The Visible Difference®

There's More to Optical **Magnification** than Meets the Eye

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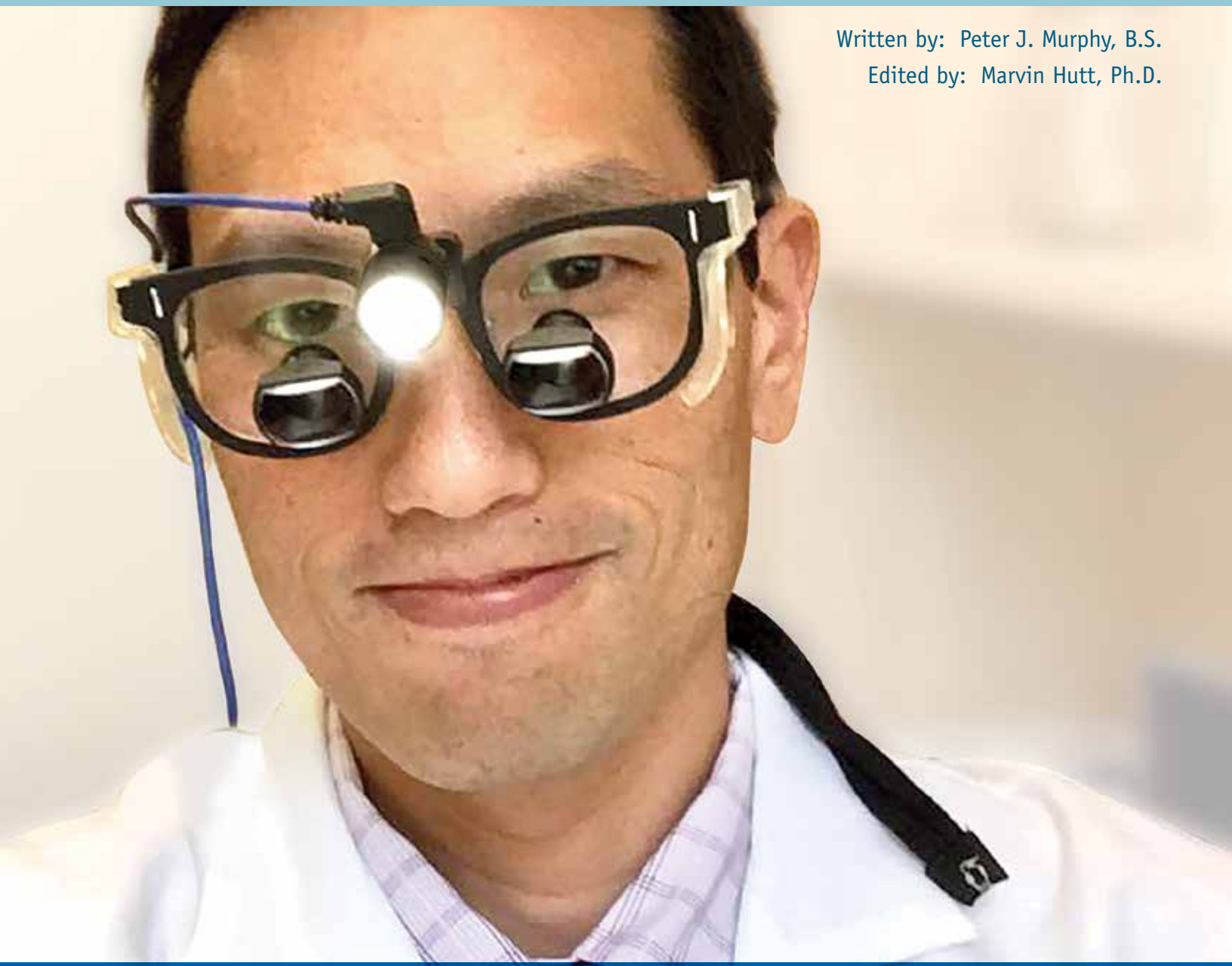

A practical guide designed to provide the dental professional with sufficient optical information to select dental telescopes that will improve visual acuity AND aid in the prevention of eyestrain, neck and lower back pain.

