Weight Measurement of Upper Eyelid Gold Implants for Lagophthalmos in Facial Paralysis

Bernardo Hontanilla, M.D., Ph.D.
Pamplona, Spain

The use of the gold weight is an established procedure in the treatment of lagophthalmos and usually produces successful results. The critical technical issues are the firm suture fixation to the tarsal plate and the high location of the weight on this plate. However, the estimated weight of the implant from the trials on the skin of the upper lid fails to obtain the expected eye closure outcomes after surgical implantation on the tarsal plate. One of the main reasons could be the different curvature on the skin and on the tarsal plate of the upper eyelid. In this study, the angles between the vertical line and the surface of the outer (skin) and inner (tarsal plate) part of the upper eyelid have been analyzed when the eye is opened and closed. The results show that an addition of 0.2 g to the gold weight estimated in the trial is required to achieve a similar closure of the eye by means of the gold implant on the tarsal plate. (Plast. Reconstr. Surg. 108: 1539, 2001.)

Gold eyelid implants are designed for the gravity assisted treatment of the functional defects of lagophthalmos resulting from facial paralysis. Placing a weight on the upper eyelid to increase the effects of gravity to close the upper eyelid is a very useful procedure for the patient with eye symptoms resulting from exposure and drying of the cornea. This surgical procedure has been established as a treatment for lagophthalmos. However, various problems beset this technique, even though it frequently provides adequate symptom relief. For aesthetic purposes, the gold weight should not be visible when the eye is open. If the portion of the upper eyelid containing the tarsal plate is not exposed when the eye is open, the bulge of the weight will not be visible, giving pleasant aesthetic results. Nevertheless, the placement of the gold weight close to the border of the upper eyelid favors better closure of the eye despite worse aesthetic results and frequent extrusion of the implant. The optimum weight is selected by attaching a trial gold weight or a sizing weight to the upper eyelid of the patient with an adhesive tape and observing the eyelid closure. The minimum weight that will bring the upper lid within 2 to 4 mm of the lower lid should be chosen. However, in almost 30 percent of cases, the choice of the gold weight implant is inappropriate to cause the closure of the eye after its definite placement on the tarsal plate. The reason could be the high position of the gold weight on the tarsal plate. This placement implies a different angle between the vertical line and the axis of the weight when it is placed on the outside of the skin of the upper eyelid (as performed in the trial) as opposed to being placed inside on the tarsal plate (final location after surgery). These two different outcomes might be caused by the different anatomical angles that influence the force acting on the weight in the upper eyelid when the head of the patient is in a vertical position (Fig. 1, left).

In this study, we tried to demonstrate the weight of the gold implant required to obtain the adequate closure of the eyelid from the estimated results in the trials before surgery.

MATERIALS AND METHODS

First, with the aim of analyzing the size of the angles, lateral photographs of the eyeball, including the eyelids, of normal people were taken, and two points in the inner and outer portion of the upper eyelid were determined (Fig. 2, above). These two points are located on the skin 5 mm above the free border of the upper eyelid and the tarsal plate and represent...
the location of the implant before and after surgery, respectively. The vertical line and the line through the outer point on the skin are usually parallel when the eye is closed. The inner point on the tarsal plate forms an angle with the vertical line that is determined by the

Fig. 1. (Left) A schematic drawing of the different forces that act over the upper eyelid after the gold weight is placed on the surface of the skin or on the tarsal plate. (Right) Figure shows a lateral view of the lids and eyeball in a fresh specimen. Note the different angles formed after placing the implant outside on the skin or inside on the tarsal plate when the eye is closed.

Fig. 2. (Above) Photographs showing the different angles formed with respect to the vertical axis when the gold implant is placed on the skin or on the tarsal plate with an open and closed eye, respectively. (Below) Magnetic resonance images showing two lateral views of eyeballs in normal people in which the different angles are illustrated after the weight is placed on the skin and on the tarsal plate.
tangential line at this point in relation to the eyeball when the eye is open and closed (Fig. 1, right and Fig. 2, above). To obtain an accurate measurement of the angles, magnetic resonance image sagittal planes (0.2 T, Siemens Inc.) of the eyeball, including the eyelids, of normal people ranging from 17 to 78 years old ($n = 60$) were used (Fig. 2, below).

The force of an object falling obeys the following formula: $mg$ (in which $m$ is the mass and $g$ is the gravity). If an object falls at an angle, the formula is as follows: $mg \cos \alpha$ (Fig. 1, left). If we match both forces when the upper eyelid falls with the gold weight on the skin surface in the trial and on the tarsal plate after the surgery, the formula is as follows: $m_1 g \cos \alpha = m_2 g \cos \beta$, in which $m_1$ is the weight of the gold implant located in the tarsal plate, $\alpha$ is the angle between the vertical axis and the implant on the tarsal plate, $m_2$ is the estimation of the implant weight placed on the surface of the upper eyelid from the trial, and $\beta$ is the angle between the vertical line and the weight located on the surface of the upper eyelid. Then, $m_1 = m_2 \frac{\cos \beta}{\cos \alpha}$.

