SurgiTel®

presents:

Declination Angle as the Key Ergonomic Factor

Key Factors for Ordering Custom Loupes: Part 1

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Definition of Declination Angle and Its Ergonomic Role

SurgiTel recognized the importance of the declination angle of loupes as the key ergonomic factor and invented flip-up style ergonomic loupes with adjustable declination angle option in 1993. Since then SurgiTel developed a family of custom loupes. Today SurgiTel offers a wide range of ergonomic loupes (2.5x to 8.0x) for various clinical applications.

The declination angle of loupes is defined as the angle between the reference line which connects the top of ears (at which frame arm rests) to the corner of eyes and the optical axis of loupe oculars (Figure 1). (Temple arms may be used as the reference line if the temple arms are mounted at the same level with eyes, but the arms of some frames are higher than eye level.)

If loupes with small declination angles force users to tilt their heads excessively, it will eventually cause significant pain in the neck, shoulders, and upper back. To prevent work-related pain and injuries, the declination angle of loupes should support a comfortable and ergonomic neck posture. The maximum head tilt recommended by ergonomic professionals is less than 20 degrees. This has been experimentally determined by measuring muscle fatigue of the neck as a function of head tilt angle.\(^1\)\(^,\)\(^2\) If you want to avoid potential chronic pain and injury you should know your personal optimum declination angle for your custom loupes.

To purchase loupes that are ergonomically built you will need to determine the two major inputs for customization: the working distance you want and the declination angle you need to avoid chronic pain and injury. It is relatively easy to determine working distance, but it is not easy for most clinicians to decide the optimum declination angle because there have been no clear guidelines to help.

Determining Optimum Declination Angle for Your Next Custom Loupes

The declination angle of your custom loupes should be equal to the downward rotation angle of your eyes which is required to see a target at your Operating Hand Position (OHP). To find the OHP, you should sit in balance on your operating chair (remove prescription or safety glasses) (or stand in balance) and then, without considering any visuals, bring your hands to your most balanced, relaxed operating position. You may confirm your OHP with a patient or someone in your office.

To find the maximum rotation angle of your eyes you will sit straight up (i.e. no forward tilt of your back) with neutral neck posture (i.e. no head tilt). Then you can find the maximum downward rotation angle of your eyes by measuring body posture angle and reference line angle (Figure 1):

\[
\text{Max Rotation Angle} = 90^\circ - \text{BPA} - \text{RLA}
\]

Where BPA = Body Posture Angle and RLA = Reference Line Angle.
A neutral neck posture can be found by tilting your head forward and backward several times and stopping at the most comfortable neck position. Taking a neutral posture photo will show both your OHP and neck posture. From this neutral posture photo you can measure body posture angle, reference line angle, and maximum rotation angle of eyes required to see your OHP. For the person in Figure 1, the posture angle is 25 degrees and the reference line angle is 12 degrees so the maximum rotation angle of your eyes required to see the OHP will be 53 degrees. In this position there is no head tilt (HTA=0 degrees). If you bring your OHP forward, the body posture angle will increase and the required maximum rotation angle of your eyes will decrease.

To find the minimum rotation angle of your eyes, you have to find your maximum head tilt angle at which you do not feel any noticeable neck strain. Maintaining your OHP, start to tilt your head forward until you start to feel neck strain. Then tilt your head back until you do not feel neck strain.

Repeat this process a few times to find your maximum comfortable head tilt angle, which is usually less than 20 degrees. Then measure head tilt angle, rotation angle of eyes to see the OHP, and posture angle.

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\text{Min Rotation Angle} = 90° - \text{BPA} - \text{RLA} - \text{HTA}
\]

Where HTA = Head Title Angle.

The reference line angle may be unique to each person. The posture angle will be smaller as the head tilt angle increases. For the person in Figure 2, the posture angle is 23 degrees and the reference line angle 12 degrees, and his head tilt angle is 20 degrees. So the minimum rotation angle of this eyes to avoid the strain in his neck will be 35 degrees.

