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Biopsies to Burnout – An Insight into Occupational Hazards in Pathology Laboratories

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Abstract

Oral and maxillofacial pathologists play a crucial role in diagnosing diseases affecting the oral and maxillofacial region. However, their daily work exposes them to a wide spectrum of occupational hazards that often go under recognized. The hazards encountered include biological risks, chemical exposures, physical injuries, ergonomic strain and psychological stress from academic and diagnostic workloads. Despite the availability of safety protocols, gaps in awareness and implementation persists. The integration of preventive measures such as, proper personal protective equipment, ergonomic workstation design, and phytoremediation techniques can significantly improve occupational safety. Innovations like digital microscopy and neutral posture optimization further reduce long-term physical strain. This review article aims to highlight the various occupational risks faced by oral pathologists and present practical strategies to mitigate them, while promoting a safer, eco-conscious laboratory environment.

Keywords: Chemical exposure, Laboratory safety, Microscope ergonomics. Occupational hazards, Oral pathology, Phytoremediation

Introduction

Oral and maxillofacial pathology is a specialized branch of pathology focused on diagnosing diseases affecting the oral cavity and its associated structures.[1] Professionals in this field, known as Oral and Maxillofacial Pathologists, perform a wide range of laboratory procedures and are routinely exposed to various occupational hazards.[2]

These hazards categorized as physical, chemical, biological, and ergonomic can lead to issues such as musculoskeletal disorders, visual strain, acute injuries, chemical exposure, and mental health conditions like depression. Despite their crucial role, oral pathologists often remain unrecognized by the public and may also underestimate the risks involved in their own work environment.[3]

Within the laboratory, oral pathologists handle biopsies, smears, aspirates, and blood samples for diagnostic and research purposes, increasing the risk of exposure to infectious microorganisms.[4] Substances such as formaldehyde, commonly used in histological procedures, are known irritants and potential carcinogens, underscoring the significance of chemical safety.[5] Physical injuries can arise from sharp instruments, electrical equipment, and flammable materials. Additionally, prolonged microscope use and static postures contribute to musculoskeletal problems, particularly affecting the back and neck.[6]

Implementing a culture of safety through disciplined handling and proper containment of hazardous materials is essential. This review article explores various occupational hazards encountered by Oral pathologists, offers strategies for their prevention and management, and proposes innovative, eco-friendly practices to promote a safer and more serene workplace.

Biological Hazards

Biological hazards in oral pathology laboratories primarily stem from handling of fresh tissues and body fluids. Among laboratory procedures, grossing poses the highest risk, while fixed specimens carry significantly reduced threat due to the inactivation of most pathogens during fixation.[7]

Exposure to biohazards can occur via aerosol inhalation, contact with injured skin, or contact with mucous membranes during the handling, processing, or disposal of biological materials. Infectious agents, including contaminated specimens, solutions, or tools, pose serious health risks regardless of their origin.[8]

To mitigate these risks, strict adherence to safety protocols is essential. This includes the use of personal protective equipment such as disposable gowns, gloves, face masks, and eye protection. Routine handwashing and proper instrument sterilization must be enforced. Immunizations against infections like Hepatitis B and COVID-19 are highly recommended for laboratory personnel. [6,9]

Additionally, universal precautions, mandated by the Occupational Safety and Health Administration (OSHA), should be followed. [10,11] Even requisition forms that accompany biopsy specimens can harbour microorganisms, and their digitalization can help reduce contamination.[12]

Proper disposal of biohazardous waste and regular freezer maintenance, including removal of damaged ampoules and specimen tubes, are critical in minimizing biological risks in the laboratory.[13]

Chemical Hazards

Oral pathology laboratories utilize a wide range of chemicals, including strong acids, alkalis, oxidizing agents, solvents, and staining solutions, that pose significant risks if mishandled. Substances like formalin, alcohol, xylene, paraffin wax, and DPX are routinely used and can cause allergic reactions, skin irritation, and respiratory issues.[14] Prolonged exposure may lead to chronic lung conditions and even cancer, with formaldehyde recognized as a mutagen and carcinogen.[15]

To minimize risk, universal precautions must be strictly followed. Direct contact with hazardous chemicals should be avoided, and appropriate personal protective equipment should be worn. Laboratories must maintain

adequate ventilation and temperature control. Chemical waste should be classified correctly, some can be disposed of in regular trash or sewer systems, while others require recycling or specialized disposal services. In case of accidental chemical exposure, immediate first aid is vital (Table I).[4]

