

# Surgical Approaches to Orbital Fractures: A Practical and Systematic Review

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**Background:** Orbital fractures constitute a significant percentage of all midface injuries. Here, we present a contemporary evidence-based review of the major surgical approaches for orbital wall fractures and analyze the literature to compare all major surgical procedures and their complication rates.

**Method:** A systematic review was conducted to compare surgical approaches (subciliary, transcaruncular, transconjunctival, subtarsal, and endoscopic) and post-operative complications in patients who underwent surgical fixation of orbital wall fractures. A database search in PubMed (PubMed Central, MEDLINE and Bookshelf) was performed for all articles containing the terms “orbital,” “wall,” “fracture,” and “surgery” with different combinations.

**Results:** A total of 950 articles were obtained and 25 articles were included, representing an analysis of 1137 fractures. The most frequent surgical approach was the endoscopic (33.3%) followed by the external surgical approaches, specifically transconjunctival (32.8%), subciliary (13.5%), subtarsal (11.5%), and transcaruncular (8.9%). The transconjunctival approach had a statistically significantly higher rate of complications (36.19%), followed by the subciliary (21.4%), and endoscopic approach (20.2%,  $P < 0.0001$ ). The subtarsal approach had a statistically significantly lower rate of complications (8.2%) followed by the transcaruncular approach (14.0%,  $P < 0.0001$ ).

**Conclusion:** The subtarsal and transcaruncular approaches were observed to have the lowest rates of complications, whereas the transconjunctival, subciliary, and endoscopic approaches were reported to have higher rates of complications. (*Plast Reconstr Surg Glob Open* 2023; 11:e4967; doi: [10.1097/GOX.0000000000004967](https://doi.org/10.1097/GOX.0000000000004967); Published online 15 May 2023.)

## INTRODUCTION

Orbital fractures account for up to 40% of all midface trauma injuries.<sup>1</sup> These fractures can be classified by those that only involve the orbital walls or those that extend to the orbital rim.<sup>2</sup> Additionally, orbital fractures can either be isolated or part of more complex fractures, such as zygomaticomaxillary complex fractures, Le Fort II fractures (orbital floor fractures), and naso-orbital ethmoid fractures.<sup>3</sup>

The mechanism of orbital floor fractures has been modeled by the hydraulic theory and the buckling theory. The hydraulic theory postulates that forces transmitted to the globe are repulsed hydraulically to the

orbital wall, where they fracture the area of impact.<sup>4,5</sup> Hydraulic forces are more likely to cause isolated orbital floor fractures than medial orbital wall fractures due to the underlying support that the trabecular ethmoid air cells give to the latter.<sup>6</sup> However, when high-energy forces are applied to the globe, a combined orbital floor and medial orbital wall fractures can occur, as observed in cadaveric experimental studies.<sup>7</sup> On the other hand, the buckling theory states that an injuring force, delivered directly along the orbital rim and surrounding structures, transmits along the orbital wall until a weak point is met.<sup>6,8,9</sup>

In general, the most common location of orbital fractures is the medial orbital wall (54.9%),<sup>10</sup> specifically at the lamina papyracea of the ethmoid bone which is the thinnest region along the medial wall.<sup>6</sup> Other fractures include combined medial orbital wall and nasal fractures

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(46%), combined naso-orbito-ethmoid fractures (26.8%), isolated inferior wall fractures (18.3%), zygomaticomaxillary complex fractures (3%), and inferior orbital rim fractures (1%).<sup>10</sup>

Initial management should follow the Advance Trauma Life Support guidelines for maxillofacial injuries. A detailed history and physical exam are imperative with particular focus on visual disturbances, including blurred or double vision and loss of vision. A high suspicion for orbital fracture should be raised when physical exam reveals impact to extraocular movements, sensation changes, and/or orbital instability. A physical examination finding that should require immediate attention and treatment is a positive oculo-cardiac reflex. This presents as a triad of symptoms, including bradycardia, nausea, and syncope. Immediate attention is required to avoid fatal cardiac arrhythmia (1:3500).<sup>11</sup>

The gold standard for diagnostic confirmation is the orbital computed tomography. For orbital floor fractures, it is essential to visualize the inferior and medial rectus muscles, best seen in the coronal plane, which may suggest entrapment and diplopia. Medial orbital wall fractures have strong associations with enophthalmos (posterior malposition) as a result of the collapse of the lamina papyracea or entrapment of the medial rectus muscle. Red-flag computed tomography scan features that indicate immediate surgical correction include orbital apex fractures in the setting of worsening vision, damage to globe or optic nerve, periorbital emphysema, retrobulbar hematoma, and impinging bone fragment.<sup>3</sup> In the pediatric population, the orbital floor can “spring back” into place causing entrapment which is also considered a surgical emergency.

