Clinical Research

# Efficacy and safety of platinum chain and gold weight implants for paralytic lagophthalmos: a systematic review

Yunia Irawati,[1,2] Tjahjono Darminto Gondhowiardjo,[1,2] Hardyanto Soebono[3]



pISSN: 0853-1773 • eISSN: 2252-8083
https://doi.org/10.13181/mji.oa.214683
**Med J Indones. 2021;30:106–15**

**Received:** May 9, 2020
**Accepted:** January 21, 2021

**Authors' affiliations:**
*[1]Department of Ophthalmology, Faculty of Medicine, Universitas Indonesia, Cipto Mangunkusumo Hospital, Jakarta, Indonesia, [2]JEC Eye Hospitals and Clinics, Jakarta, Indonesia, [3]Department of Dermatovenereology, Faculty of Medicine, Public Health and Nursing, Universitas Gadjah Mada, Dr. Sardjito Central General Hospital, Yogyakarta, Indonesia*

**Corresponding author:**
Yunia Irawati
Department of Ophthalmology, Faculty of Medicine, Universitas Indonesia, Cipto Mangunkusumo Hospital, Jalan Kimia No. 8, Central Jakarta 10430, DKI Jakarta, Indonesia
Tel/Fax: +62-21-31902885
**E-mail:** yunia_irawati@yahoo.com

**ABSTRACT**

**BACKGROUND** Surgery has been proposed as a treatment of paralytic lagophthalmos. However, no consensus has been reached on the best treatment. This study was aimed to investigate the efficacy and safety between platinum chain and gold weight implants to treat paralytic lagophthalmos.

**METHODS** This study used all randomized controlled trials or observational studies (prospective or retrospective) using platinum chain and gold weight implants for paralytic lagophthalmos surgery that were published from 1990 to 2020 in the PubMed, Cochrane, and Google Scholar databases. Efficacy was indicated by the reduction of ≥3 in lagophthalmos, and safety was measured based on complications after surgery.

**RESULTS** The efficacy of platinum chain and gold weight implants were 60–100% and 10–93.6%, respectively. The complications of platinum chain implant were 0–2.9% of extrusion and 0–3.3% of migration. However, gold weight implant had 0–13.3% of migration.

**CONCLUSIONS** Both platinum chain and gold weight implants have similar efficacy to treat paralytic lagophthalmos. However, gold weight implant has a higher rate of complication.

**KEYWORDS** paralytic lagophthalmus, prostheses and implants, surgical techniques

Normal eyelid closure and blink reflex are important to maintain a stable tear film and healthy corneal surface. Lagophthalmos is a term to describe the condition of incomplete or defective closure of the eyelids, causing corneal exposure and excessive evaporation of the tear film. Types of lagophthalmos include facial nerve paralysis (paralytic lagophthalmos), post-trauma or surgery condition (cicatricial lagophthalmos), and during sleep (nocturnal lagophthalmos). Studies have revealed several causes of lagophthalmos, including Bell's palsy, secondary to trauma, infections, and tumors. Management of lagophthalmos is targeted to prevent keratitis, re-establish normal eyelid function, and regain a cosmetically acceptable appearance.[1]

Paralytic lagophthalmos is treated using a conservative or surgical approach. The surgical approach is recommended for patients who are have a high risk complications from a long-term therapy of conservative approach (i.e. ophthalmic ointment and eyelid taping).[2] Certain surgical techniques have been proposed as a definitive treatment of paralytic lagophthalmos, including the placement of an upper eyelid weight implant (lid loading), permanent tarsorrhaphy, palpebral spring, temporalis muscle transfer (TMT), and lower eyelid support (i.e. lateral tarsal strip and medial canthoplasty).[3,4]

Some literature had reported surgical techniques and implant insertion in treating paralytic lagophthalmos yet no consensus has emerged.[5]

Therefore, this study was aimed to evaluate the efficacy and safety of platinum chain and gold weight implants in managing paralytic lagophthalmos.

## METHODS

This systematic review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines. The literature search was conducted in the online databases of PubMed, Cochrane, and Google Scholar for articles published between 1990 and 2020 with an exhaustive list of keywords, which were "paralytic lagophthalmos", "platinum chain implant", or "gold weight implant". After entering the keywords, all full-text articles were screened by reviewing the abstracts to select relevant articles. Subsequently, those articles were screened based on the inclusion and exclusion criteria. Randomized controlled trials and observational studies (cross-sectional, prospective, or retrospective) reporting platinum chain and gold weight implants surgery for paralytic lagophthalmos patients were included. Furthermore, only articles written in English and full-text access were included in the final analysis. Levels of evidence IV and V (Oxford Centre for Evidence-Based Medicine 2011), such as case series, case controls, letters, comments, editorials, and mechanism-based reasoning, were excluded. YI and TDG completed the literature search independently. In addition, these two reviewers further cross-checked the reference lists of all selected articles to identify other relevant studies. The discrepancies were resolved by discussion. The reference lists of the included studies were also checked for the potentially relevant articles. We did not contact the authors of the eligible studies for additional data.