Formaldehyde, a ubiquitous air pollutant (liberated from commonly used fixative i.e., formalin), is so harmful that it is classified as a mutagen and carcinogen when inhaled. Recent studies revealed that placing certain indoor plants can reduce air pollutants like formaldehyde in laboratories through a process called Phytovolatilization (one of seven approaches in Phytoremediation) (FIGURE-1). Low levels of Formaldehyde in air could be removed by plant leaves alone, while higher concentrations of the toxic chemical can be filtered by activated carbon firstly, then the plant roots and associated microorganisms degrade and assimilate remained chemicals. Cell culture studies revealed that Spider plant (Chlorophytum comosum L) shoot can metabolise Foramaldehyde to organic acids, amino acids, free sugar, lipids and cell wall components.[16]

Other volatile Organic compounds like Benzene, toluene, xylene, Ammonia are also liberated in Laboratories. These reagents have adverse effects when inhaled. To reduce such airborne chemical pollutants, phytoremediation offers an eco-friendly solution. Certain indoor plants can absorb and degrade hazardous compounds (Table II). By incorporating these plants, laboratories can naturally reduce toxic vapor concentrations, improving both air quality and overall workplace health.[17]

Ergonomic Hazards

Ergonomics is the scientific study of how people interact with their work environment, with the goal of optimizing comfort, safety, and performance. In oral pathology, prolonged microscope use, repetitive movements, and static postures often lead to ergonomic hazards, particularly musculoskeletal disorders (MSDs). A study by Gupta et al. (2015) revealed that fewer than half of oral pathologists are aware of the importance of ergonomics in their profession. Commonly affected areas include the neck, back, shoulders, arms, wrists, and eyes—often in combination. The incidence of such issues among oral pathologists (31%) significantly exceeds that of general pathologists (1.9%) and microbiologists (5.4%).[18]

Doug Elizondo stated that, A mismatch between the physical capacity of workers and physical demands of their jobs can result in Musculo Skeletal Disorders (MSDs).[19] MSDs develop gradually due to repetitive micro-trauma and poor posture, affecting muscles, tendons, ligaments, and joints. Examples include rotator cuff syndrome, sciatica, tendonitis, and trigger finger Tarsal tunnel syndrome, Sciatica, Epicondylitis, and tendonitis.[20]

Neutral Posture (NP): The Gold Standard (Figure 2)

Maintaining a neutral posture minimizes strain. Key features of NP include:

- Ears aligned over shoulders
- Shoulders aligned with hips
- Straight wrists
- Elbows close to the body
- Relaxed shoulders
- Balanced head, not tilted

Four Ergonomic Pillars for Workstations:

1. **Support** – Proper seating and lumbar support.
2. **Reach** – Easy access to frequently used items.
3. **Breathing** – Unrestricted chest movement.
4. **Vision** – Minimized eye and neck strain.

Working Positions

- **Sitting**: Slight lumbar curve, relaxed shoulders.
- **Sit/Stand**: Alternates posture, relieving pressure on back and hips.
- **Standing**: Use anti-fatigue mats and supportive footwear. [20,21]

When undertaking special tasks such as microtomy, pipetting, and microscopy in histopathology laboratories certain ergonomics must be followed (Table III), (FIGURE 3, 4).[19]

According to Sundaragiri KS et al., neutral erect posture can be obtained if certain modifications are incorporated in the designing microscopes. These include having an optical path (distance from the ocular lenses to the specimen being viewed) ranging between 45 to 55 cms. Also, another consideration should be the angle of the eyepieces which should not go beyond 300 above the horizontal plane.[21]

Modern microscopes now offer ergonomic improvements like Tilting/swivelling eyepiece tubes, Adjustable observation tube height, Video monitors to replace eyepiece viewing,[21] Refocusing stopper,[22] Automatic objectives changeover,[23] Microscope positioners[24]. Digital microscopes and eye piece less microscopes, which are modified stereo microscopes, are a recent innovation in Microscopy.[25] Incorporating these modifications into future compound microscope designs would be highly beneficial for Pathologists. For older models, ergonomic accessories like extended eyepiece tubes, padded armrests, and observation tube extenders can help reduce strain. The '20-20-20 rule' that states for every 20 minutes look 20 feet away for 20 seconds and blink 20 times is advocated.[26]

Physical Hazards

Physical hazards in oral pathology laboratories arise from exposure to sharp instruments, bone dust, electrical equipment, and flammable chemicals. These hazards can result in injuries, burns, or even serious accidents if proper safety measures are not followed.[27,28]

Many chemicals used in histology, such as diethyl ether, ethanol, methanol, and acetone, have low flash points and are highly flammable. Additionally, oxidizing agents like sodium iodate, chromic acid, and mercuric oxide pose combustion risks when they come into contact with incompatible materials.[7,8,29,30]

To reduce such risks, install and maintain equipment properly, train staff on safety procedures, ground all electrical outlets and dispose sharp instruments in designated "sharp" containers, and clean microtomes, cryostats immediately after blade removal.[7]

Routine inspections and chemical safety audits are recommended to identify potential hazards and ensure all safety protocols are in place. In accidental physical injuries, first aid should be followed (Table IV).[6]

Other / Miscellaneous Hazards

The role of an oral pathologist extends beyond laboratory diagnostics. It includes academic responsibilities such as teaching, research, curriculum development, and administrative duties.[31] This multifaceted role often leads to increased workload and mental strain.[3]

Balancing academic commitments with clinical and diagnostic responsibilities can result in stress-related physical and emotional symptoms. Prolonged academic stress may affect productivity, interpersonal relationships, and overall well-being.

