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The Historical Evolution of Orbital Decompression

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Abstract

The earliest account of orbital decompression was published in 1888. Since then, various approaches have been reported throughout the years - transcutaneous, transnasal, transcranial, transantral, transconjunctival, transcaruncular, temporal fossa, swinging eyelid, ab interno, and ab externo. The current trend for orbital decompression includes four surgical techniques: 1) Deep lateral orbital decompression with or without medial orbital wall decompression (balanced decompression); 2) Orbital fat decompression; 3) Deep lateral orbital decompression via transtemporal fossa approach; and 4) Endoscopic medial orbital wall decompression with or without orbital floor decompression. The choice of surgical procedure may differ in every case, depending on the severity of proptosis and the surgeon's preference or skill. With the advancements in technology, orbital decompression is continuously transforming. Nonetheless, the main goal has always been to achieve a more effective decompression for disfiguring proptosis and compressive optic neuropathy.

Keywords: Historical evolution; Deep lateral orbital decompression; Medial orbital wall; Endoscopic;

Introduction

Orbital decompression is a surgical procedure aimed at improving proptosis and relieving compressive forces on the optic nerve. The current notion is that deep lateral orbital decompression, as well as balanced decompression, which includes an additional medial orbital wall decompression, were the initial options for this procedure. In the latter years, medial orbital wall decompression (with or without orbital floor decompression or deep lateral wall decompression) as the primary technique became widely performed. In this manner, surgical procedures for orbital decompression have been established. Ever since this type of surgery was first performed about 130 years ago, our predecessors have made various efforts on improving techniques in order to achieve more effective decompression and to reduce complications related to the surgery.

Discussion

Orbital decompression was first performed by Krönlein in 1888 [1]. The Krönlein method was a popular approach for removing orbital tumors. He focused on the thinness of the anterior portion of the lateral orbital wall and removed the dermoid cyst by fracturing this part. After which, Dollinger became the first surgeon to perform orbital decompression in 1890 for thyroid eye disease [2]. This involved two cases of superficial lateral wall decompression using the Krönlein method. However, conspicuous scarring on the skin prevented widespread application of the Krölein method for orbital decompression. To overcome this issue, Hirsch performed inferior orbital wall decompression via a transnasal approach in 1929 [3].

The pioneer of the transcranial approach for orbital decompression was Naffziger, who in 1931 rejected the supraorbital wall through the anterior cranial region [4]. In 1936, Sewall, an otolaryngologist and anatomist, devised a method of orbital decompression through the fronto-ethmoidal sinus [5]. However, he did not actually perform his own surgical method. Instead, Kistner operated in 1939 using Sewall's proposed procedure [6].

The first wave of innovations on orbital decompression originated from Walsh and Ogura, whose technique involved a transantral approach to decompress the inferior and medial orbital walls [7]. This procedure has been the mainstay of orbital decompression for a long period of time. In 1990, Kennedy et al. reported on the use of an endoscope for orbital decompression by approaching through the maxillary sinus, which made the surgical procedure even more popular [8]. Goldberg et al. [9] then reported that the incidence of postoperative ocular motility disorders can be reduced by preserving the inferomedial orbital strut, which is a thin bony junction of the inferior orbital wall and medial orbital wall [9]. As medial orbital wall decompression was increasingly performed using an endoscope, otolaryngologists were surpassing ophthalmologists with regards to this procedure. Medial orbital wall decompression done by ophthalmologists involved the swinging eyelid approach, which will be discussed further, to decompress the medial orbital wall via the orbital floor. Another approach involved directly cutting through the skin via a Lynch incision. However, poor surgical field exposure and damage to the skin were disadvantages to this cutaneous approach. Shorr et al. in [10] reported on the transcaruncular approach to orbital decompression, which served as a solution to the previous problems [10]. This approach allowed the procedure to be carried out with better view of the surgical field and withholding trauma to the skin.