The primary outcomes were the changes in lagophthalmos (reduction ≥3 mm) and complications after surgery. The secondary outcomes were the improvement of visual acuity, resolution of keratitis, and tearing. For each study, the following information was extracted and written in Table 2: (1) surname of the first author, (2) year of publication, (3) study design, (4) level of evidence, (5) number of subjects included in the analysis, (6) age range of subjects included in the studies, (7) etiology of lagophthalmos, (8) type of treatment, (9) changes in lagophthalmos, (10) resolution of keratitis, (11) resolution of tearing, (12) improvement of visual acuity, (13) bulging of implant, (14) implant extrusion and migration, and (15) occurrence of ptosis.

## RESULTS

The total initial search yielded 73 articles. After the duplicate articles were removed, the remaining 72 were reviewed, and a total of 25 studies of potentially relevant studies were further identified in full-text. The flowchart of the study selection is summarized in Figure 1.

The characteristics of all paralytic lagophthalmos patients from 25 studies are shown in Table 1. There were 968 patients (989 eyes) with 947 unilateral and 21 bilateral cases with various follow-up times ranging from 2 months to 5 years. The most common etiology for paralytic lagophthalmos was the presence of a tumor. Acoustic neuroma was the most common tumor causing nerve palsy, followed by parotid tumor, cholesteatoma, malignant melanoma, parotid cancer, temporal bone cancer, and glomus tumor.

The gold weight implant was the most commonly used technique by surgeons (75.6%), whereas the platinum chain implant was the second most preferred treatment. In some conditions, the surgeons preferred to combine the lid loading technique with several eyelid surgery techniques, such as TMT, tarsorrhaphy, levator aponeurosis recession, lateral canthopexy, or palpebral spring, to achieve the desired outcome.

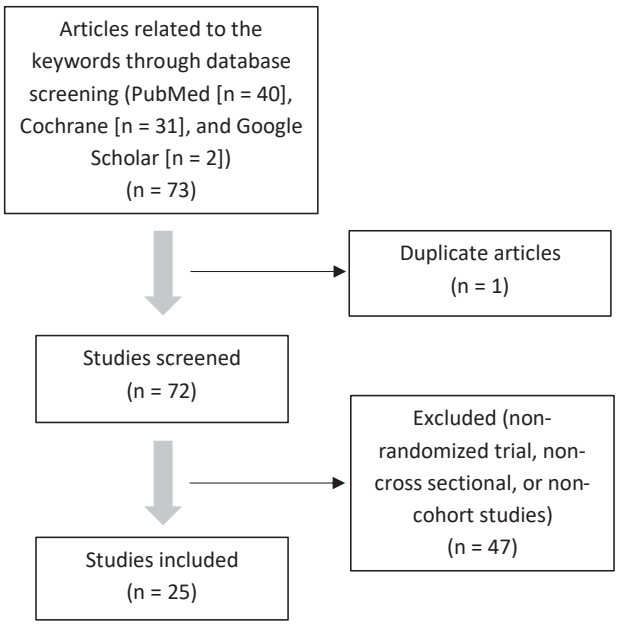


**Figure 1.** Flowchart of the study selection process

**Table 1.** Characteristics of the total population

| Characteristics | N = 968 patients (989 eyes) |
|---|---|
| Age (years), min–max | 8–90 |
| Follow-up (months), min–max | 2–60 |
| Eyes involvement | |
| Unilateral cases | 947 |
| Bilateral cases | 21 |
| Etiology (n = 968 patients) | |
| Tumor | 402 |
| Bell's palsy | 30 |
| Idiopathic | 15 |
| Others* | 166 |
| NA | 355 |
| Type of surgery (n = 989 eyes) | |
| Lid loading | |
| Gold weight implant | 413 |
| Platinum chain implant | 241 |
| Combination lid loading + eyelid surgery | |
| Gold weight + temporalis muscle transfer | 130 |
| Gold weight + tarsorrhaphy | 63 |
| Gold weight + levator aponeurosis | 54 |
| Gold weight + lateral canthopexy | 49 |
| Gold weight + palpebral spring | 39 |

NA=not available
*Other etiological conditions such as Hansen's disease, trauma, herpes zoster, vascular, infection, iatrogenic, and congenital

**The efficacy of lid loading technique (platinum chain *versus* gold weight implants)**

The reviewed studies showed that paralytic lagophthalmos was measured prior to surgery and at a follow-up after surgery. Three studies reported that the efficacy of platinum chain implant was 90–100%.[6–8] Meanwhile, nine studies reported that the efficacy of gold weight implant was ranged from 10–93.6%, and the lowest efficacy of gold weight implant (10%) was found from a study by Ueda et al.[9] One study reported that several combination techniques, such as gold weight implant coupled with levator aponeurosis, lateral tarsal strip with temporal permanent tarsorrhaphy, and suspension of the lateral tarsoconjunctival flap, were 100% effective.