Once surgical intervention is recommended, the type of surgical approach should be determined. There are four surgical approaches that can be performed for orbital fractures: the subciliary, the subtarsal, the transcaruncular/transconjunctival, and the endoscopic. Although there are multiple variations for the surgical approaches, the majority of the published articles about orbital fractures focus on surgical techniques, and just a few compared outcomes between surgical approaches.<sup>12</sup> Furthermore, only one randomized control trial evaluated differences between open surgical approaches without including the endoscopic approach.<sup>13</sup> The purpose of this practical review is to elucidate the risks and benefits of each surgical approach, and determine the one that offers lower complication rates.

## METHODS

A systematic review was conducted to compare surgical approaches (subciliary, transcaruncular, transconjunctival, subtarsal, and endoscopic) and postoperative complications in patients who underwent orbital wall fractures. (See table, Supplemental Digital Content 1, which displays the detailed number of complications reported per study included in the review. <http://links.lww.com/PRSGO/C535>.) A database search was performed in June 2021 in PubMed (PubMed Central, MEDLINE and Bookshelf) for all articles containing the terms “orbital,”

## Takeaways

**Question:** What are the risks and benefits of each surgical approach for orbital wall fractures, and which one offers the lowest complication rates?

**Findings:** We conducted a systematic review on postoperative complications and results of each surgical approach and found that subtarsal and transcaruncular approaches have a statistically significantly lower rate of complications.

**Meaning:** Choosing the correct approach for orbital wall fractures, it is imperative to understand the risks associated with each method. The subtarsal and transcaruncular approaches were observed to have the lowest rates of complications.

“wall,” “fracture,” and “surgery” with different combinations. PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) 2020 guidelines were used for article identification and final selection. Two independent researchers (M.P. and J.J.) obtained preliminary data and selected final manuscripts following the inclusion and exclusion criteria. Inclusion criteria consisted of articles describing the surgical approach on patients who had orbital wall fractures after 1999. Studies older than 1999 were not considered in this review due to the evolution of surgical approaches since that time and because most of these studies did not separately report complications for each approach. Studies evaluating other factors such as types of implants or materials used, studies using novel approaches, nontraumatic surgical procedures, and non-English articles were also excluded.

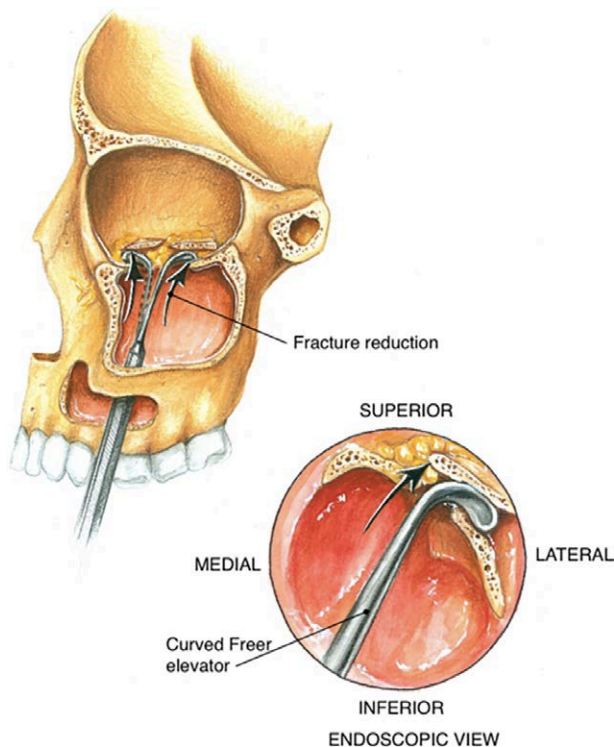
## Statistical Analysis

Total number of complications and noncomplications were summed by each of five surgical approaches. A five by two cross-tab was created with each row corresponding to specific surgical approach (endoscopic, subciliary, subtarsal, transcaruncular, and transconjunctival) and each column corresponding to whether complication occurred or not (yes/no). A chi-square test was used to evaluate whether there was a statistically significant relationship between surgical approaches and complication rate. This test was calculated using PROC FREQ with option of “chisq” using SAS version 9.4 (SAS Institute, Cary, N.C.; [www.sas.com](http://www.sas.com)). The level of statistical significance was set at a *P* value less than 0.05.

