REVIEW ARTICLE

Occular Hazards in Orthodontics: An Overview

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ABSTRACT

Aim: The aim of the article is to discuss the hazards related to eye and vision in orthodontic clinic and lab.

Summary: A personnel working in an orthodontic clinic and patients taking orthodontic treatment are exposed to a plethora of occupational hazards. Lack of adequate knowledge about the potential hazards can cause serious accidents and can disable a person for the rest of their life. There is a risk of damage from physical agents, chemical agents and radiation. One of the most delicate organs which have high risk of abuse is the eye. This article aims to comprehensively evaluate the factors acting as potential risk for ocular damage especially in an orthodontic clinic. The article discusses in detail the photochemical damage from photopolymerization units. The article also discusses the damage caused to the eyes from caustic chemicals and physical agents used in the clinics. To safeguard eye from various hazards proper protective eyewear are recommended. The article not only attempts to highlight the factors serving as potential threat to the eye but also discuss the preventive and remedial methods to ensure occular safety.

Keywords: Blue light hazard, headgear, endophthalmitis, photopolymerization unit, photochemical damage,

INTRODUCTION

Eyes are exposed to a variety of hazards in the dental clinic. There is a risk from potentially damaging chemicals, high intensity lights and high-speed cutting instruments. In orthodontic clinic there is additional risk from small cut pieces of highly resilient wires. Eyes are one of the most delicate organs of the body and require special care while working in hazardous environment. Dental operatory and laboratory have potential for hazardous exposure to eye. Improper handling and negligence can be dangerous to personnel's working in the operatory and laboratory. There is risk of injuries from variety of chemicals, traumatic injury and from exposure to high intensity lights.[1,2]

A survey of Southland dental practices revealed that the eye protection of all the personals working in the dental clinic setup were substandard and much below than the recommended.[3] Wazzan *et al*.[4] reported that prevalence of occular injury in dental set up was as high as 42.3%. They also reported that dental technicians were more prone to ocular injury than the dentist. Another study done in the Lagos university teaching hospital showed that dental technicians suffered more occular abuse. The prevalence amongst dental technicians was maximum with a value of 40% and minimum for dental students with a value of 15.4%.[5]

According to one survey 99% orthodontist did not give eye protection to their patient or attending staff while using light cure units. Orthodontist seemed to have poor knowledge of the hazards associated with light cure systems and as high as 84% were unaware of the intensity of the curing lights.[6] In Britain only 66.8% of orthodontist wore eye protection and 64.3% of patients wore eye protection during procedures. The wearing of goggle with side pieces and plastic lenses which conform to British standards 2092 BS is recommended for all staff and patients.[7]

All health care providers should be properly educated and trained about the potential risk associated in their working area. It is mandatory for the people working in the dental clinic and lab to have adequate training to prevent and manage accidents. Such training is a must for the safety of both health care provider and the patients. Occupational Safety and Health Act (OSHA) was passed by the US congress in the year 1970. The act identifies employer's obligation to protect employees from occupational risk. The act has defined set guidelines for ensuring safe working environment for workers. The guidelines have been set for health care workers also. All over the world the OSHA regulations have been considered to be the gold standard for ensuring safety in work place.[8,9] OSHA regulations specifically discusses eye protection measures to be taken in

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hazardous environment under the part 1910.

Photochemical Injury

Use of dental curing lights is popular for photopolymerization of resins in dental sciences. The curing lights emit light with intensity of 400-500 nm wavelength. The colour of the curing light falls in the blue spectrum with some amount of ultravoilet irradiation.[10-12] Large number of dental materials are activated by light which is predominantly intense blue in colour. The blue light are short wavelength visible light. Unprotected exposure to such short wavelength visible light has been accepted as a risk for the long term visual health. The risk has been termed as the 'blue light hazard" in the literature.[13,14]

According to one estimate a restorative dentist will be exposed to light from curing units to as many as 40 hours in a year.[15] According to another estimate an orthodontist requires 15 -20 minute to cure the brackets in both the arches. The long curing time is inconvenient and cumbersome both for patients and the doctor.[16,17]

Mechanism of Damage

Retina is the photosensitive layer of the eye. The retinal cell has adapted to convert the radiant energy in the form of photons in meaningful visual signals. Retina is a highly specialized cell layer but at the same time it is vulnerable to damage by light. The damage to retinal cells can be either photochemical or photothermal. Each day eye receives about 10^{12} to10^{15} photons. The number of photons can significantly increases in certain work related environment.[18]

Brief exposure to high intensity light can cause photothermal damage of the eye and prolonged exposure can lead to what is called as photochemical damage. Not all cells are susceptible to damage by light. The inner ganglion cells, amacrine cells bipolar cells are more transparent and are less likely to be damaged by phototoxicity rods and cones on the other hand have photopigments and stand a greater risk of damage from high intensity light. Laboratary studies have suggested oxidative damage of photopigment which causes apoptic changes in the retinal cells.[19] The photoxidative changes caused by blue light can induce age related macular changes.[20]