**Resolution of keratitis from the groups of lid loading technique (platinum chain *versus* gold weight implants)**

Table 2 also shows nine studies reporting resolution of keratitis due to lagophthalmos surgery. The gold weight implant exhibited 62–100% (eight studies), and the platinum chain implant exhibited 70–97.4% (three studies) for the resolution of keratitis. Bianchi et al[6] showed the improvement of keratitis was scored from 0 to 2 (0: persistence of keratitis; 1: partial resolution; or 2: complete resolution). Notably, Aggarwal et al[14] and Abell et al[15] did not use a specific measurement to assess the pre- and postoperative keratitis following the placement of platinum chain and gold weight implants. Berghaus et al[7] used a keratopathy index to assess the resolution of keratitis following the placement of platinum chain and gold weight implants. Using this keratopathy index, the findings related to the cornea of patients were classified into various degrees (i.e. 0 indicates a normal cornea, whereas 3 indicates ulcer of the cornea).

**Resolution of tearing with lid loading technique**

Bianchi et al[6] found that the resolution of tearing for a platinum chain implant technique was ranged from 24–70%. The study divided the postoperative resolution of tearing into three grades: frequent tearing = 1; good restoration = 2; and complete restoration = 3. The result showed the use of artificial drops progressively decreased in all paralytic lagophthalmos patients. During the 2 months follow-up, only two patients continued to occasionally use ointments. None of the patients required eye patching at night within 3 weeks for the postoperative care, resulting a consequent drastic improvement in their quality of life.[6]

**Improvement in visual acuity for lid loading technique**

Five studies reported the improvement in visual acuity. Three studies from Berghaus et al,[7] Malhotra et al,[8] and Kartush et al[13] showed the improvement in visual acuity after the placement of the platinum chain and gold weight implants was 40–95%. The best improvement was reported in a study performed by Kartush et al[13] that showed an improvement of 95% of the average of + 2.4 lines by the gold weight implant technique.

**Complications related to lid loading technique**

Despite the advantages, some studies reported complications resulting from the lid loading

**Table 2.** Changes in lagophthalmos and resolution of keratitis, ptosis, and measurement of MRD following surgical techniques for lagophthalmos

| First author, year, country | Study design, (level of evidence) (n eyelids) | Type of treatment | Lagophthalmos | | Keratitis | | Ptosis (eyes) | MRD (mm) | | Efficacy |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Preoperative | Postoperative | Preoperative | Postoperative | | Preoperative | Postoperative | |
| Platinum chain implant | | | | | | | | | | |
| Oh,[5] 2018, Korea | Interventional study, (III) (n = 37) | Platinum chain implant | NA | Pc: 32 patients full close & 5 patients 1.12 mm | - | - | - | - | - | NA |
| Bianchi,[6] 2014, Italy | Retrospective study, (III) (n = 43) | Platinum chain implant | NA | Pc: all patients showed improvement | Pc: all patients | Pc: 7% partial resolution & 93% complete resolution | - | - | - | 100% |
| Berghaus,[7] 2003, Germany | Clinical follow-up study, (III) (n = 63) | Platinum chain and gold weight implants | Gw: 5 mm<br>Pc: 4.2 mm | Gw: 0.3 mm<br>Pc: 0.4 mm | Pc and Gw: all patients | Gw: 77%<br>Pc: 70% | Gw: 15.2%<br>Pc: 10% | NA | NA | Gw: 80% complete closure and 100% covering of cornea<br>Pc: NA |
| Malhotra,[8] 2015, United Kingdom | Prospective study, (III) (n = 18) | Platinum chain implant | Pc: 3.2 mm | Pc: 1.1 mm | - | - | - | - | - | 90% |
| Bladen,[10] 2012, United Kingdom | Retrospective case-controlled study, (III) (n = 22) | Platinum chain and gold weight implants | Gw: 5.1 ± 4.1 mm<br>Pc: 6.3 ± 3.0 mm | Gw: 1.7 ± 1.8 mm<br>Pc: 1.0 ± 1.9 mm | - | - | Gw: 45.5 %<br>Pc: 0 | Gw: 5.1 ± 0.8<br>Pc: 5.1 ± 1.6 | Gw: 2.6 ± 1.2<br>Pc: 2.7 ± 1.5 | NA |
| Mavrikakis,[11] 2014, Greece | Cohort study, (III) (n = 15) | Platinum chain implant | NA | NA | - | - | Pc: 16.7 % | Pc: 3.5 | Pc: 2.3 | NA |
| Silver,[12] 2008, USA | Interventional study, (III) (n = 102) | Platinum chain implant | NA | NA | - | - | - | - | - | NA |
| Gold weight implant | | | | | | | | | | |
| Ueda,[9] 1995, Japan | Retrospective study, (III) (n = 130) | Gold implant and TMT | NA | NA | NA | Complete relief of corneal irritation<br>Tmt: 63%<br>Gw: 62% | - | - | - | Complete closure:<br>Tmt: 62% (48)<br>Gw: 10% (5) |