As described, orbital decompression surgery was developed based on the process of releasing orbital contents into the paranasal sinuses. In 1989, however, a second wave of surgical innovations led by Leone and his colleagues suddenly emerged [11]. This was the first report of deep lateral orbital wall decompression, which was based on a particularly novel idea of enlarging the orbital volume by scraping the bone marrow deep into the lateral orbital wall. Until then, lateral orbital wall decompression simply meant superficial lateral wall decompression that involved fracturing the anterior portion of the lateral orbital wall [12]. However, the predominance of deep lateral orbital decompression did not follow immediately after the aforementioned report. It took six years to establish such widespread adaptation, owing to the swinging eyelid approach as popularized by the textbook of Rootman, Stewart & Goldberg [13]. The swinging eyelid approach itself was introduced by McCord in 1981 and was primarily used for inferior-to-medial orbital wall decompression [12]. In Europe, many ophthalmologists performed inferomedial decompression using this method. However, the most recent conventional method for balanced decompression, wherein deep lateral and medial orbital walls are simultaneously decompressed, is to use the swinging eyelid approach and the transcaruncular approach.

As previously mentioned, transcranial orbital decompression was first reported by Naffziger in 1931 [4]. Unfortunately, the extremely invasive nature and steep learning curve prevented its widespread practice as an approach to orbital decompression. In 1969, however, the tide turned when Tessier reported their own method employing the transcranial approach. Since Krastinova et al. [14] and Koornneef et al. [15] reported the results of this method further into the mid-1980s, the transcranial approach has been the mainstay of orbital decompression for about 10 years. Koornneef, in particular, taught many surgical fellows as a professor at the University of Amsterdam. With the success of his apprentices, such as Mourits [16] and Baldeschi [17] this technique took the world by storm. However, since the latter half of the 1990s when the swinging eyelid approach has gained popularity, the number of ophthalmologists performing this transcranial procedure dwindled on account of its invasiveness and the fear it imparts on patients.

When it comes to minimally invasive approaches, subciliary incision for the lower eyelid and eyelid crease incision for the upper eyelid must not be overlooked. The transconjunctival approach is historically the oldest technique of accessing the orbit from the lower eyelid, [18] whereas the subciliary incision was eventually recognized after World War II [19]. Although lower eyelid subciliary incision is an approach to the orbit that ophthalmologists are familiar with in terms of orbital floor fracture repair, this approach has led to the introduction of inferior and medial orbital wall decompression. The upper eyelid transpalpebral approach to the orbit is also a relatively new method and was first introduced in the 1998 publication by Goldberg et al. [20].

A slightly different trend in orbital decompression is “orbital fat decompression.” Although it was originally reported by Moore in 1920, [21] Olivari’s [22] report in 1991 drew attention to this procedure, in which an average of 6cc of orbital fat removal and about 6mm of proptosis reduction were claimed possible [22]. Although fat decompression has many advantages over bone decompression, such as reduced postoperative ocular motility complications, there have been reports of blindness due to orbital hemorrhage and damage to the motor nerves and sensory nerves within the orbit [23]. Further complications, such as direct injury to the inferior oblique and superior oblique muscles, have also been reported. The current EUGOGO guidelines state that fat decompression must only be performed as an adjunctive procedure to bone decompression.

Ab-externo deep lateral orbital decompression through the temporal fossa has also been recently reported [24]. A disadvantage of the conventional internal approach of deep lateral orbital decompression is the narrow view of the surgical field, owing to the preservation of the lateral orbital rim bone [25]. To address such drawbacks, a method was devised to expose the lateral orbital wall after detaching the temporalis muscle, making it possible to perform surgical decompression safely and securely. Another notable feature of this report was the possibility for greater exposure of the dura. Although the report merely explained that the dura mater becomes a posterior anatomical landmark, another report published by Goldberg et al. presented evidence of more effective decompression [26]. Goldberg et al. [20] showed that exposing the dura, which is in contact with the posterior

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border of the lateral orbital wall, can shift the orbital contents towards the intracranial space and enhance the decompression effect. This debunked previous assumptions suggesting that resection of the posterior border of the lateral orbital wall did not produce a more effective decompression, creating a new trend in deep lateral orbital decompression.

