Magnification and its increasing role in clinical practice

By Professor Laurence J. Walsh

"every dental professional is at risk for an occupational musculoskeletal injury because of poor posture secondary to eyestrain, if visual enhancement aids are not used..."

Magnification is becoming an increasingly important requirement for high quality contemporary dentistry. Magnifying loupes, intra-oral cameras (IOC), and surgical operating microscopes (SOM) are the three common magnification tools in use. The published literature suggests that every dental professional is at risk for an occupational musculoskeletal injury because of poor posture secondary to eyestrain, if visual enhancement aids are not used. As well as reducing the ongoing concern of eyestrain because of the sustained, demanding and intense near visual work required in dentistry, these can offer very real improvements in the quality of work undertaken whilst also improving posture.

Eyestrain

During intense near visual work, the ciliary muscle of the eye, which produces accommodation (focusing) and the extra-ocular muscles, which converge the visual axis of each eye on to the object of interest, become fatigued. Subconscious attempts to alter posture to improve near vision can result in musculo-skeletal complaints, as well as eyestrain. Conversely, solutions to eyestrain (such as loupes or operating microscopes) provide a major improvement to the operator's posture. As we age, the discrepancy between the visual demands of dentistry (close visual work) and our visual abilities increases. This is particularly common above the age of 40 years. Presbyopia is a reduction in the ability to attain sharp focus for near vision. It occurs because of reduced elasticity of the lens as a consequence of normal aging, and results in blurred near vision. The unconscious desire to hold a printed text at arm's length in order to read it is a classic sign of this condition.

The contributing factors to eyestrain in dentistry include:

- The need to change focus from near to far objects, e.g. from the teeth to the bracket table, patient charts, radiographs or computer screens;
- Inadequate lighting on the target, e.g. because of shadowing from the lips and cheeks;
- Poor visual contrast between objects of interest, e.g. because of the similar hue of tooth structure and adhesive restorative materials;
- Glare from reflections of the operating light from enamel surfaces;
- Glare from reflections of daylight or artificial lighting from surfaces in the workplace, or from computer screens;
- Frequent movement of the object of interest (e.g. tooth or instrument), which requires tracking of the eyes; and
- Other visual problems such astigmatism.

Dental staff who suffer eyestrain or visual fatigue may experience the following signs and symptoms:

- Temporary blurring of vision;
- Difficulties in visual accommodation;
- Photophobia;
- A vague discomfort in the eyes;
- Feelings of heaviness of the eyes;
- Dull bilateral headaches;
- Bloodshot eyes;
- A burning and itchy sensation in the eyesk and
- Increased lacrimation (tear production).[1]

Intra-oral cameras

Since their introduction in 1987, these have become widely used for co-diagnosis and patient education. Modern systems have benefited from improvements in image sensor technology and image display units, with compact CMOS colour cameras and LCD screens now the usual combination. Using zero degree and 90 degree optics, these cameras are normally used for demonstrating to