Table continued on next page

**Table 2.** (continued)

| First author, year, country | Study design, (level of evidence) (n eyelids) | Type of treatment | Lagophthalmos | | Keratitis | | Ptosis (eyes) | MRD (mm) | | Efficacy |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Preoperative | Postoperative | Preoperative | Postoperative | | Preoperative | Postoperative | |
| Gold weight implant | | | | | | | | | | |
| Kartush,[13] 1990, USA | Retrospective study, (III) (n = 38 in 37 patients) | Gold weight implant | Gw: 5.4 mm | Gw: 0.1 mm | Gw: 81% | Complete resolution: 76% | Gw: 13.2 % | NA | NA | 73.7% |
| Aggarwal,[14] 2007, India | Prospective interventional case series, (III) (n = 30) | Gold weight implant | Gw: 7 mm | Gw: 2.3 mm | NA | Complete resolution: 80% | - | - | - | 70% |
| Abell,[15] 1998, USA | Prospective study, (III) (n = 6) | Gold weight implant | NA | NA | NA | Complete resolution: 100% | - | - | - | NA |
| Daigavane,[16] 2017, India | Interventional study, (III) (n = 20) | Gold weight implant | NA | NA | - | - | - | - | - | NA |
| Baheerathan,[17] 2009, United Kingdom | Retrospective study, (III) (n = 16) | Gold weight implant | NA | Gw: only 1 patient had residual lagophthalmos | - | - | Gw: 0 | NA | NA | 93.6% |
| Sönmez,[18] 2007, Turkey | Cross-sectional, (III) (n = 41) | Gold weight implant | NA | NA | - | - | - | - | - | NA |
| El Toukhy,[19] 2009, Egypt | Prospective study, (III) (n = 12) | Gold weight implant | Gw: ≥5 mm | NA | NA | Gw: 100% | - | - | - | 92% |
| Wagh,[20] 2016, London | Retrospective study, (III) (n = 38) | Gold weight and platinum chain implants | Gw: 7.42 mm blink & 5.47 mm gentle | Gw: 2.18 mm blink & 1.18 mm gentle | Gw: 36.8% diffuse corneal staining & 63.2% inferior corneal staining | Gw: 97.4% complete resolution & 2.6% inferior mild punctate | Gw: 2.6% | NA | NA | NA |
| Nakazawa,[21] 2004, Japan | Prospective study, (III) (n = 7) | Gold weight implant and lateral canthopexy | NA | NA | - | - | - | - | - | NA |