There's More to Optical **Magnification** than Meets the Eye

The use of magnification in dentistry can provide increased image size, which improves visual acuity and results in better patient care. However, magnification that simply increases image size is not enough. Only good magnification and illumination will help reduce eyestrain, neck and lower back pain. Good optical design is necessary to accomplish all objectives.

This guide will provide you with enough information to decide what is best for the patient and you.

In dentistry the most common occupational hazard is eyestrain. Studies show that 87% of dentists suffer from some type of eyestrain. Ninety percent of dentists will require visual assistance at some point in their practice lives.[2,3] Second to eyestrain is lower back pain, which is shared by 57% to 60% of surveyed dentists.[1,2] It is also clear that permanent relief from current lower back pain treatments is limited. In fact, no treatment is more than marginally effective.[1]

"The two conditions undoubtedly go together."[4] It is equally obvious that the emphasis must be on prevention.[5,6]

Optical design and manufacture must result in improved visual acuity. It should also help prevent eyestrain, neck and lower back pain. Unfortunately, when optical physics and physiology are ignored in telescope design, the dentist may see better results in the patient; poorly designed telescopes are contributing to eyestrain and poor posture, leading to neck and lower back pain.

Through-the-Lens Telescopes vs Flip Up Telescopes: A Comparison

In order to understand the optical physics and the differences in the two designs, we must first examine some basic optical rules.

Decentration

When a lens is edged and surfaced, it is polished to a specific optical center, matching the interpupillary distance of the practitioner the lens is surfaced for. Interpupillary distance is the distance in millimeters between the pupils of the eyes. As your eyes converge from the interpupillary distance to work at a closer point, a new interpupillary distance is established: the functional interpupillary distance. You work at two different interpupillary distances during each procedure throughout the day (see Figure 1).

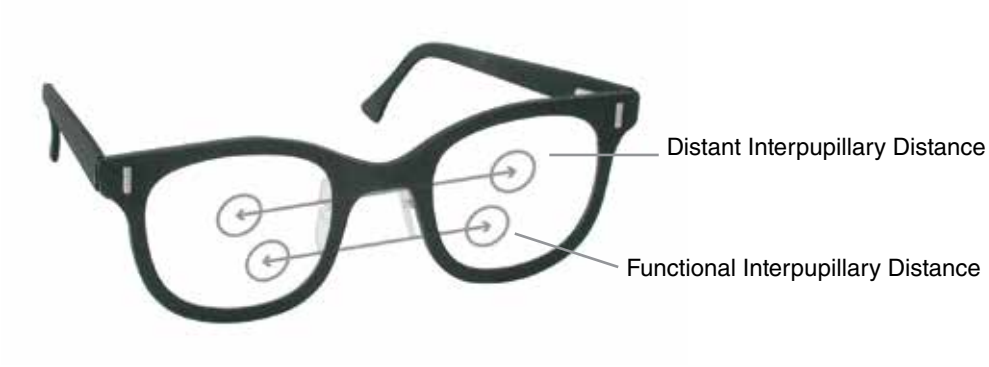

FIGURE 1

Decentration and Through-the-Lens Design

A properly designed through-the-lens system, (such as all Designs for Vision telescopes), uses four separate lenses. The carrier lenses are surfaced to your distant interpupillary distance. The telescope lenses are surfaced to your near, or functional, interpupillary distance. Consequently, you are always looking through the exact center of your prescription. Correct optical axis is assured through the permanent positioning of the telescope lenses to your exact functional interpupillary distance (see Figure 2).

FIGURE 2

Through-the-lens telescopes (properly designed and individually custom manufactured) help prevent eyestrain.

Decentration and Most Flip-Up Designs

Most flip-up telescopes use only two lenses. These telescopes are not surfaced to your functional interpupillary distance. As such, the position of the telescopes when lowered are not optically correct (see Figure 3).