## SURGICAL APPROACHES

### Subciliary

The subciliary approach was first introduced by Converse in 1944 to address orbital floor fractures.<sup>14</sup> It is classically described as a cutaneous incision placed at the skin crease several millimeters below and parallel to the lash line (Fig. 1). The incision begins at the punctum medially and is continued laterally for 15 mm beyond the lateral canthus.<sup>15</sup> The skin is dissected from the orbicularis to the



**Fig. 1.** Endoscopic approach. Reprinted with permission from *Otolaryngol Head Neck Surg.* 140(6):849–854. © 2009 by Official Journal of the American Academy of Otolaryngology-Head and Neck Surgery Foundation.

level just beneath the tarsal plate before traversing the orbicularis muscle fibers down to the orbital septum (stepped or subciliary skin-muscle flap). This plane is then followed to the infraorbital rim. The periosteum is then incised, and access is gained to the fracture site. This stepwise fashion is completed so that there is no direct scarring of the eyelid, mitigating against scar inversion. There are two modifications: the subciliary skin flap, which divides the orbicularis fibers at the same level of the periosteal incision rather than subtarsally, and the nonstepped skin muscle flap, where the skin and orbicularis muscle are incised at the same time to the tarsal plate and the incision follows the preseptal plane to the infraorbital rim.<sup>15</sup> The skin-muscle approach seems to have more favorable aesthetic outcomes with decreased skin necrosis than the skin-only approach, decreased ecchymosis, and lower incidence of ectropion. Nevertheless, the subciliary approach has been shown to have a higher incidence of denervation of the pretarsal orbicularis.<sup>15</sup>

### Subtarsal

The subtarsal approach was also created by Converse.<sup>14</sup> The incision is made along the lower border of the tarsal plate in the subtarsal fold (Fig. 2). If there is edema, then the incision is made 5–7 mm from the lower eyelid margin following the inferolateral cant approximating the normal subtarsal crease. The orbicularis muscle is then encountered and divided in the direction of its fibers below the skin incision and carried to the level of the infraorbital

rim in a preseptal plane. This prevents scar inversion and preserves all innervations to the pretarsal orbicularis and much of the preseptal orbicularis.<sup>15</sup>

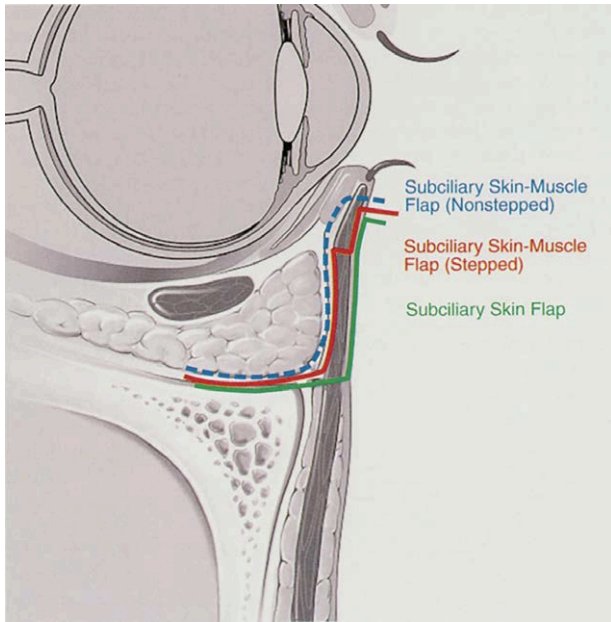
### Transcaruncular/Transconjunctival

The transconjunctival approach can use two separate routes to access the infraorbital rim: retroseptal and preseptal (Figs. 3 and 4).<sup>16</sup> The retroseptal route includes a transconjunctival incision with direct entry into the fat compartments of the lower eyelid and subsequently the infraorbital rim. The preseptal route makes an incision just below the tarsal border and enters toward the suborbicularis oculi/preseptal space above the fusion of the lower lid retractors and the orbital septum. The infraorbital rim is reached using the supraperiosteal plane.

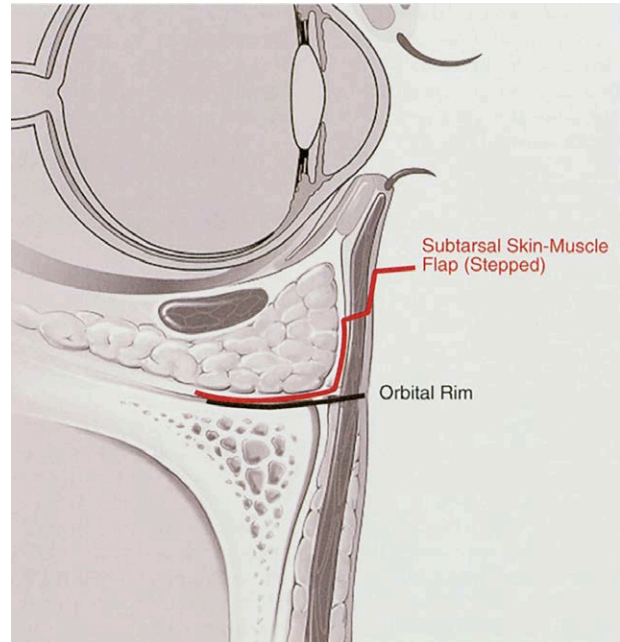
Similarly, the transconjunctival approach allows access to the medial orbital wall using a medial conjunctival incision posterior to the lacrimal draining system along the semilunar fold (Figs. 3 and 4).<sup>17</sup> Incisions can either be precaruncular or transcaruncular. This dissection pathway is continued inside the periorbital soft tissue until the posterior lacrimal crest is reached. The lacrimal system is left intact and the periorbital is incised until the medial orbital wall is encountered.