There is a risk of photoretinitis from high intensity visible light. The photopolymerisation units used for curing dental resins donot have enough intensity to cause photothermal damage. The maximum permissible exposure time is between 2.4 to 16 min per day. The distance between the source and the eye should not be less than 25 cm.[21]

Until recently rods and cone were considered to be the only photosensitive cells. Recent research in this field has shown that there is another type of photosensitive cells called "intrinsically photosensitive retinal ganglion cells".[22,23] These sparsely situated cells are most sensitive to blue light. They are important modulators of circadian rhythms.[24] When light fall on the photoreceptor cell it gets bleached. The bleached cell is unresponsive and useless until it is rejuvenated by a metabolic process called visual cycle. The blue light makes the cell unbleached and responsive even before it is ready. This increases the potential oxidative damage of retinal pigment epithelium layer. This further leads to development of lipofuscin in these cells. Excessive build-up of lipofuscin leads to development of Drusen. Drusen are white and yellow deposit of excess lipofuscin. Drusen prevents the retinal pigment epithelium to provide nutrients to the photoreceptors leading to their degeneration.[25]

Filters: Filters of inferior quality are inadequate in controlling radiation from the curing light. It is the responsibility of the supplier to specify the standards of the filters to be used. In addition the filters should be marked according to the testing procedure for specific use. A good filter should transmit 1% of light below 500nm.The glasses should be matched with the curing light units.[26,27,28] Goggles with coloured glasses provide better protection from intense blue light. The paddle shaped filters provided with the curing light is unable to filter scattered light completely (Fig. 1).

Figure 1: Paddle shaped filter attached to the curing light is unable to provide complete protection from intense light. Goggles of tinted glasses provide better protection

Drilling with high-speed headpieces greatly increases the risk of injury to the eye in dental office.[29] A small piece of bur or a cut piece of hard material being cut can shoot at the eye like a projectile. The injury from such high speed moving object can result in severe eye injury. According to Burton effective protection to the eye is provided only when the glasses have side shields with edges approximating the eye. The eye wear should have lenses of hard plastic. Only such type of glasses can provide complete protection from particles, droplets and aerosol. To maintain these glasses it should be cleaned regularly and sterilized as per direction of the manufacturer (Fig. 2).[30]

Laser in orthodontics have been used for bonding and debonding of brackets.[31]At present the use of laser in dentistry is limited but will be used more frequently in the coming future. The main issues related with the use of lasers are mainly related to the safety. Lasers are highly

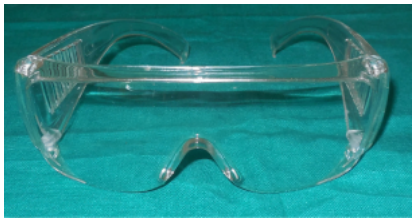

Figure 2: Protective eye wear of clear plastic with side shields provide better protection from aerosol , splash and projectile particle moving at high speed

concentrated form of energy and have the potential to cause damage to soft and hard tissues. They have manufacturers recommended guidelines for occular safety. These guidelines should be strictly followed to ensure safety of the patient, doctor and the assistant.

Prevention of occular trauma should be given high priority by all healthcare providers.[32] Proper protective eye shields should be worn by the dentist and assistant. Studies have shown that majority of eye injury occur in the work place. To avoid accidents all the workers should be educated about the hazards related to the profession specifically .There should be a written display of the safety measures to be followed by the workers. Many people forget to wear proper eye protection. If the safety protocol is displayed in written then the chances of negligence will reduce.[33-36]

Headgear Injury: In orthodontic treatment sometimes patients have to wear extraoralorthopedic appliances .There are documented cases where patients have got serious occular injuries from headgears and facebows. The injury from these orthopaedic appliances can result in loss of vision.[37-40]

A survey of British orthodontist revealed 4% incidence of facial injury with headgear. The injury to the patient by headgears was extraoral 40% of the time and 50% of the times the injury was in the midface region. Headgears should be worn with safety feature failure to do so can result in a medicolegal complication.[37]In case of severe malocclusion headgear still serves as an important device to provide anchorage. Unfortunately some patients have been injured with the headgear because of improper handling. The injuries have resulted because of the catapult like effect of the elastic components. The facebow has recoiled because of the elastics and injured the soft tissues in few patients.[41,42]In order to prevent any type of injuries from facebows various manufactures have introduced facebows with improved safety features. These include self-releasing extra-oral traction systems, plastic neckstraps, shielded facebows, and locking facebows (Fig. 3).[43,44]

Headgears given to orthodontic patients have the potential to damage the eye seriously. Few patients have injured their eye while sleeping .It is required on the part of the patient to wear the headgear while sleeping so that orthopaedic effect can be enhanced. Patients who receive headgears are of younger age group and there is high risk of injury with such