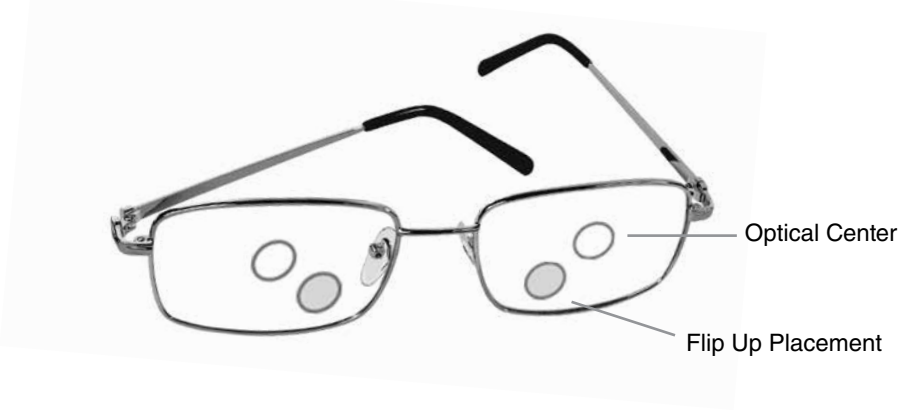

FIGURE 3

By placing the telescopes away from the optical center of the carrier lenses, you will induce prism, changing the prescription you are looking through – an obvious cause of eyestrain.

Working Distance, Depth of Field, Reflectance, and Field of View

Working Distance

There is no single, ideal working distance. Ideal working distances vary according to the individual.[7, 8, 9, 10, 11, 12] Thus, the ideal working distance built into a dental telescope should be exactly the proper ergonomic working distance for you. Any compromise in this automatically compromises your posture and may lead to eyestrain, neck and lower back pain. Sixty percent of dentists suffer lower back pain.[3]

An examination of working distance easily demonstrates this:

Working Distance Range Telescopes

Most manufacturers' telescopes (other than Designs for Vision) use a pre-set range of working distances. If your correct working distance is 14.5" and you use a telescope with a pre-set working distance range of 14" to 18"; you will either work at your normal posture of 14.5" and have a limited depth of field, or the telescope will move you unwittingly to a 16" working distance. Either position is wrong and may contribute to eyestrain and lower back pain (see Figure 4).

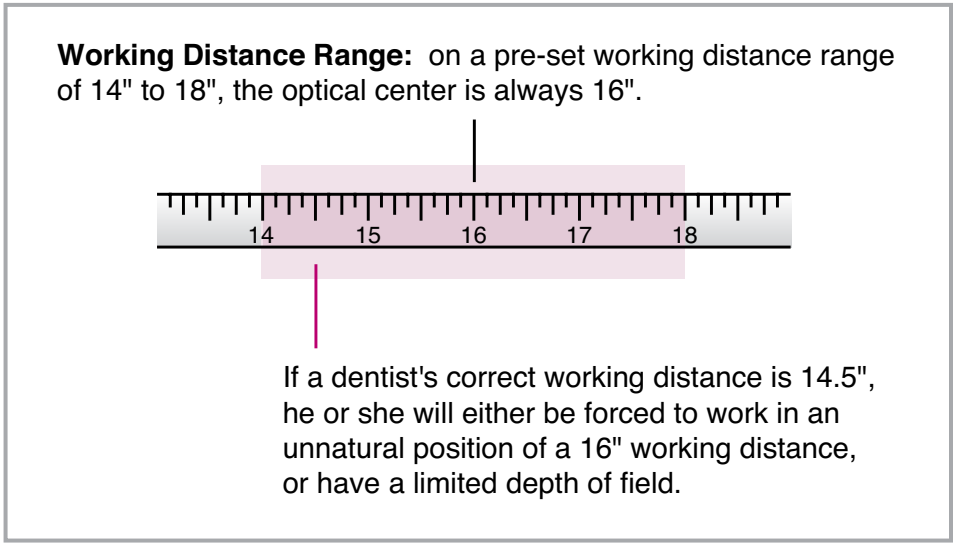

FIGURE 4
Eye Strain, Neck and Lower Back Pain are more likely to occur when your working distance is fitted into a Pre-determined Range.

