties and adequate bond strength even in presence of moisture[5]. In addition to micromechanical lock with enamel surface irregularities they provide chemical bonding resulting in in superior bonding strength.[6,7]

The success of fixed appliance therapy mainly depends on capability of adhesive system to resist failure to a large number of forces directed to bracket adhesive-enamel junction as well as various mechanical and thermal factors in the mouth .Orthodontic adhesive should be capable of enabling brackets to stay bonded to the enamel for the whole duration of treatment and to permit easy removal of brackets when needed without damage to enamel surfaces and with least discomfort to the patient[8,9]. Adhesive should be non-irritating to the oral tissues, allow working time for proper positioning of bracket .They should be simple to apply, Should be convenient for curing and should have fluoride release potential[10]. Bond strength of adhesive should be sufficient to withstand all forces and stresses exerted by mastication and arch wires. Bond strength ranging from 5MPa -10 MPa is adequate for clinical situation[14,15,16.]

A major problem that the clinician encounters during fixed orthodontic treatment is bond failure. Bond failures

are a menace and it delays treatment outcome. Numerous modifications have been made to the type of resin and the acid etching technique. Light curing adhesives and fluoride releasing resins are examples of such modifications. Tavas and Watts first described the use of visible light cure composites used in orthodontic bonding[11,12] .It provides the orthodontist sufficient time for removal of excess adhesive material and precise bracket position[12]

The best way to evaluate clinical performance of orthodontic adhesives without any doubt is in-vivo studies. The factors that can contribute to bond failure are present only in human mouth. The exact simulation of clinical condition is not possible in an in vitro setting but the controlled testing environment in in-vitro study can offer great possibilities for investigating chemical and physical properties of adhesives and evaluation of factors that might alter their expected performance. Thus they provide valuable information regarding the amount of force that is responsible for failure in bracket adhesive enamel Junction and give directions for clinical practice and in-vivo investigations[13].

Mobile phone is an integral part of modern telecommunication, which may have negative effect on different organs, cells and materials used as a part of treatment. These negative impacts culminate from radio frequency electromagnetic radiation (RFER) emitted from mobile phones[22]. Insufficient understanding of potential adverse effect of mobile phones has raised concern among healthcare professionals[23]. The motive of this study is to throw a light to the effect of radio frequency electromagnetic radiation emitted from mobile phone on bond strength of brackets in fixed orthodontic therapy.

The bond strength depends primarily upon the quality of enamel bracket and adhesives used. Proximity to oral cavity, duration of conversation during mobile phone use might be serious factor to exposure. It is an established fact that tissues take up radiations and enamel can never be an exception. Increased nickel-ion release it has been detected after mobile phone conversation, and decreased in pH of saliva might affect the bond strength. The quality of adhesive may change either due to the presence of leached out nickel ions or by direct exposure to radio frequency electromagnetic radiation.

So in this line of thought the radio frequency electromagnetic radiation might alter the shear bond strength. The study will focus only on the effect of mobile phone radiation on shear bond strength and how it may affect is left for future research.

Materials and methodology

This study was conducted at department of orthodontics and Dentofacial orthopedics KMCT dental College Manassery, Calicut, Kerala, as an invitro experimental study. The study sample consisted of 200 human maxillary premolar that were extracted as a part of orthodontic treatment. The samples were collected and stored in distilled water at room temperature in a plastic container. The fluid media was changed at periodic intervals in order to prevent the growth of bacteria and subsequent contamination of sample.

All the samples were healthy and without carious lesion, with no evidence of surface defects or any developmental morphological aberrations. After extraction, the teeth were washed, immersed in Physiological saline, and stored in a closed plastic box until testing.

Teeth with perfect crown, those without caries and teeth that had not been treated with chemical agents, such as hydrogen peroxide, alcohol or formalin were included in the study. Teeth with anatomical defects, fractures and deciduous teeth were excluded from the study

The teeth were randomly divided into two groups of hundred teeth each. The teeth were rinsed with tap water by using an air/ water syringe for 20 seconds, cleaned with a non-fluoridated oil-free pumice for 30 seconds, rinsed for an additional 20 seconds, and dried with oil free compressed air for 20 second.

The etchant with 37% phosphoric acid was applied to the buccal surface for a period of 30 second. The teeth were then rinsed for 15 second and warm air dried for 5 second.