Table continued on next page

**Table 2.** (continued)

| First author, year, country | Study design, (level of evidence) (n eyelids) | Type of treatment | Lagophthalmos | | Keratitis | | Ptosis (eyes) | MRD (mm) | | Efficacy |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Preoperative | Postoperative | Preoperative | Postoperative | | Preoperative | Postoperative | |
| Gold weight implant | | | | | | | | | | |
| Bladen,[22] 2011, United Kingdom | Retrospective study, (III) (n = 107) | Gold weight implant | Gw:<br>Blink: 6.0 ± 4.3 mm<br>Gentle: 4.3 ± 4.2 mm<br>Forced: 3.5 ± 4.3 mm | Gw:<br>Blink: 4.0 ± 2.1 mm<br>Gentle: 2.5 ± 1.8 mm<br>Forced: 2.4 ± 3.6 mm | - | - | NA | Gw: 4.0 ± 3.3 | Gw: 2.7 ± 1.6 | NA |
| Lessa,[23] 2009, Brazil | Retrospective study, (III) (n = 29) | Gold weight implant covered by levator aponeurosis | Gw: 4–5 mm | Gw: 0.5 mm | - | - | Gw: 3.4 % | NA | NA | 100% |
| Kao,[24] 2004, USA | Retrospective study, (III) (n = 25) | Retrograde, post levator aponeurosis gold weight implant | NA | NA | - | - | - | - | - | NA |
| Lavy,[25] 2004, USA | Prospective study, (III) (n = 25) | Gold weight implant | Gw: 4–10 mm | Gw: 0–2 mm | - | - | Gw: 9.1 % | NA | NA | 82% |
| Foda,[26] 1999, Egypt | Retrospective study, (III) (n = 42) | Gold weight implant and lateral canthoplasty | Gw and lateral canthoplasty: 5–14 mm | Gw and lateral canthoplasty: 0–3 mm | - | - | - | - | - | 88% |
| Jayashankar,[27] 2008, India | Prospective study, (III) (n = 50) | Customized gold weight implant | Gw: mean 5.9 mm | Gw: 0–1 mm | Gw: all patients | Complete resolution: 92% | - | - | - | 68% |
| Tan,[28] 2013, New Zealand | Retrospective study, (III) (n = 63) | Gold weight implant with lateral tarsorrhaphy | NA | NA | - | - | - | - | - | 83% |
| Terzis,[29] 2008, Virginia | Retrospective, (III) (n = 39) | Gold weight vs. palpebral spring | NA | NA | - | - | Gw: 0<br>Ps: 0.02 % | NA | NA | Gw: 76.1%<br>Ps: 76.9% |

Gw=gold weight; MRD=margin reflex distance; NA=not available; Pc=platinum chain; Ps=palpebral spring; TMT=temporalis muscle transfer; Tr=tarsorrhaphy

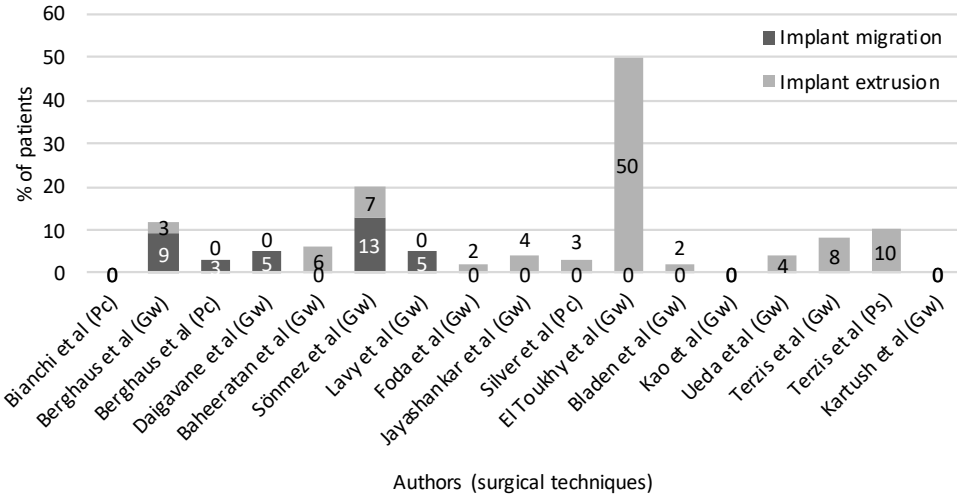


**Figure 2.** Implant extrusion and migration following surgical techniques for lagophthalmos. Gw=gold weight; Pc=platinum chain; Ps=palpebral spring

technique for paralytic lagophthalmos, as shown in Figure 2. The incidence of implant bulging and affected eyelid contour following the placement of the platinum chain or gold weight implants were recorded in five studies. The rate of bulging of the gold weight implant was 14–81.8%.[9,10] Bladen et al[10] stated that bulging was more common in the gold implant. Meanwhile, three studies demonstrated that the rate of bulging of the platinum chain implant ranged from 7–22%. Bulging was evaluated after resolution of edema. In addition, implant extrusion and migration were reported in 15 studies. In subjects using platinum chain implant, the incidence of extrusion and migration was 0–2.9% and 0–3.3%, respectively. In addition, the incidence of extrusion was 0–50% and migration was 0–13.3% in subjects using gold weight implant. The highest incidence of implant extrusion was reported in the study conducted by El Toukhy et al.[19] The combination of gold weight implant and lateral canthoplasty conducted by Foda et al[26] exhibited a low rate of extrusion (2.4%) and no migration. Notably, a study by Ueda et al[9] reported that the combination of gold weight implant and TMT exhibited a low rate of extrusion (3.8%) and no migration.