### Endoscopic

Since its inception in the 1990s, the endoscopic method has evolved. Generally, endoscopic methods are carried out through a transnasal approach. Initial procedures performed a medial infundibulectomy, initially done via sickle knife (Fig. 5). The uncinat process is then removed with forceps via sublaxation. The maxillary ostium is enlarged so that a 30-degree or 70-degree endoscope can be used to identify the orbital fracture. Ureteral balloon catheters can be used to elevate the fractured contents to their normal state.<sup>18</sup> Initial procedures were done without rigid fixation, hence the use of the balloon. Modern endoscopic procedures are also conducted transnasally; however, there are other access sites (ie, transconjunctively).<sup>19</sup> Largely, standard transnasal endoscope procedures are used, including 4-mm rigid nasal endoscopes (0 degree and 30 degrees). The orbital floor can be accessed via wide maxillary antrostomy, and an anterior ethmoidectomy is performed to assess the medial orbital wall in relation to the orbital floor. An isolated orbital floor fracture can then be created, which then causes herniation of orbital contents. Unstable bone fragments are removed, and a porous polyethylene plate (ie, MEDPOR; Stryker Corporation, Kalamazoo, Mich.) is inlayed along the defect.<sup>20</sup> The use of a balloon inside the maxillary sinus for reduction of orbital fat is associated with more discomfort in comparison to nasal packing, which is now preferred. Complications that can arise from endoscopic approaches include discomfort, damage to surrounding structures, and increased infection (especially packing compared with balloon inflation). However, there are advantages including better visualization of the anatomy and aesthetic outcome.<sup>20</sup> This method is generally used by otolaryngologists, and there are many studies accepting the validity of this method.



**Fig. 2.** Different subciliary approaches. Reprinted with permission from *Plast Reconstr Surg.* 2003;111(5):1708–1714.



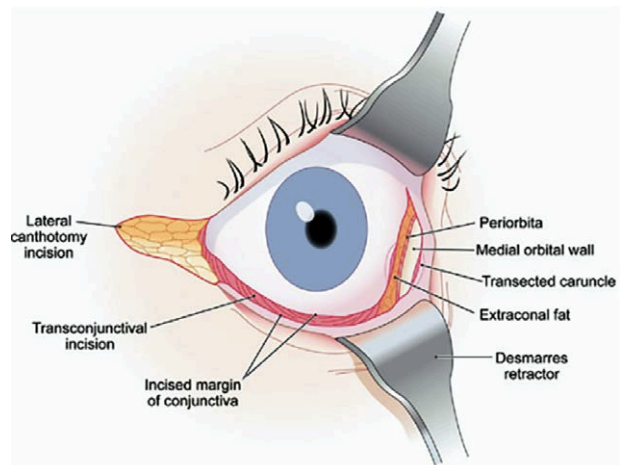
**Fig. 3.** Subtarsal approach. Reprinted with permission from *Plast Reconstr Surg.* 2003;111(5):1708–1714.

## RESULTS

A total of 950 articles were retrieved from the search. After inclusion and exclusion criteria, a total of 25 manuscripts published between 1999 and 2020 were included in this review (Figure 6, Table 1). The number of patients in the studies ranged from four to 103, with a total of 1137 patients. Six studies evaluated the transcaruncular approach<sup>12,17,35,38,40,43</sup>; 12 studies, the endoscopic approach<sup>12,24,26,29,31,33,34,36,37,39,41,42</sup>; seven, the transconjunctival approach<sup>13,21,23,25,27,28,30</sup>; three, the subciliary approach<sup>13,21,30</sup>; and four, the subtarsal approach.<sup>13,22,30,32</sup> The range of follow-up of the studies varied from 2 weeks to 63 months (Table 1).