A layer of Trans bond XT primer was applied with an applicator brush in a single gentle stroke directed cervico-coronally. Trans bond XT adhesive was spread on the base of 3M bracket placed on the mid buccal surface of the crown and a firm seating pressure was applied until bracket to tooth contact was achieved. The excess material was removed from around the bracket base. 200 stainless steel MBT 022 X028 inch 3M Unitek Gemini metal maxillary premolar brackets with bondable bases (9.61mm^2) were used for the study. All the brackets were of uniform size. The brackets used for the purpose were manufactured by 3M ESPE. All the teeth with Trans bond XT adhesive were then light cured with high intensity LED light curing unit for 30 seconds each split as 10 seconds of curing from mesial aspect teeth, 10 second of curing from distal side and 10 seconds from buccal aspect. LED curing light is kept close to the specimen as possible. Etching, Priming, bonding and curing were done after the extracted teeth were engage on a typhodont. 10 minutes after bonding procedures were completed; all the teeth were stored in artificial saliva of pH 7.2 at room temperature. At the end of 48 hours teeth were segregated into two groups is designed as group A and group B with 100 teeth in each group.

Fig 1: Phone attached to phantom

Fig 2: Phantom head with saliva around bonded

- **Group A** teeth is reinserted into the typhodont and mounted on to the Phantom head to facilitate exposure to mobile phone radiation.
- **Group B** which is unexposed to mobile phone radiation is mounted on Blue square acrylic Block with the bracket facing outside; it is again kept in saliva till the calculation of SBS.

Huawei MT 7 mobile phone set at 900-megahertz frequency (2G) is made available beside the Phantom head in such a fashion a person holding the phone while in conversation. Sufficient saliva is made available around the teeth. A call is made to the phone for 20 minutes continuously, changing the phone position to the other side at the end of 10 minutes (that is 20 minutes of mobile use is split into two 10 minutes from right and

left side of phantom head). This is continued for 5 days. Sufficient amount of saliva with a pH around 7.2 to 7.4is made around the tooth during these days. All the hundred teeth exposed to mobile phone radiation is mounted on to a Red coloured square acrylic Block with bracket facing outside and kept in saliva for another 2 days. The color-coded acrylic blocks for identification designed as group A and group B are taken for SBS calculation at Universal testing machine.

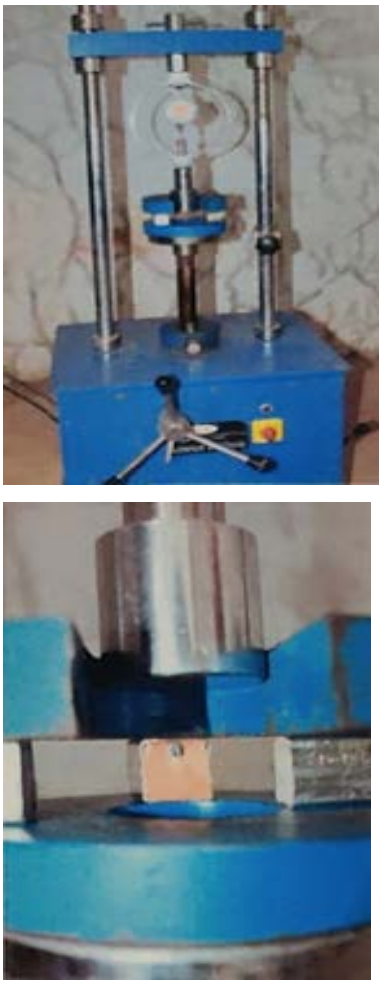

Fig 3: Universal testing machine

Shear Bond strength of teeth were tested using a universal test machine manufactured by Shimadzu Corporation Japan, at department of civil engineering KMCT engineering college at Calicut. The head speed of the machine was set at 1.25mm/min. The testing was done at a temperature of 28 degree Celsius. The acrylic Block with the teeth embedded having bonded brackets where place at the base of the testing machine. The whole unit was stabilized using clamp Tighten with screw at the base. The head was directed towards the base of the bracket or the bracket adhesive interface. The bond strength values were recommended from the dial in Newton and converted into Mega Pascal.

Results

The study observed that mobile phone use has effect on shear bond strength (SBS) of brackets in fixed orthodontics.

Table1: measurement of the shear bond strength of brackets.

Group	Mean SBS (MPa)	SD
Group A(exposed)	3.51	2.17
Group B (un exposed)	4.01	0.89

Figure 4: graph showing SD of exposed and unexposed groups.