The incidence of ptosis following the placement of the platinum chain or gold weight implants is shown in Table 2. Only studies by Bladen et al[10] and Malhotra et al[8] assessed the pre- and postoperative conditions measured by margin reflex distance following the upper eyelid implantation. Incidence of ptosis following the gold weight and platinum chain techniques were ranged from 0–45.5% and 0–16.7%, respectively. One study investigated the combination of gold weight implant and palpebral spring with a 0.02% ptosis rate.[29]

Other postoperative complications included astigmatism and eye infections. Only two studies (Mavrikakis et al[11] and Lavy et al[25]) reported the occurrence of astigmatism after placement of a gold weight implant. In addition, six studies in the group of gold weight implant reported the occurrence of infections on the eyelid followed by the implant removal.

**Table 3.** Improvement in visual acuity following lid loading surgical techniques

| Author | Surgical techniques | Visual acuity* | |
|---|---|---|---|
| | | Preoperative | Postoperative |
| Berghaus et al | Gw | 0.5 | 0.7 |
| Kartush et al | Gw | 0.28 | 0.66 |
| Abbel et al | Gw | 0.34 | 0.6 |
| Berghaus et al | Pc | 0.5 | 0.7 |
| Malhotra et al | Pc | 0.48 | 0.55 |

Gw=gold weight; Pc=platinum chain
*Presented in logMAR

## DISCUSSION

These findings have shown that lid loading is the first-line treatment for paralytic lagophthalmos. The efficacy of the lid loading technique with platinum is higher than that of the gold weight implant. A study from Ueda et al[9] showed a low efficacy of gold weight implant. They reported only five patients (10%) among 52 paralytic lagophthalmos patients who had undergone lid loading treatment accomplished completed closure

of the eye after the lid loading. Gold weight implant is more accessible in public, cheaper, and has been used for decades. Therefore, the number of studies that using gold implant were twice higher than platinum chain implant. This shows that gold weight implant has been more commonly applied than platinum chain implant which has been used since 2003. Gold weight commonly characterized as 99.99% rigid gold with three drill holes were made for pretarsal attachment, with the weights ranging from 0.9 to 2.8 g and a diameter of around 29.3 mm. The exact size for each person would be varied according to the individual curvature of the patients' tarsus. The platinum chain commonly consisted of 97% of platinum and 3% of iridium alloy with four drill holes in each platinum segment. Thus, there are approximately 12 holes for a piece of platinum used for a common eyelid size. The density of platinum is 21.5 g/cm$^3$, and the weight ranges from 1.0 to 2.0 g.[6,7,10]

The platinum chain implant has a higher density, is thinner, and is 10% smaller than the gold weight implant. Platinum is also more biocompatible than gold as it can be shaped to fit the natural motion of the eyelid, thus reducing the risk of migration, extrusion, and adverse reaction to metal. Based on the material characteristics, shape, and amount of drill holes for pretarsal attachment, the platinum chain showed better effectiveness regarding its characteristics.

Moreover, the complications have also been found higher in gold weight implant because it induces disseminated lymphoid infiltration and fibrous connective tissue as a granulomatous reaction, leading to the formation of a capsule with possible type IV hypersensitivity.[15,22] In contrast, the platinum chain implant does not induce the formation of such capsule. The use of a platinum chain implant leads to better improved cosmetic results compared with a gold plate because the chain can be shaped to fit the natural motion of the eyelid.

El Toukhy et al[19] reported a 50% incidence of gold weight implant extrusion. It was related to an infection and inflammation, which were high in the low socio-economic groups of leprosy patients. Sönmez et al[18] suggested that weight should be placed higher on the tarsal plate to overcome the risk of extrusion. In addition, a study by Bladen et al[10] reported that a fixation of less pretarsal visibility of the implant and high on the tarsus with a small levator recession, fixation, and aponeurosis drape resulted in less pretarsal visibility of the implant and lower risk of extrusion or migration. Despite the differences, both types of implants have been reported to effectively treat lagophthalmos, with an observed improvement in eyelid parameters without affecting the findings of magnetic resonance imaging.

Foda et al[26] noted that ptosis occurred after a placement of a gold weight implant due to the inappropriate weight selection. Patients with paralytic lagophthalmos occasionally had a weakness on both the upper and lower eyelids. In these cases, the weight of soft tissues under the action of gravity can lead to an exposure of the inferior portion of the cornea, which is difficult to correct through upper lid loading alone. Older patients are more susceptible to the development of lower lid sagging and ectropion due to loss of muscle tone associated with paralysis. Lower lid ectropion can be corrected through various surgical techniques depending on the severity of the laxity, including canthoplasty, lateral tarsal strip, fascia lata suspension, and tarsorrhaphy.