Knowing required minimum and maximum rotation angles of your eyes, you are ready to decide your optimum declination angle of your next custom through-the-lens (TTL) loupes. The optimum declination angle of the person in Figure 1 & 2 will
be between 35 and 53 degrees. If you want to choose an angle larger than the minimum rotation angle for your eyes for your ergonomic posture as the optimum declination angle, you should find the maximum downward rotation of your eyes which do not create significant strain in your eye muscles. Note that you may increase the maximum limit of rotation of your eyes by continued practice.

If you do not want to guess the declination angle of your custom TTL loupes, you may try a front-lens-mounted (FLM) loupes with the adjustable declination angle option. Many clinicians are very happy with SurgiTel ergonomic FLM loupes with the adjustable declination angle option. Once you find your optimum declination angle, you can order your true custom TTL loupes and keep your FLM loupes as a your back-up or you may refurbish it for one of your dental team members.

**Determining Declination Angle of Your Current Loupes and Your Head Tilt Angle**

Following similar steps shown for determining your optimum declination angle, you can measure the declination angle of your current loupes and your head tilt.

To find the declination angle of your current loupes and your head tilt angle which allows you to see your OHP, first you should find your OHP and neutral posture (Figure 1). Removing your loupe and sitting in balance (no forward tilt of your back) on your operating seat (or stand in balance) with neutral neck posture, you bring your hands to your most balanced, relaxed operating position. You may confirm your OHP with a patient or someone in your office. Take a neutral posture photo which shows the neutral posture of your neck and your OHP. From this photo you can establish the reference line to measure your head tilt angle.

Now wear your loupe and tilt your head until the field of view is centered around your OHP and take a photo (Figure 3). This is your operating posture with your current loupe. Using this operating posture photo with your current loupe and the neutral posture photo taken earlier, you can measure the declination angle of your current loupe and body posture angle. Then you can compute your head tilt angle using the reference line angle measured with the neutral posture photo. The reference line angle will be a unique value for each individual.

For a quick study, we will compare two popular traditional TTL loupes to SurgiTel TTL & FLM loupes. We will compare their declination angles and the head tilt angles of the user by taking photos of both neutral posture and operating posture (Figure 4, next page).

The declination of the traditional TTL loupe #1 is 24 degrees and the head tilt angle of the user is 33 degrees. The declination of the traditional TTL loupe #2 is 22 degrees and the head tilt angle of the user is 36 degrees. The declination angle of SurgiTel TTL loupe is 35 degrees and the head tilt angle of the user is 20 degrees. The declination angle of SurgiTel FLM loupe is 45 degrees and the head tilt angle of the user is only 9 degrees.
Figure 4

(a) Operating posture with Designs for Vision TTL

(b) Operating posture with Orascoptic TTL

(c) Operating posture with SurgiTel TTL loupe

(d) Operating posture with SurgiTel FLM loupe
The head tilt angles with both traditional TTL loupes are significantly larger than the recommended head tilt angle of 20 degrees. The head tilt angle with SurgiTel’s standard TTL loupe (35 degree declination angle) is 20 degrees. Recently, SurgiTel has invented an assembly method to make TTL loupes with even larger declination angles to up to 45 or 50 degrees. (The maximum declination angle of SurgiTel TTL loupes will vary according to frame type and facial features.)

If your head tilt angle is significantly larger than 20 degrees with your current loupes and you may have been experiencing pain or strain in your neck, shoulders, and upper back, you should consider a new loupe built with your optimum declination angle. You may also work with an ergonomic consultant. Both Bethany Valachi and Tom Caruso, who have been lecturing on Dental Ergonomics, offer individual consulting. The question to ask is: Can chronic pain in neck, shoulders, and upper back be eliminated by switching to loupes with your optimum declination angle? The answer is “yes,” for most cases. However, working non-ergonomically with a non-ergonomic loupe for too long could cause enough injury to require surgery. At this point, ergonomic loupes may only alleviate pain. Never let non-ergonomic loupes take you this far!

For more information, read the companion paper: Can Chronic Neck Pain Be Eliminated or Healed?

References