To manage these challenges effectively, oral pathologists should:

- Maintain a structured daily schedule
- Set realistic goals for academic and laboratory tasks
- Delegate responsibilities when appropriate
- Prioritize mental health through mindfulness, exercise, and short breaks[32]

Conclusion

Oral pathologists are susceptible to a range of occupational hazards—biological, chemical, physical, ergonomic, and psychological. Awareness and proactive management of these risks are essential for maintaining a safe, productive, and healthy work environment. Ensuring quality in oral pathology begins with proper sample handling and extends through accurate diagnosis and safe laboratory practices. Promotion of health and safety of patient, laboratory personnel and environment should be the primary objective in quality and safety control programs. Simple measures such as incorporating indoor plants can improve air quality and contribute to overall well-being. Similarly, ergonomic practices and scheduled breaks can significantly reduce physical strain, especially during prolonged microscope and academic work.

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Legend Tables and Figures

Table 1: First aid for accidental chemical exposure

Chemical Hazard	First Aid
Acid on Skin	Wash thoroughly; apply cotton soaked in 5% aqueous sodium carbonate.
Alkali on Skin	Wash thoroughly; apply cotton soaked in 5% acetic acid or undiluted vinegar.
Acid in Eyes	Rinse with water using a wash bottle; instil 4 drops of 2% aqueous sodium bicarbonate.
Alkali in Eyes	Rinse thoroughly; instil 4 drops of saturated boric acid solution.
Ingested Acid	Administer 5% soap solution, followed by water; rinse burns with 2% aqueous sodium bicarbonate.
Ingested Alkali	Give 5% acetic acid, lemon juice, or vinegar solution; rinse with the same and follow with water.
Poisoning	Seek immediate medical attention; place the victim in open air while waiting for help.

Table 2: Plants that absorb chemical air pollutants

Plant	Chemical Absorbed
Spider Plant (Chlorophytum comosum)	Formaldehyde
Peace Lily (Spathiphyllum wallisii)	Formaldehyde, Benzene, Ammonia
Snake Plant (Sansevieria trifasciata)	Formaldehyde, Xylene, Toluene
Rubber fig (Ficus elastica Roxb. ex Hornem)	Formaldehyde, Xylene
Golden pothos (Epipremnum aureum)	Formaldehyde, Benzene, Xylene

Table 3: Ergonomics for Specific Tasks

Using a Microtome	Pipetting	Microscope Use
• Adjust height and maintain upright posture. • Use as little force as possible when turning the handwheel. • Operate the microtome with the hand in a pistol grip position (wrist aligned with forearm in handshake position). • Use padded supports to reduce wrist pressure. • Prefer automatic microtomes for repetitive tasks.	• Use light-touch or electronic pipettes. • Place work supplies such as trays and beakers within easy reach • Maintain neutral wrist posture and avoid twisting. • Alternate hands and use low-profile containers.	• Sit upright with scope at eye level. • Keep arms close and supported. • Use adjustable eyepieces or angle stands. • Take breaks: Every 15 minutes look into the distance; every 30–60 minutes, stretch and walk.

Table 4: First Aid for Physical Hazards

Hazard	First Aid
Injury From Broken Glass	Rinse wounds thoroughly to remove glass fragments, then apply Mercurochrome or Acriflavine ointment.
Severe Burns (On Fire)	Smother flames with a blanket or coat. Do not remove clothing. Keep the victim warm and wait for medical help. Do not apply creams or ointments.
Minor Burns	Immerse in cold water or apply ice to reduce pain. Apply a mild antiseptic ointment and loosely bandage. Avoid popping blisters.
Electric Shock	Switch off the power source immediately. Begin mouth-to-mouth resuscitation if necessary. Call a physician and place the victim in a ventilated area.

Figure 1: Phytovolatilization in Indoor Plant

Figure 2: Neutral Posture While Performing System Work

Figure 3: Ergonomics While Using Microscope

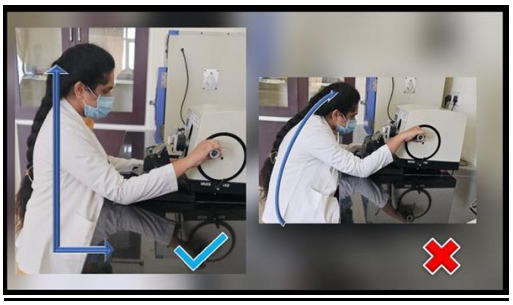

Figure 4: Ergonomics While Using Microtome