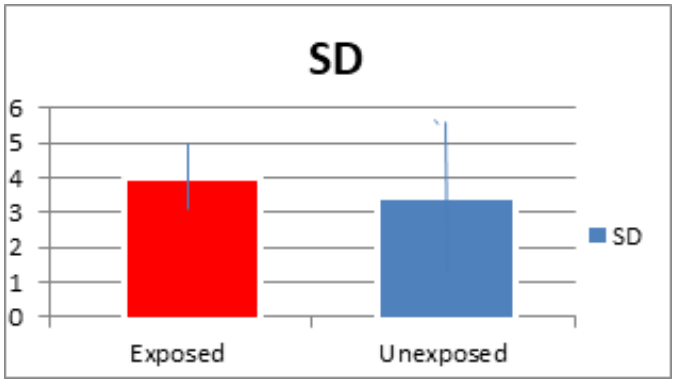

Table 2: comparison of the shear bond strength of brackets

Group	n	Mean+/- SD	t value	P value
Group A Exposed	100	3.51+/-2.17	2.14	0.03*
Group B unexposed	100	4.01+/-0.89		

(Unpaired t test) (*p<0.05; statistically significant) (**p<0.001; statistically highly significant), where

n=sample size, SD= standard deviation. The mean SBS of group A with 100 samples exposed to mobile phone radiation was 3.51mpa with a SD of +/- 2.17. The mean SBS of group 100 samples unexposed to mobile phone radiation was 4.01mpa with SD of +/- 0.89. Unpaired t test done to analyze the difference of mean SBS among group gave 2.14 as value. Test of significance gave a statistically significant p value of 0.03.

Discussion

Direct bonding of orthodontic has resulted in an improved oral environment by enhancing the ability for plaque removal by the patient, minimizing soft tissue irritation, eliminating the need for separation, absence of post-treatment band spaces and providing the patients with a relatively more aesthetic orthodontic appliance[25]. During last three decades, tremendous advances in the development of orthodontic adhesives have allowed practitioners to bond bracket to tooth surface quite successfully. One of the great advances in the profession of orthodontics has been the introduction of light cure adhesives. Light cure composite resin has become the most popular orthodontic adhesive. These adhesives have provided the practitioner the luxury of curing on demand. This gives the orthodontist a reduced risk of contamination, easy removal of excess adhesive, and more working time to position the bracket accurately. Over the past several years, curing light have experienced vast improvements. Plasma arc and now light emitting diode technology is the most common means of light curing for bracket bonding. Compared with the halogen curing system, LED lights can achieve clinical success with reduced curing time.

Orthodontic arch wires and brackets used in malocclusion treatment are fabricated from several alloys most commonly from SS, NITI, Titanium alloy (composed primarily of Titanium and molybdenum) and Cobalt chromium nickel alloys. Very little has been investigated about the impact of high frequency generated by mobile phone on orthodontic wires and brackets. The cell phones are the most popular communication method in world. Many concerns have been raised regarding the possible effects of radiations emitted by these devices. Our hypothesis was that comparing the shear Bond strength of brackets in orthodontic after exposure to mobile phone radiation there would be appreciable difference with non-exposed group.

A radio frequency magnetic field can transfer energy by means of electromagnetic induction in the surrounding areas. A radio frequency alternating current passed through a coil of wire (that is the mobile phone antenna) act as the transmitter, while a second coli (that is or any conducting object) can act that receiver. Shortly, the current flow through the first coil induces a voltage across the end of the second coil (that is orthodontic wire) through electromagnetic induction. Although they are low power radio frequency transmitters mobile phones are operating at frequencies between 450 megahertz and 2700 megahertz. Essentially, the RF energy that is radiating from the antenna of the mobile phone seeks to communicate to the nearest cell phone relay tower.

Thus depending upon the distance to the nearest relay Tower, mobile phone can change their power output in the range of 0.1 watts to 2 watts.as the phone gets closer to relay tower (the good reception area), the transmitter output power is diminishing automatically, Consequently, the long distances from the relay Tower increases the power output of the phone transmitter. Signal penetration loses inside buildings also increase the power output of the phone transmitter. The reported measurements for the average penetration lose are

between 7.6 dB and 16.4 dB depending upon building material and the operation frequency.