Thus, the weight of the gold implant to be finally placed on the tarsal plate must be the weight of the implant placed on the upper lid multiplied by the ratio between the cosine of both angles. We applied an overdosage gold weight on the tarsal plate in 15 patients according to the data shown in Table I.

### TABLE I
Weights of the Gold Implants

<table>
<thead>
<tr>
<th>Estimated Weight of the Implant on the Skin (g)</th>
<th>Final Weight of the Implant on the Tarsal Plate (g)</th>
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<td>0.8</td>
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<tr>
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<tr>
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<td>2.30</td>
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</table>

RESULTS

The angle between a tangential line to a point located 5 mm high on the surface of the upper eyelid and the vertical line when the

![Image](image_url)

**Fig. 3.** This figure shows a patient presenting a right-side facial paralysis with the eyes open (above, left) and closed (above, right). (Center, left) A 1.2-g gold weight was placed on the surface of the skin of the right upper eyelid. (Center, right) Closure of the eyes with the 1.2-g gold weight. Note the correct closure of the right upper eyelid. The same patient is shown 2 weeks postoperatively with a 1.4-g gold weight on the tarsal plate with the eyes open (below, left) and closed (below, right).
eyelid is open is $22 \pm 1$ degrees ($n = 60$), and the angle between the tarsal plate and the vertical line is $40 \pm 1$ degrees ($n = 60$) (Fig. 2, above, left, and below, left). There are not statistically significant differences in the angles between age and sex. The average of the ratio between the cosine of both angles is $1.152 \pm 0.012$. The angle between a tangent to a point located 5 mm high in the surface of the skin of the upper lid and the vertical line when the eyelid is closed is $0 \pm 1$ degrees ($n = 60$), and the angle between the tarsal plate and the vertical line is $18 \pm 1$ degrees ($n = 60$) (Fig. 2, above, right, and below, right). There are not statistically significant differences in the angles between age and sex. The ratio average between the cosine of both angles is $1.051 \pm 0.011$.

Thus, 1.152 is the constant used. The estimated implant weight after the trial on the skin of the upper eyelid is multiplied by this constant to calculate the weight of the implant to place on the tarsal plate (see the formula shown before). The estimated weights of the gold implant to produce optimum eye closure and the weights required to achieve the same eye closure when the implant is placed on the tarsal plate are shown in Table I.

**DISCUSSION**

The choice of the optimum weight placed on the patient’s upper eyelid through the fixation of a trial gold weight or a sizing weight with an adhesive tape is evaluated by observing eyelid closure. The smallest weight which will provide good covering of the cornea should be used because large weights are more likely to migrate. As suggested by Manktelow, the minimum weight that will bring the upper lid within 2 to 4 mm of the lower lid should be chosen. It has been emphasized, however, that an underdosage gold weight implant is chosen to produce the same closure of the eye when it is finally placed on the tarsal plate in almost the 30 percent of cases. Compared with the speed of the normal blink reflex, the eye closure that is produced by the gold weight is very slow. To make the weight work, it is required that the patient should close the eyes and keep them closed for 1 or 2 seconds to give time for the lid to descend. Moreover, the same gold weight selected often results in a delayed eye closure when it is placed on the tarsal plate as opposed to the surface of the skin of the upper eyelid. Given the high position of the gold weight on the tarsal plate, the reason could be the different angle formed between the vertical line and the axis of the weight when it is placed on the skin of the upper eyelid (as performed in the trial) and when it is placed inside on the tarsal plate (final location after surgery). These distinct effects are presumably caused by the different angles that influence the force acting over the upper lid when the head of the patient is in a vertical position. According to the results observed in this study, the value of the angle between the vertical line and the gold implant on the superficial eyelid skin is 22 degrees when the eye is open and 0 degrees when it is closed. However, these results are 40 and 18 degrees, respectively, for the angle between the
This variation leads to a different overall force acting on the eyelid when the gold implant is placed on the surface of the skin or on the tarsal plate. Thus, as previously mentioned, a constant must be multiplied by the mass of the implant estimated in the trial to achieve the same closure of the eye after the final location of the gold implant (Table I). Although skin laxity during taping may alter the effect of the weight on lid closure, it is not affected when the gold weight chosen is placed on the tarsal plate in cases in which no skin recession is needed or no elevation of the eyebrow is performed. If it were the case, it should be necessary to add to the gold implant the weight of the skin resected (Fig. 3). Moreover, care should be taken when the eyebrow is lifted because some quantity of skin is repositioned out of the upper eyelid, and it is necessary to test preoperatively the action of the gold weight carrying out the elevation of the eyebrow with the finger. However, recession of the levator muscle should be considered at surgery to avoid the possibility of postoperative ptosis of the upper eyelid. Thus, mild ptosis is present in four patients of our series after placing a heavier gold weight. Anyway, according to the results presented in this study, a gold weight implant 0.2 g heavier than expected should be chosen to obtain better eye closure in terms of quantity and time of closure for lagophthalmos in facial paralysis. Therefore, if a 1.2-g implant results in eyelid closure in the trial, one should use a 1.4-g implant to obtain the best results. In 15 patients, we obtained satisfactory results following the conclusions presented in this study (Fig. 4).

REFERENCES