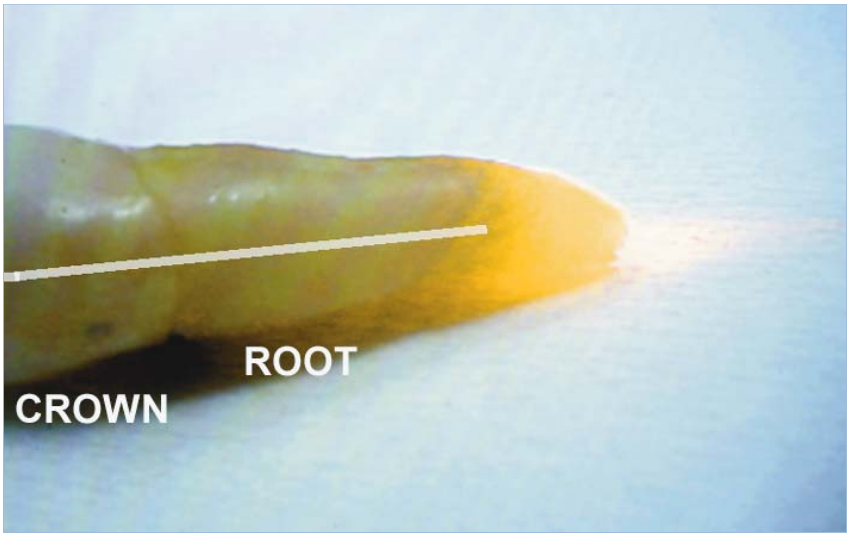

Figure 1. Laboratory example of transmission of near infrared radiation from the root canal through the radicular dentine, from an optical fiber placed in the apical third of the root canal (shown by the line). The image was captured using a conventional intra-oral camera with a zero degree lens. Note the energy blush (yellow-white) which can be seen emitting through the apical third of the root and also from the canal orifice.

Figure 2. The author's current "headgear" comprising through-the-lens loupes (Orascoptic) and a high intensity 3 watt white LED light on a headband (Heine).

patients aspects of hard and soft tissue pathology, with relevant images being "frozen" through the use of volatile memory. Motion video capture, still image capture, and high resolution colour printing are all straightforward as standards for these have become consolidated over time.

The use of solid optics (akin to those in endoscopes) for examining periodontal pockets and root canals originally seemed promising, however technical difficulties with the fragility of solid optical elements and the challenges of coaxial lighting have yet to be overcome.

An unusual feature of intra-oral cameras which many practitioners will not be familiar with is the fact that the CMOS and CCD sensors used are sensitive in the near infrared region, and can show laser and non-coherent radiation in the 700 nm - 1300 nm wavelength region which is not visible to the human eye. Laser emissions in this wavelength range include those from diode (810-830 nm, 980 nm) and Nd:YAG (1064 nm) lasers. Scatter of near infrared laser energy, and its penetration of energy through teeth and soft tissues during periodontal and endodontic disinfection procedures can be visualized using these systems (Figure 1).[2]

Magnifying loupes

Visual changes with aging (presbyopia) are a common stimulus for practitioners to consider wearing loupes, however this author believes that early use of loupes should be routine because of the benefits they provide to posture. To reduce eyestrain, a working distance (e.g. between 25 and 36 centimetres) is normally chosen.

Loupes come in a variety of mounting options (stick on, flip up, through the lens) and magnifications, with 2X - 6X being the typical range, and 2.5X the most common.

The use of loupes of either Galilean or Prismatic (Kepler) designs not only provide greater detail of the oral cavity (better, clearer vision), thereby reducing eyestrain, but do so without the need to be closer to the patient. This promotes correct upright posture by limiting the working distance, and discouraging bending the neck. This facilitates optimal ergonomic muscle balance in the neck and upper body, and enhances both productivity and safety.[3,4]

Loupes can be combined with illumination, using both local light sources (incandescent lamps, and LEDs), or distant sources (such as xenon halogen lamps) delivered by fiber optics or fluid waveguides. The advent of high intensity LEDs supplied by lightweight lithium ion batteries gives high portability (Figure 2).

Surgical operating microscopes

These represent the "gold standard" in magnification because of their flexibility and outstanding illumination of the field of view. Typical SOMs offer variable magnification (such as 3X - 30X, over 3-5 ranges). Coaxial lighting is delivered using high intensity quartz tungsten halogen lamp units (100-150W). Beam splitters allow for a second viewer (for an assistant or second operator), or the attachment of still image or motion cameras (Figures 3 and 4). The latter can, like intra-oral cameras, be viewed on LCD monitors, either for patient education, or more importantly, as a replacement for natural vision while operating. Just as we can master the skill of operating while using a mirror, so can the skill of operating using the image on a monitor be acquired with practice. Regardless of their manner of use, SOMs offer major advantages in terms of reduced visual strain and better posture.

In addition to their obvious uses in hard and soft tissue procedures, SOMs have another interesting application - the examination of instruments after reprocessing. With both hand and rotary endodontic instruments, concerns with conventional cleaning approaches have been expressed in the literature. Conventional methods typically result in bioburden remaining on

Figure 3. Typical SOM (Zeiss Pico) with video output from an internal CCD sensor and illumination supplied from a separate high intensity light source.

Figure 4. Composite video and S-video outputs from the SOM can be captured and/or displayed on a monitor.