Designs for Vision's Custom Working Distance

All Designs for Vision's telescopes offer a custom working distance to your exact specification. For example, if you choose a custom working distance to your exact ergonomically correct working distance of 17.5", the depth of field will center on that exact working distance (see Figure 5).

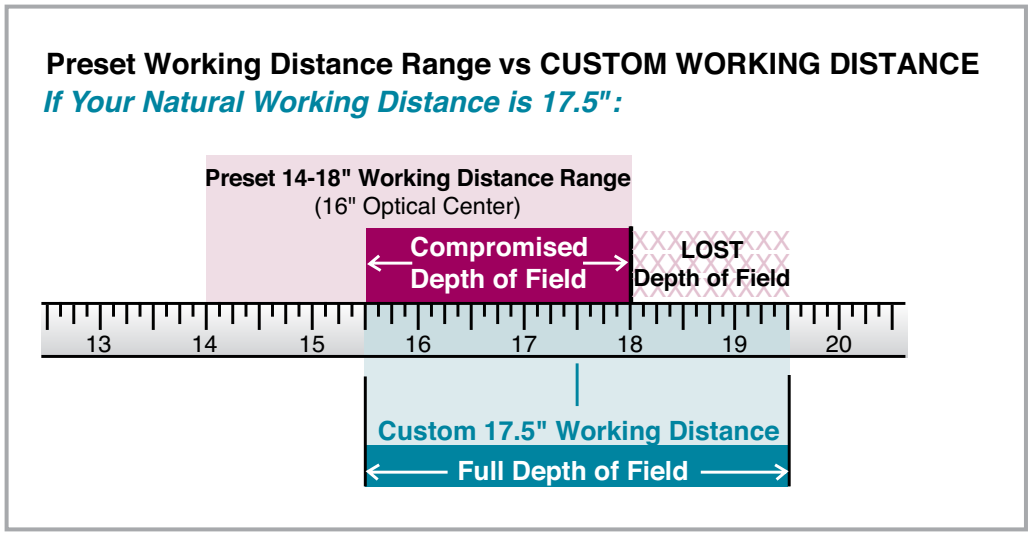

FIGURE 5

Custom working distance will add to comfort and the prevention of eyestrain, neck and lower back pain.

Depth of Field

Depth of field is the area that remains in focus when looking through a lens system. It is a function of magnification, reflectance and illumination. Simply, the lower the magnification the greater the depth of field; all other things being equal.

Reflectance

The lower the reflectance the greater the depth of field. This is mostly accomplished by anti-reflectance coatings on the lenses. Most manufacturers coat with magnesium fluoride (MgFl). As with fine 35mm cameras, only Designs for Vision uses precision multi-layer coatings of three materials:

(A) Silica (SiO2)

(B) Zirconium Dioxide (ZrO2) and Titanium Dioxide (TiO2)

Mixture

(C) Magnesium Fluoride (MgFl)