Berghaus et al[7] reported that astigmatism rarely occurred in patients who underwent the lid loading technique. However, it might occur at a low grade within 18 months after surgery. Astigmatism could be prevented by combining the lid loading technique with the high pretarsal and levator fixation technique in which the position of the implant is above the cornea and indirectly contacted the globe when the eye is open, thus inducing less corneal warpage. In addition, glasses with cylindrical lenses could be used to correct astigmatism due to the lid loading.

The resolution of tearing, secondary to the management of lagophthalmos, is difficult to determine because the data in those studies were limited. Bianchi et al[6] observed the resolution of tearing. Tearing in paralytic lagophthalmos is caused by an irritation of the eye or lacrimal pump dysfunction. In the management of lagophthalmos, the eye irritation can be reduced through an eyelid closure. However, the lacrimal pump dysfunction cannot be fully resolved, and the tearing symptoms may persist in some patients. Another important finding of this review is the improvement of visual acuity around 0.2 to 0.38 in three studies for gold weight groups and 0.07 to 0.2 for platinum chain groups, which is shown in Table 3. The majority of patients achieved an improvement in visual acuity as a result of the resolution of exposure keratopathy and less corneal clouding.

This systematic review only evaluated retrospective studies that could provide data of the etiologies, complications, benefits, and appropriate management of lagophthalmos and served as the basis for future prospective studies. A wide variety of factors may contribute to the observed discordance in the assessment of lagophthalmos. For example, only a few studies reported a percentage of effectiveness; therefore, the interpretation of the results was quite challenging. The not available data in Table 2 was due to the lack of clear statements. For example, the results in the studies were stated as 'judged to be nearly complete in all patients' or 'nearly all patients'. Hence, further level I–II studies to provide additional evidence are needed.

The existence of bias in this review may arise from several factors, such as the etiology and severity of lagophthalmos and the selection of surgical techniques. In patients whose lagophthalmos affects the upper eyelid, the application of lid loading—using a load to withstand gravity—may be very useful. Lagophthalmos involving the lower eyelid can be managed through the combination of the lateral tarsal strip and tarsorrhaphy. Therefore, the selection of patients prior to surgery is important in determining the most appropriate technique.

Some studies reported a combination of lid loading with other techniques, including tarsorrhaphy, palpebral spring, and TMT, and showed that the efficacy of such combination was good with less complication. Alternatively, combining the techniques might result in better outcomes. This study is expected to give a further consideration for the treatment options of paralytic lagophthalmos, which could improve patient's condition.

Limitations of this study include the inconsistent data of effectiveness as some of the articles did not state the exact percentage of the effectiveness and the precise size of lagophthalmos improvements. Thus, arranging a prospective randomized controlled study to compare platinum chain and gold weight implants for paralytic lagophthalmos is suggested. In conclusion, the platinum chain and gold weight implants effectively reduced the measurement of lagophthalmos, keratitis, and tearing and improved visual acuity. However, the risks of bulging, migration, extrusion of implant, and infection were higher in the gold weight implant. Both platinum chain and gold weight implants are effective, but the platinum chain has a lower complication rate than the gold weight implant.

**Conflict of Interest**

The authors affirm no conflict of interest in this study.

**Acknowledgment**

We would like to thank Areyke Herlina Caroline Manorek for helping in English proofing and editing of this manuscript. We would also like to thank Florentina Priscilia, Carennia Paramita, Dewinta Retno Kurniawardhani, and Krystle Gabriella for helping to collect data, assist with the analysis, and revise the manuscript.

**Funding Sources**

None.