## COMPARISON BETWEEN SURGICAL APPROACHES

The total number of orbital fractures included in the analysis was 1137 (Table 2). The most frequent surgical approach was the endoscopic (33.3%), followed by the external surgical approaches. The most frequent external surgical approaches included the transconjunctival (32.8%), the subciliary (13.5%), the subtarsal (11.5%), and the transcaruncular (8.9%). The incidence of complications regardless of surgical approach was 22.6%. The reported complications included diplopia, motor deficit, ptosis, entropion, ectropion, enophthalmos, corneal injury, proptosis, lagophthalmos, keratoconjunctivitis sicca, vision disturbances, scar, epiphora, scleral show, asymmetry, intraorbital hemorrhage, trichiasis, implant misplacement, canthal dystopia, hyperpigmentation, lower eyelid skin dimpling, lid edema, infection, and blepharoptosis. When complications were analyzed by surgical approach, the transconjunctival approach had a statistically significantly higher rate of complications (36.2%), followed by

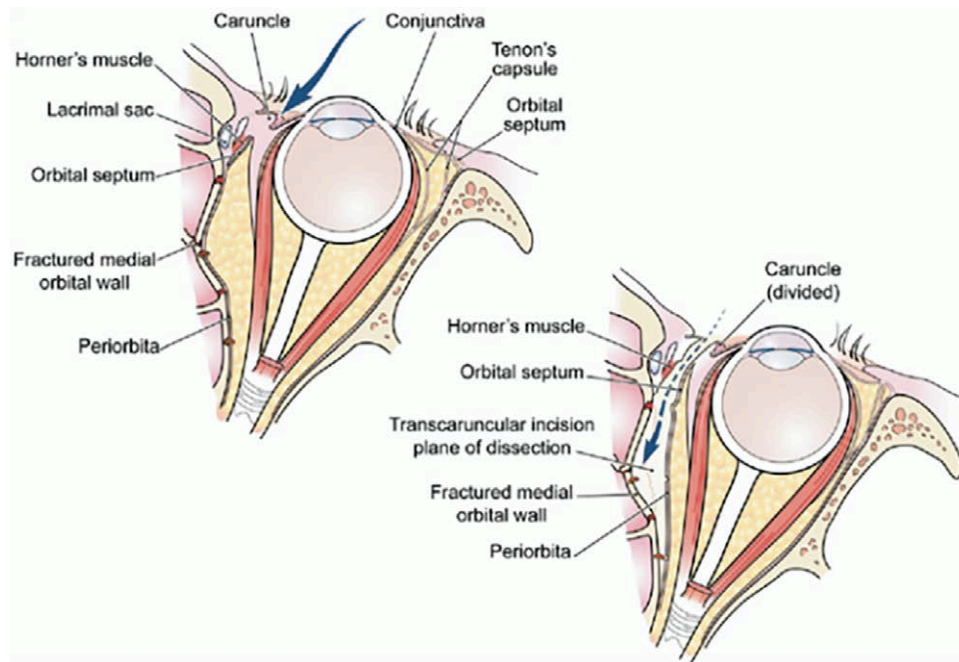


**Fig. 4.** Transcaruncular, transconjunctival, and lateral canthotomy incisions. Reprinted with permission from *Plast Reconstr Surg.* 2007;65(11):2345–2349.

the subciliary (21.4%), and endoscopic approach (20.2%,  $P < 0.0001$ , Table 2). The subtarsal approach had the statistically significantly lowest rate of complications (8.2%) followed by the transcaruncular approach (14.0%,  $P < 0.0001$ , Table 2).

## DISCUSSION

This practical review summarizes and highlights the initial evaluation and surgical approach of orbital fractures. Reporting the complications such as retrobulbar hemorrhage, infection, intraorbital hemorrhage/



**Fig. 5.** Axial views of transcaruncular approach (blue arrow) to the right medial orbital wall fracture and relationships. Reprinted with permission from *Plast Reconstr Surg.* 2007;65(11):2345–2349.

hematoma, and sensory injury, related with each surgical approach is important, as all these issues can potentially lead to blindness although there is a low probability of this happening.<sup>44</sup> This study demonstrated that the subtarsal and transcaruncular approaches for orbital fractures have the lowest complication rates.