A surgical procedure, in which the lateral orbital wall is advanced anteriorly and then fixated, has also been reported [27] The procedure involves external decompression of the lateral orbital wall, advancing the osteotomized lateral wall bone 4 mm anteriorly and 2 mm laterally. After which, the bone was fixated with titanium plates. Theoretically speaking, this would have been an excellent surgical technique. In reality, however, the procedure was rather unmanageable for ophthalmologists who actually perform majority of the orbital decompression surgeries. Hence, widespread execution was not fulfilled [28]. More recently, a study by Men et al. [29] proposed the adjunctive use of a lateral wall implant in lateral orbital wall decompression to create additional space by laterally displacing the temporalis muscle [29].

Currently, the trend of orbital decompression surgery performed as the primary procedure can be divided into 4 types as follows:

a) Deep lateral orbital decompression with or without medial orbital wall decompression (balance decompression).

b) Orbital fat decompression.

c) Deep lateral orbital decompression via transtemporal fossa approach.

d) Endoscopic medial orbital wall decompression with or without orbital floor decompression, mainly performed by otolaryngologists.

(1) Deep lateral orbital decompression with or without medial wall decompression (balanced decompression) is currently the most popular procedure of choice worldwide due to the low risk for postoperative complications. Furthermore, orbital fat decompression may be added as an adjunctive procedure.

(2) Orbital fat decompression as the primary surgical option is indicated in less severe proptosis and is mainly performed in the United States by the group of Goldberg et al. and in Germany by the group of Olivari et al. While the previously published report by Kikkawa et al. focused on graded orbital decompression based on the severity of proptosis, [30] Goldberg et al. proposed a more conservative method for patients with mild to moderate proptosis and introduced the minimally invasive surgical approach that removes a small portion of the inferior orbital wall for intraconal fat debulking [31]. With the advancements in technology, Wang et al. has published a study on robot-assisted orbital fat decompression with the da Vinci Xi surgical system, which provided stability, dexterity, and good visualization [32].

(3) Deep lateral orbital decompression via temporal fossa approach is currently the technique that is actively performed in England by Geoffrey Rose et al. The decompression effect is the same as in (1), but with a wider surgical field and, hence, shorter duration of operation. Because Moorfields Eye Hospital in London, where Geoffrey Rose practices, is the world's busiest ophthalmology institution and, consequently, has quite a substantial waiting list of patients, Rose probably arrived at this procedure in order to accommodate the large number of patients requiring surgery.

(4) Although endoscopic medial orbital wall decompression with or without orbital floor decompression, which is mainly performed by otolaryngologists, is an excellent surgical option for eliminating visible scars, cosmesis alone is not enough to make this procedure a primary option due to higher incidence of postoperative ocular motility disorders. In the case of compressive optic neuropathy, however, it is actually the preferred technique that can gently access the orbit without putting pressure on the optic nerve.

Few studies on stereotactic navigation in orbital decompression surgery have also been published in literature. Heisel et al. [33] reported that the image-guided technique reduced the need for subsequent strabismus surgery while decreasing operative time as well [33] In addition to this, Prevost et al. [34] reported having greater proptosis reduction in the eyes that have undergone surgery with a navigation system [34]. However, duration of surgery was said to increase by an average of 40 minutes owing to setting up of the navigation device. The use of robotic system in orbital surgery has also been gaining popularity. Mattheis et al. [35] was first to report the use of Medineering Robotic Endoscope Guiding System in endoscopic balanced orbital decompression, which allows the surgeon to utilize both hands and to perform the procedure more efficiently [35].

Conclusion

Orbital decompression as a surgical procedure has immensely evolved throughout the years. From the early Krönlein method to the latest robot-assisted decompression, various approaches and modifications have emerged from the need for a more effective and efficient orbital decompression. Although conventional procedures have been established depending on the areas of practice, with the advancements in technology, further surgical innovations are continuously transforming orbital decompression as we know it.

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