The effects of using mobile phone on the parotid gland have been studied by other researchers' heavy users of mobile phones demonstrated increased rates of salivary and blood flow, and greater volume of parotid gland secretion. The increase in salivary flow rate is known to have a diluting effect mostly on salivary macro molecules and to a lesser extent on ions, since the ions diffuse relativity easily along with the watery secretion. The concentration of salivary calcium, magnesium, and phosphate were lower in the mobile users[26]. We know that as the radio frequency signal may interfere with other electronic devices (that is electro medical or Navigation systems) turning cell phones "off" is often a mandatory request in places with a high security risk, such as hospital or Aeroplan.

So, on an orthodontic background aim of the study was designed to evaluate the effect of radio frequency electromagnetic radiation emitted from mobile phone on Bond strength of brackets in fixed orthodontic therapy. The study observed that there is significant reduction in SBS after exposing to non-ionizing radiofrequency emitted from mobile phones. Though the exact mechanism, as to how and why it occurred cannot be completely inferred from the study but it can throw light in that direction. Effects of ionizing radiation used in the treatment of head and neck cancer had been studied in detail and consequently its effect on physical and adhesives properties of dental enamel after radiotherapy and bonding of metal and ceramic bracket has been studied by Gabriela Christina satin et al[27]. They observed that is irradiated enamel exhibited lower tensile strength when subjected to micro shear strength. Significant shear strength values were found for teeth subjected to irradiation where orthodontic brackets (metal or ceramic) were bonded to enamel.

Bracket- composite resin fracture was predominant type in irradiated teeth[28]. The resin tag formed at the resin-enamel interface was deeper and more extensive in the irradiated group. So, coming back to the non-ionizing scenarios, the possible reasons for decreased SBS after exposure to RFER (radio frequency electromagnetic radiation exposure) can be broadly categorized as alterations occurring in three specific sites.

1. Enamel resin interface
2. Bracket resin interface
3. Loss of quality of cured resin alone
4. As combinations of above[28]

Studies have come up evaluating effect of mobile phone use on metal Ion release from fixed orthodontic appliances. Increased Nickel ion leach from orthodontic appliances has been established as part of mobile phone use. Muhammad Ali saghri et al[22] said mobile phone usage has time -dependent influence on the concentration of nickel in the saliva of patient with orthodontic appliances. These leached ions apart from causing nickel allergy to sensitive individuals may also impede the quality of the alloy used or it can cause chemical reactions at the bonding interface. Saliva act as an electrolyte to carry nickel which can also be a reason to the reduced SBS values[22].

Muhammad Hossein Toodehzaeim et al has established that reduced salivary pH by any means can decrease the SBS values[29]. Ionut cornel et al[23] has observed that a temporary decrease in pH values of saliva in patients exposed to GSM 900 megahertz. The average pH value under normal condition was 7.02. When the mobile phone was used, the average pH value decreases to 6.8. Yani Ham zany et al[30] in their study keeping human saliva as an indicator of adverse health effects of using

mobile phones may cause oxidative stress and modify salivary function. Considering these 3 studies, we can arrive at a point that exposure to mobile phone radiation can reduce SBS values. The increase in temperature felt during mobile phone use is definitely conducted to the surrounding oral structures and the attachments in oral cavity like the orthodontic brackets and wires. The sustained increase in local temperature during mobile phone conversation can have an impediment in SBS values. The aforementioned reasons can be few of the many reasons for decreased SBS after RFER (radio frequency electromagnetic radiation exposure). The scenario demands further investigations to understand the hidden facts.

Being an in vitro study, results may differ from in vivo conditions. Bond failure can occur in human mouth through a plethora of other causes like masticatory forces, acute thermal fluctuations and acute pH changes.

Premolar teeth that is to be removed as part of orthodontic treatment is bonded few days prior to extraction in patients using mobile phones and can be tested for SBS immediately after extracting the tooth, this will give almost similar value of an in Vivo study

Conclusion

The study concluded that RFER (radio frequency electromagnetic radiation exposure) emitted from mobile phones has effect on SBS of brackets. The radiation emitted from mobile phone in close proximity while in use reduces the SBS of brackets. The reduction of SBS is statistically significant. The increase the metal ion leach present in saliva, the increase in local temperature, the decreased salivary pH, the altered salivary volume components and functions all secondary to radiations emitted from mobile phones in close proximity while in use can be taken as few of many reasons for drop in shear bond strength of brackets.

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