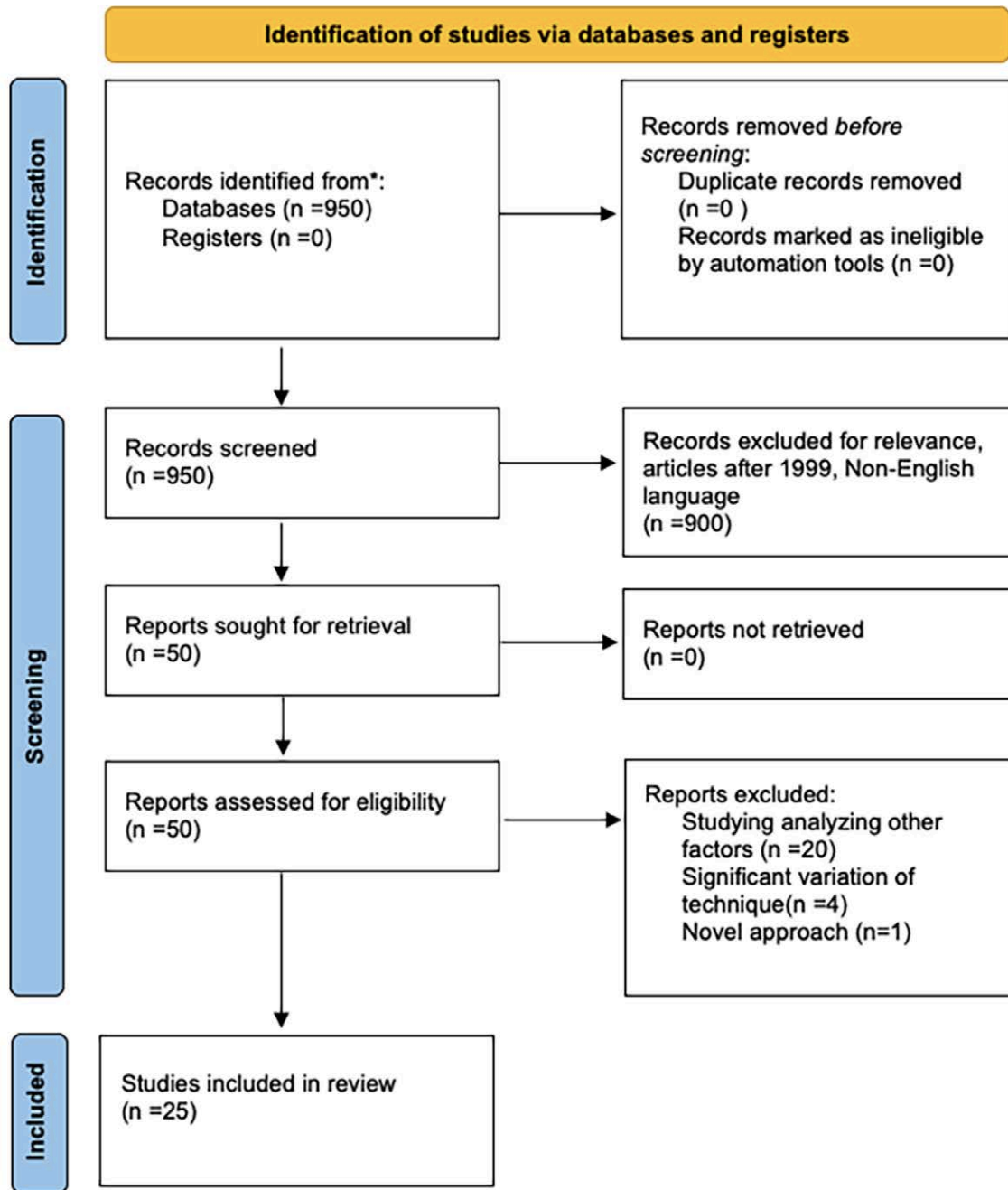
During the early days of transcutaneous orbital wall reconstruction, there were several concerns about scarring, especially now when compared with the conjunctival or endoscopic methods. Our findings align with Bähr’s 1992 study<sup>45</sup> showing a significantly lower incidence of complications for the subtarsal approach (8.8%) compared with the subciliary (25%) and transcaruncular approaches (30.4%). In our current study, the incidence of complications for the subtarsal approach was 8.2% (Table 2). Out of the 131 patients who underwent a subtarsal approach, nine (6.9%) experienced scar; five (3.82%) had scleral show; three (2.29%), ectropion; two (1.53%), lid edema; one (0.76%), epiphora; and one (0.76%), keratoconjunctivitis sicca. Similarly to our study, Bähr et al<sup>45</sup> also noted scar and scleral show as the most frequent complications for the subtarsal approach.

We have observed that scar was present more frequently in patients who had a subtarsal approach compared with those who underwent a subciliary approach. Heckler et al<sup>46</sup> postulated that the etiology of the difference in scar formation is that the subtarsal incision has poorer muscle mobility and skin quality in comparison to the subciliary incision. Additionally, there is an increased risk for noticeable scar as the incision is further away from the lash line in comparison to a subciliary approach.<sup>12</sup> Contrary to this, in 2021, Oztel et al<sup>47</sup> found that out of a series of 67 patients who underwent subtarsal incision for orbital wall

fractures, 61 had no visible scar. Although the conjunctival incision has no scar, the excellent outcomes proposed by Oztel et al<sup>47</sup> demonstrate that scar formation may actually be limited, and that subtarsal incisions should be considered when reconstructing the orbital wall. Finally, when comparing surgical approaches, it is imperative to consider exposure and access for selecting the best approach. Both transcaruncular and subtarsal incisions allow for direct wide exposure of the orbital floor when compared with endoscopic and transconjunctival approach. When there is concomitant fracture to the lateral border of the orbit, a subtarsal incision can be extended with a lateral canthal extension.<sup>26</sup>