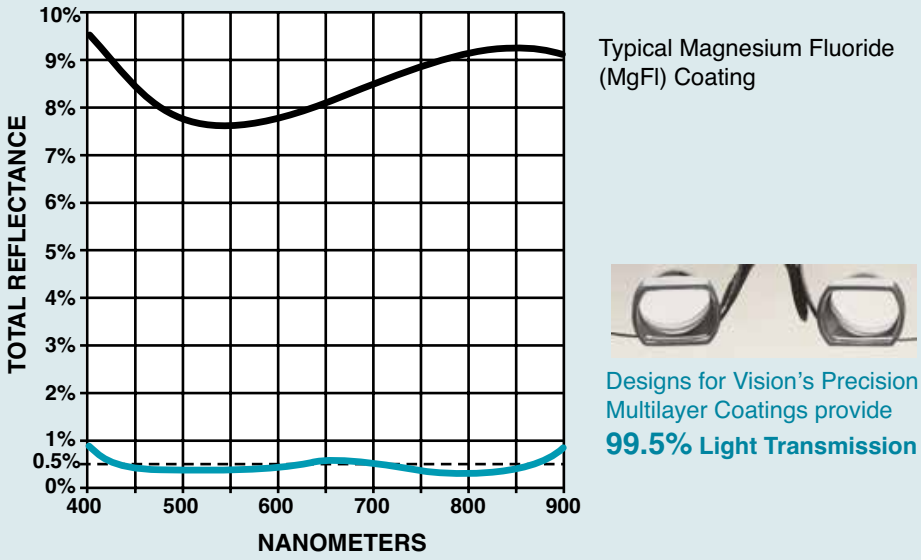

FIGURE 6:
Chemicals and independent testing by Melck (U.S.A.) and Kohno Optica (Japan)

The coating is 7-layered and vacuum evaporated in the following order:

(A) + (B) + (A) + (B) + (A) + (B) + (C)

Evaporation time and temperatures used are 'company confidential' and not disclosed.

The result of this precision multi-layered coating is a total reflectance curve sheet that is less than 0.5% and will withstand heat of 375°C (see Figure 6).

The lower the reflectance, the better the visual acuity and depth of field, given the same magnification and illumination. A manufacturer to state that 'our lenses are coated' is simply not enough, particularly when patient care is involved.

Field of View

Field of view covers the entire area seen through a lens system. The larger the field of view, the more easily your eye moves through the field in a natural way. It is determined by the type of telescope system (Galilean or Keplerian), the magnification, distance of the eye lens from the eye, and the size of the system.

Galilean vs Keplerian: A Galilean system (e.g. Designs for Vision's Standard Field Telescopes) is always a positive objective lens (usually a doublet) and a negative eye lens. It is lighter in weight than a Keplerian system.

A Keplerian system (e.g. Designs for Vision's Expanded Field Telescopes) is always a positive objective lens with an erecting prism and a positive eye lens. It is a larger system, yet it permits a wider field of view and higher magnifications.

Magnification: The higher the magnification the smaller the field of view.

Distance of Eye Lens from the Eye: The closer the eye lens to the eye, the greater the field of view (stand away from a window, then move closer and note the increase in the field of view). Thus, given the same magnification, a through-the-lens telescope will always provide a greater field of view, as the eye lens is always closer to the pupil of the eye.

Size of the System: The only way optical science can increase field of view is to increase the size of the system, given the same magnification. This is a trade-off. You must balance the acceptable field of view against an acceptable weight and size of the system and its application.

A system that is too heavy or that you cannot see around without the risk of infection is poorly designed.

Caveat Emptor –
If the manufacturer claims greater depth of field and field of view in the comparison of like telescopes under the same illumination, check the magnification! (In linear magnification, 4 diopters always = 1X, 8 diopters = 2X, etc. To state that 5 diopters approximately = 2X is simply incorrect.)

The best way to assess the magnification is to simply compare for yourself, looking at like objects.

Angulation and Alignment

Angulation and alignment must be custom fit and permanently positioned to allow ergonomically correct posture which aids in the prevention of neck and back strain. Proper angulation and alignment are essential to align the optical axis of the carrier (or prescription lens) to the optical axis of the telescope, which must align to the visual axis of the eye. This helps prevent eyestrain.

Figure 7 explains the differences in angulation and alignment between through-the-lens and most flip-ups.