## REFERENCES

1. Pereira MV, Gloria AL. Lagophthalmos. Semin Ophthalmol. 2010;25(3):72–8.
2. Seiff SR, Carter SR. Reanimation of the paretic eyelid complex. Facial Plast Surg Clin North Am. 1998;6:21–30.
3. Lee V, Currie Z, Collin JR. Ophthalmic management of facial nerve palsy. Eye (Lond). 2004;18(12):1225–34.
4. Bhama P, Bhrany AD. Ocular protection in facial paralysis. Curr Opin Otolaryngol Head Neck Surg. 2013;21(4):353–7.
5. Oh TS, Min K, Song SY, Choi JW, Koh KS. Upper eyelid platinum weight placement for the treatment of paralytic lagophatlmos: a new plane between the inner septum and the levator aponeurosis. Arch Plast Surge. 2018;45(3):222–8.
6. Bianchi B, Ferri A, Leporati M, Ferrari S, Lanfranco D, Ferri T, et al. Upper eyelid platinum chain placement for treating paralytic lagophthalmos. J Craniomaxillofacial Surg. 2014;42(8):2045–8.
7. Berghaus A, Neumann K, Schrom T. The platinum chain: a new upper-lid implant for facial palsy. Arch Facial Plast Surg. 2003;5(2):166–70.
8. Malhotra R, Ziahosseini K, Poitelea C, Litwin A, Sagili S. Platinum segments: a new platinum chain for adjustable upper eyelid loading. Br J Ophthalmol. 2015;99(12):1680–5.
9. Ueda K, Harii K, Yamada A, Asato H. A comparison of temporal muscle transfer and lid loading in the treatment of paralytic lagophthalmos. Scand J Plast Reconstr Surg Hand Surg. 1995;29(1):45–9.
10. Bladen JC, Norris JH, Malhotra R. Cosmetic comparison of gold weight and platinum chain insertion in primary upper eyelid loading for lagophthalmos. Ophthalmic Plast Reconstr Surg. 2012;28(3):171–5.
11. Mavrikakis I, Detorakis ET, Baltatzis S, Yiotakis I, Kandiloros D. Corneal topography with upper eyelid platinum chain implantation using the pretarsal fixation technique. Med Hypothesis Discov Innov Ophthalmol. 2015;4(1):9–13.
12. Silver AL, Lindsay RW, Cheney ML, Hadlock TA. Thin-profile platinum eyelid weighting: a superior option in the paralyzed eye. Plast Reconstr Surg. 2009;123(6):1697–703.
13. Kartush JM, Linstrom CJ, McCann PM, Graham MD. Early gold weight eyelid implantation for facial paralysis. Otolaryngol Head Neck Surg. 1990;103(6):1016–23.
14. Aggarwal E, Naik MN, Honavar SG. Effectiveness of the gold weight trial procedure in predicting the ideal weight for lid loading in facial palsy: a prospective study. Am J Ophthalmol. 2007;143(6):1009–12.
15. Abell KM, Baker RS, Cowen DE, Porter JD. Effectiveness of gold weight implants in facial nerve palsy: quantitative alterations in blinking. Vision Res. 1998;38(19):3019–23.
16. Daigavane S, Iratwar S, Gautam S. Management of lagophthalmos by custom made gold implants. IJARIIT. 2017;3(1):428–32.

17. Baheerathan N, Ethunandan M, Ilankovan V. Gold weight implants in the management of paralytic lagophthalmos. Int J Oral Maxillofac Surg. 2009;38(6):632–6.
18. Sönmez A, Öztürk N, Durmuş N, Bayramiçli M, Numanoğlu A. Patients' perspectives on the ocular symptoms of facial paralysis after gold weight implantation. J Plast Reconstr Aesthet Surg. 2008;61(9):1065–8.
19. El Toukhy E. Gold weight implants in the management of lagophthalmos in leprosy patients. Lepr Rev. 2010;81(1):79–81.
20. Wagh VK, Lim WS, Cascone NC, Morley AM. Post-septal upper eyelid loading for treatment of exposure keratopathy secondary to non-cicatricial lagophthalmos. Orbit. 2016;35(5):239–44.
21. Nakazawa H, Kikuchi Y, Honda T, Isago T, Morioka K, Yoshinaga Y. Treatment of paralytic lagophthalmos by loading the lid with a gold plate and lateral canthopexy. Scand J Plast Reconstr Surg Hand Surg. 2004;38(3):140–4.
22. Bladen JC, Norris JH, Malhotra R. Indications and outcomes for revision of gold weight implants in upper eyelid loading. Br J Ophthalmol. 2012;96(4):485–9.
23. Lessa S, Nanci M, Sebastiá R, Flores E. Treatment of paralytic lagophthalmos with gold weight implants covered by levator aponeurosis. Ophthalmic Plast Reconstr Surg. 2009;25(3):189–93.
24. Kao CH, Moe KS. Retrograde weight implantation for correction of lagophthalmos. Laryngoscope. 2004;114(9):1570–5.
25. Lavy JA, East CA, Bamber A, Andrews PJ. Gold weight implants in the management of lagophthalmos in facial palsy. Clin Otolaryngol Allied Sci. 2004;29(3):279–83.
26. Foda HM. Surgical management of lagophthalmos in patients with facial palsy. Am J Otolaryngol. 1999;20(6):391–5.
27. Jayashankar N, Morwani KP, Shaan MJ, Bhatia SR, Patil KT. Customised gold weight eyelid implantation in paralytic lagophthalmos. J Laryngol Otol. 2008;122(10):1088–91.
28. Tan ST, Staiano JJ, Itinteang T, McIntyre BC, MacKinnon CA, Glasson DW. Gold weight implantation and lateral tarsorrhaphy for upper eyelid paralysis. J Craniomaxillofac Surg. 2013;41(3):e49–53.
29. Terzis JK, Kyere SA. Experience with the gold weight and palpebral spring in the management of paralytic lagophthalmos. Plast Reconstr Surg. 2008;121(3):806–15.