Finally, with the advent of endoscopic techniques, there has been a push to be minimally invasive for aesthetic outcomes with results similar to those of transcutaneous approaches. Han et al<sup>12</sup> completed a comparison study of transcaruncular approach with endoscopic endonasal reduction. They ultimately concluded that the reduction rate in degree of enophthalmos, diplopia, and extraocular movement limitation between the two groups was insignificant (average reduction rate of endoscopic approach was 89.2% versus 90.7% for transcaruncular). However, they noticed that operation time, length of hospital stay, and cost were higher in the endoscopic approach.

As we improve our endoscopic technique, this may become the standard of care for orbital wall reconstruction; however, subtarsal or transcaruncular approaches are preferred at this time because they are low-complexity and low-cost procedures. Both procedures have minimally invasive incisions with a direct approach to the orbital floor and infraorbital rim.



From: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ* 2021;372:n71. doi: 10.1136/bmj.n71

Fig. 6. Inclusion criteria.

### LIMITATIONS

The main limitation of this systematic review is the heterogeneity of included studies which makes it difficult to compare types of complications between surgical approaches. In addition, the retrospective nature and different follow-up periods of the included articles may have influenced the rate of complications. This shows that there is a clear need for level 1 evidence comparing the surgical approaches discussed, with the inclusion of endoscopic

techniques. High quality randomized controlled trials can help to reduce the confounding variables found in this study and definitively determine which approach has the fewest complications and best overall outcomes for orbital wall reconstructions. Moreover, selection bias may have occurred when trying to make the data uniform. Regardless of the limitations, we believe this review elucidates the best surgical approach that offers the lowest rate of complications for orbital wall reconstruction.