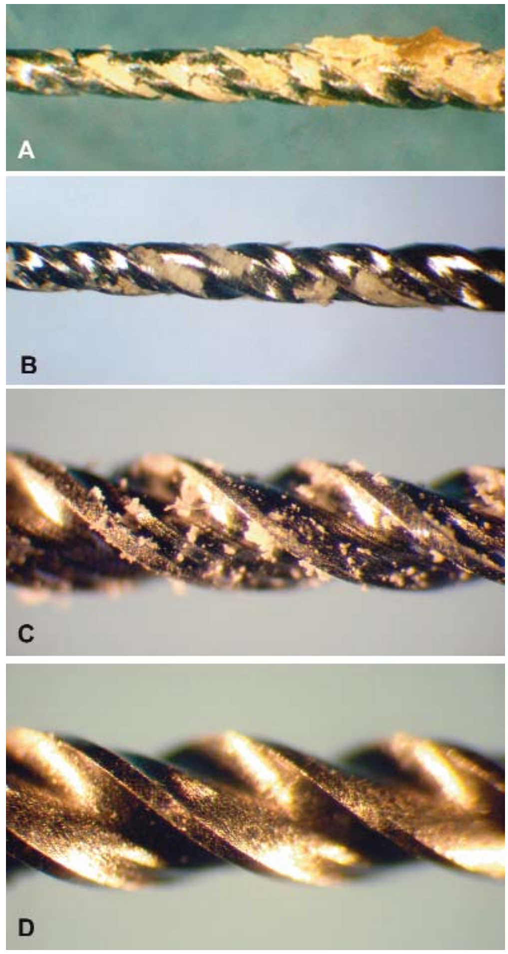

Figure 5. Examples of rotary files viewed under the SOM. A: Immediately after use. Heavy deposits are present. B: After chairside plunging through sponge ten times to remove gross contamination. C: Same file after conventional ultrasonic cleaning, without enzymatic cleaner (shown at higher magnification than A or B). Scattered debris remains. D: A second file used once at the same time as A, but processed using the "Melbourne" protocol with Empower™ enzymatic cleaning agent used prior to and during ultrasonic cleaning; no debris remains.

the surfaces of instruments after these have been through a thermal disinfector or ultrasonic cleaner (Figures 5A-C). This bioburden can readily be seen using the SOM, as can blunted edges, shiny spots, unwrapping, corrosion (such as that caused by sodium hypochlorite), and breakage. The development of effective protocols for reprocessing endodontic instruments by Parashos et al in 2004[5] provided a major advance in addressing concerns regarding bioburden. Their protocol comprises 10 vigorous strokes in a scouring sponge soaked in 0.2 per cent chlorhexidine solution, a 30 minute pre-soak in Empower™ enzymatic cleaning solution, 15 minutes ultrasonication in the same solution, and a 20 second rinse in running tap water. The protocol can be applied to all endodontic files. Use of the SOM by dentist or dental assistants for examining these instruments can be very useful when introducing the method, and for assessing the ability of new dental staff in performing it effectively (Figure 5D).

References

1. Walsh LJ. Workplace Health and Safety in Contemporary Dental Practice, Australian Dental Association (Qld), 2005, chapter 14.
2. Amyra T, Walsh LJ. An assessment of techniques for dehydrating root canals using infrared laser radiation. Aust Endodont J 2000; 26(2):78-80.
3. Friedman MJ. Magnification in a restorative dental practice: from loupes to microscopes. Compend Contin Educ Dent. 2004; 25(1): 48-55.
4. Christensen GJ. Magnification in dentistry: useful tool or another gimmick? J Am Dent Assoc. 2003;134(12):1647-1650. Available online at http://jada.ada.org/cgi/content/full/134/12/1647
5. Parashos P, Linsuwanont P, Messer HH. A cleaning protocol for rotary nickel-titanium endodontic instruments. Aust Dent J 2004; 49(1): 20-27.

CPD POINTS AVAILABLE

Continuing Education credits are available on this article for subscribers by answering the questionnaire at www.dentalpractice.com.au

About the author

Professor Laurence J. Walsh is the technology editor of Australasian Dental Practice magazine. He is also a noted commentator on and user of new technologies and is the Head of The University of Queensland School of Dentistry.