Figure 3: Headgear with safety modules which get separated from the face bow in case of a heavy pull force.

kind of appliance. There are reported cases where patients have developed devastating endophthalmitis following an ocular injury from a headgear appliance.[45]

Apart from injury to the patients from headgear there is additional risk of trauma from cut pieces of orthodontic wires. Small pieces of orthodontic wires can fly like projectiles and hurt the eye of the patient as well as the doctor. In orthodontic treatment highly resilient nickel titanium wire are frequently used. The free end of the wire when cut can shoot at high speed .Intra orally distal end of the wires are cut with distal end cutter. Distal end cutter holds the cut piece of wire and prevents the wire from being lost. Orthodontic wire should be cut in such a way that both the pieces of the wire should be held while cutting.

Trauma to the eye can occur while trimming acrylic on the lathe. The acrylic appliances while trimming can slip from the hands and can shoot like projectiles. Especially the appliance is wet while polishing buffing and there are high chances of slippage. Also the acrylic shavings can also go in the eye while trimming. It is recommended that protective eye equipments should be worn while trimming acrylic.

Chemical Burns: Chemicals causing injury from chemicals can be broadly classified as acid and alkali. In case of abuse from acids the cornea of the eye is first attacked and suffers the maximum loss. The cornea of the eye is made of several transparent layers. The outer surface is the layer of epithelium limited below by Bowman's capsule. Beneath the Bowman's capsule is the Decemet's membrane. In order to cause opacity of the cornea the chemical must penetrate to the level of Bowman's capsule. If the chemical penetrates entirely through the coats of the eye then the eye collapses. The severity of the damage depends on the strength of the chemical, duration of exposure and the type of initial treatment given. When eye is abused with acids acid albumins are produced causing softening of the epithelium

followed by scarring of the eye. Alkali on the other hand combines with alkaline albuminates and soap. The alkali deeply penetrates the epithelium causing necrosis. In case of chemical injury no efforts should be made to neutralize the chemical. It has been found that neutralizing solution causes more damage. Washing with copious amount of water is the most recommended first aid to be given.[46]

In orthodontic clinic acid splash can occur during rinsing etchant. Alkali is present in the disinfecting solutions. Hydrofluoric acid of up to 5% concentration is used in orthodontics to etch porcelain crowns.[47]Chemical treatment of porcelain with hydrofluoric acid greatly increases the bond strength of the attachments. Conventional etching with phosphoric acid is unable to roughen the surface sufficiently.[48,49]Hydrofluoric acid in low concentration elicits increased light sensitivity and corneal ulceration. In higher concentration complete corneal opacity can occur.[50-52] Care should be taken to avoid any accidental exposure to these chemicals. In case there is as a splash of any potentially harmful chemical it should be washed immediately. A hand shower attached in the hand washing area is very useful in washing the eye. The shower can be raised above the head and a gentle stream of water can be directed on the eye (Fig. 4).

Figure 4: In case of splash the water should be poured in the eye from a hand shower such that water drains from the side and not go in the other eye.

Blood Borne Pathogens: Majority of people having HIV and Hepatitis are unaware of their infection. In a study conducted in 2003 estimated that 27% out of 53000 HIV positive patients were unaware of their infection.[53]Although the risk for accidental exposure to HIV is less but not completely absent. According to one estimate the risk of getting HIV is 0.5% from needle stick injury and 0.1% for mucous membrane exposure.[54,55]

Healthcare workers are at higher risk of acquiring HIV even from infected body fluids.[56] The number of patients having HIV and hepatitis has increased greatly. Even more than that, the patients are unaware of their infection. Health care providers should be more careful while working on the patients where there is a risk of splash of blood or body fluid. Such infections are easily transmitted through splash of body fluid on exposed mucosa or eye. It is prudent on the part of the healthcare provider to safeguard himself though this route of transmission.[57] In dental set up high-speed hand-pieces and water sprays are used frequently. Compressed air and water is ejected from these instruments. The jet of air and water along with patients saliva produces an aerosol. This aerosol increases the risk of infection in dental set up.[58-60] Protective eye goggles with side shield provide adequate protection from infected aerosol and fluid splash.

CONCLUSION

Eye protection should be given high importance while working in orthodontic clinic. Patients, assistants and lab technicians as well as the orthodontist themselves should be fully aware of the potential ocular hazards. Proper protective eye equipments should be worn as well as written instructions should be displayed in the work area to create awareness. The patients and parents should be given proper instruction to wear and remove headgears. In case of splash of any caustic chemical agent in the eye it should be washed with copious amount of water and no effort should be made to neutralize the chemicals. It is mandatory on the part of the employer to ensure a safe working environment failing which medico legal issues may arise. Following the given sets of instruction accidents in general and particularly related to eye can be avoided.

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