**Table 1. Included Studies That Evaluated Different Types of Surgical Approach for Orbital Fractures**

Authors	Year	No. Patients	Number of Orbital Fractures	Surgical Approach	Complications	Follow-up
Bronstein et al <sup>21</sup>	2020	82	82	Subciliary	Diplopia (n = 10), motor deficit (n = 2), ptosis (n = 1), entropion (n = 1), enophthalmos (n = 2), corneal injury (n = 6), proptosis (n = 3), ectropion (n = 2), lagophthalmos (n = 1), Keratoconjunctivitis Sicca (n = 3), vision disturbances (n = 1)	At least 6 mo
Mahajan et al <sup>22</sup>	2020	102	102	Transconjunctival	Diplopia (n = 11), motor deficit (n = 1), ptosis (n = 5), entropion (n = 4), enophthalmos (n = 7), infection (n = 4), corneal injury (n = 7), proptosis (n = 7), ectropion (n = 2), lagophthalmos (n = 1), Keratoconjunctivitis Sicca (n = 4), vision disturbances (n = 1)	At least 6 mo
Mohamed et al <sup>15</sup>	2020	30	30	Subtarsal	Scar (n = 5), scleral show (n = 3)	At least 12 mo
		15	15	Subciliary	Ectropion (n = 3), scleral show (n = 4), epiphora (n = 2)	NS
		15	15	Subtarsal	Scar (n = 2), ectropion (n = 1), scleral show (n = 1), epiphora (n = 1)	NS
		15	15	Transconjunctival	Entropion (n = 3), ectropion (n = 1), scleral show (n = 2), epiphora (n = 3)	NS
Park et al <sup>23</sup>	2019	32	32	Transconjunctival	Ptosis (n = 7)	3 mo
Kühnel et al <sup>24</sup>	2017	17	17	Endoscopic	Infection (n = 1), sensory injury (n = 1)	NS
Chou et al <sup>25</sup>	2017	19	19	Transconjunctival	Diplopia (n = 1)	Median: 3.2 mo (range: 2 wk–6 mo) Range: 6–15 mo
Wu et al <sup>26</sup>	2013	93	93	Endoscopic	Diplopia (n = 3), enophthalmos (n = 1), asymmetry (n = 1), intraorbital hemorrhage (n = 1)	Mean: 22 mo (range: 2–48 mo) Mean: 70.8 mo (range: 11–163 mo)
Novelli et al <sup>27</sup>	2011	53	56	Transconjunctival	Entropion (n = 2), trichiasis (n = 2)	Mean: 22 mo (range: 2–48 mo) Mean: 70.8 mo (range: 11–163 mo)
Han et al <sup>12</sup>	2009	29	29	Endoscopic	Enophthalmos (n = 4)	Mean: 70.8 mo (range: 11–163 mo)
		19	19	Transcaruncular	Implant misplacement (n = 1), enophthalmos (n = 2)	Mean: 70.8 mo (range: 11–163 mo)
Kim et al <sup>28</sup>	2009	103	103	Transconjunctival	Diplopia (n = 5), enophthalmos (n = 4), canthal dystopia (n = 1), hyperpigmentation (n = 4), lower eyelid skin dimpling (n = 2)	At least 6 mo
Hinohira et al <sup>29</sup>	2009	23	23	Endoscopic	Enophthalmos (n = 1)	Mean: 12.9 mo
Ridgeway et al <sup>30</sup>	2009	74	74	Subtarsal	Scar (n = 1), ectropion (n = 2), lid edema (n = 1)	NS
		56	56	Subciliary	Scar (n = 2), ectropion (n = 7), lid edema (n = 5)	NS
		45	45	Transconjunctival	Entropion (n = 2)	NS
Ducic and Verret <sup>31</sup>	2009	63	63	Endoscopic	Poor reduction (n = 2)	NS
Baqain et al <sup>32</sup>	2008	12	12	Subtarsal	Scar (n = 1), keratoconjunctivitis sicca (n = 1), scleral show (n = 1), lid edema (n = 1)	Mean ± SD: 37.25 ± 23.7 mo (range: 10–73 mo)
Jeon et al <sup>33</sup>	2007	40	40	Endoscopic	Diplopia (n = 6), motor deficit (n = 1), enophthalmos (n = 4)	Range: 1.5–52 mo
Jin et al <sup>34</sup>	2007	48	48	Endoscopic	Diplopia (n = 11), enophthalmos (n = 2), infection (n = 1)	Range: 3 mo–4 y
		48	48	Transcaruncular	Diplopia (n = 20), implant misplacement (n = 1), enophthalmos (n = 4), scar (n = 1), intraorbital hemorrhage (n = 1), ectropion (n = 2)	Range: 3 mo–4 y
Kim et al <sup>35</sup>	2005	13	13	Transcaruncular	Diplopia (n = 1), ocular motility (n = 3)	Range: 5–24 mo
Sanno et al <sup>36</sup>	2003	21	21	Endoscopic	Diplopia (n = 4), mydriasis and blepharoptosis-superior orbital fissure syndrome (n = 1)	Mean: 34I days
Lee et al <sup>37</sup>	2002	16	16	Endoscopic	Diplopia (n = 1)	Range: 13–25 mo
Graham et al <sup>38</sup>	2002	5	6	Transcaruncular	None	Mean: 19.3 mo (range: 6–63 mo)
Chen et al <sup>39</sup>	2001	9	9	Endoscopic	Diplopia (n = 1), enophthalmos (n = 1)	Mean: 10 mo

(Continued)

**Table 1. (Continued)**

Authors	Year	No. Patients	Number of Orbital Fractures	Surgical Approach	Complications	Follow-up
Shorr et al <sup>17</sup>	2000	10	10	Transcaruncular	None	Mean: 23 mo (range: 2–62 mo).
Baummann and Ewers <sup>40</sup>	2000	5	5	Transcaruncular	None	Mean: 12 mo
Jin et al <sup>41</sup>	2000	16	16	Endoscopic	Diplopia (n = 1), enophthalmos (n = 2)	Mean: 7 mo
Chen et al <sup>42</sup>	1999	4	4	Endoscopic	Enophthalmos (n = 1)	Mean: 11 mo (range: 8–16 mo)

NS, not specified.

**Table 2. Comparison of Complications between Surgical Approaches for Orbital Wall Fractures\***

Approach	No.		
	Complications (n = 257)	Complications (n = 880)	Total (N = 1137)
Endoscopic	52 (20.2%)	327 (37.2%)	379 (33.3%)
Subciliary	55 (21.4%)	98 (11.1%)	153 (13.5%)
Subtarsal	21 (8.2%)	110 (12.5%)	131 (11.5%)
Transcaruncular	36 (14.0%)	65 (7.4%)	101 (8.9%)
Transconjunctival	93 (36.2%)	280 (31.8%)	373 (32.8%)

\*P using chi-square test, with  $P < 0.0001$  indicating a statistically significant relationship between any of five approaches and complication rate.

### CONCLUSIONS

The subtarsal and transcaruncular approaches were observed to have the lowest rates of complications, whereas the transconjunctival, subciliary, and endoscopic approaches were reported to have higher rates of complications. Further research is needed to determine the best approach for patients with orbital wall fractures.

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### DISCLOSURE

Dr. Janis receives royalties from Thieme and Springer publishing. All the other authors have no financial interests to declare in relation to the content of this article.

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