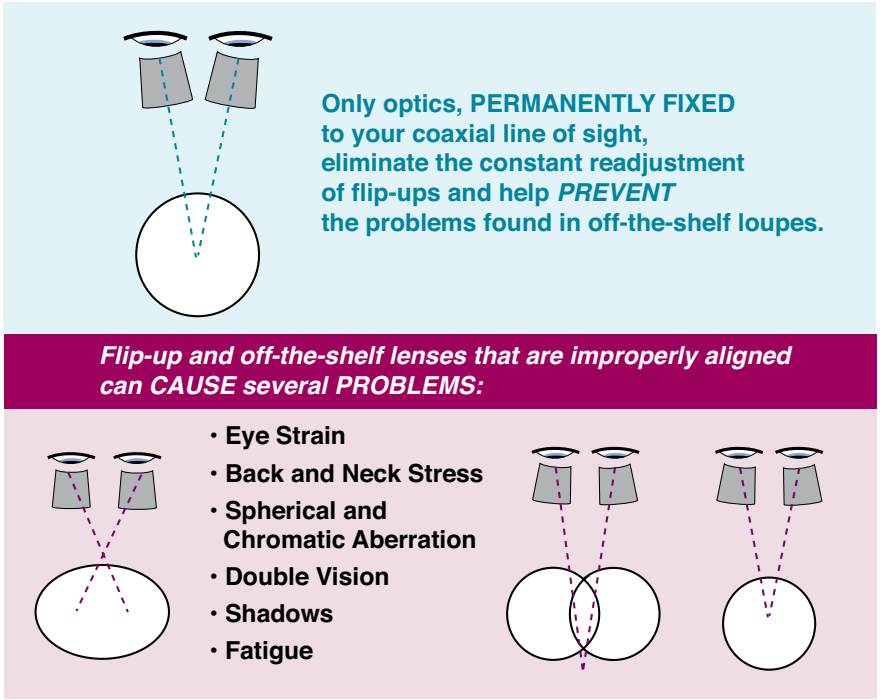

FIGURE 7
Only Designs for Vision's custom manufactured through-the-lens telescopes overcome the problems inherent in off-the-shelf and flip-up designs.

Eyeglass Prescription and Telescopic Magnification

In fixed lens magnification, when your eyeglass prescription requires change or presbyopia requires a bifocal prescription, your glasses are returned to the manufacturer to ensure that the four new lenses conform exactly to your ergonomically correct working distance, angulation, and alignment. Thus, the custom made telescopes you use after the prescription change or addition conforms exactly to the telescopes you used before the change.

A major disadvantage of most flip-up telescopes occurs when your prescription changes, which changes the working distance of the telescope and increases the amount of induced prism. You must now adjust to a new working distance and additional eyestrain. (In fact, one manufacturer actually warns the optical professional that bifocal strength "MUST NOT" be overly strong, and should be set for a normal 40 cm (15"-16") reading distance).

This manufacturer realizes the problems with single lenses behind flip-up telescopes and tries to compensate for the negative effect by changing your necessary and proper prescription. This only leads to increased eye strain.

Infection Control

Fixed, Through-the-Lens Telescopes:

These offer the safest method of infection control.

The telescopes are disinfected with alcohol (Isopropyl Alcohol 70% by volume). They are positioned on your head. You then glove. The telescopes are left in place throughout the procedure. They are light enough and easy to see around if need be. At completion of the procedure, you remove and dispose the gloves. Lastly, place the telescopes on your chest for a face to face consultation with the patient without telescopes and mounting apparatus interfering.

Flip-Up Telescopes:

Cross contamination occurs as soon as you touch the telescopes during a procedure. This is especially dangerous if the telescopes are not disinfected between patients. You should re-glove each time you raise or lower the flip-up telescopes.

Additional Discussion

In selecting a magnification level, it is best to select the level of magnification that enables you to work effectively and comfortably. Designs for Vision's records indicate that the most popular magnifications in Dentistry are 2.5X and 3.5X.

Illumination is an important additional factor. Greater illumination increases both depth of field and visual acuity. LED illumination is recommended.

If the telescopes you are evaluating take several days to a week or more to become accustomed to, you are probably compensating for your telescope as opposed to having them work for you. This, as previously explained can lead to eyestrain, neck and lower back pain.

Magnifying your procedure will certainly provide a better result for the patient. Be certain your choice of telescopes provides a better result for you.

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About the Author

Peter J. Murphy, B.S. (1939 - 2015) was C.O.O. and co-owner of Designs for Vision, Inc., an optical design company specializing in optics and fiberoptics. Mr. Murphy is the holder of a number of optical patents. Designs for Vision, Inc. designs and manufactures for the Partially Sighted, Dentistry, Surgery, Night Vision (I.T.T.), M.R.I. Camera Optics (Hitachi Corp.) and a number of O.E.M. optical designs.

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