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Is Surgery Needed for Diplopia after Blowout Fractures? A Clarified Algorithm to Assist Decision-making

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Background: Diplopia is a common symptom after blowout fractures, with an incidence of 43.6%–83%. Although there is some consensus toward surgical correction, diplopia is not always resolved by surgery. Thus, there is a clinical dilemma for surgeons with regard to performing surgery at a specific time. This review aimed to create an algorithm to support accurate and effective decision-making.

Methods: We reviewed articles published on PubMed during 2013–2020 regarding orbital fractures. Articles discussing surgical treatment for blowout fractures and diplopia were included. Five reviews, six prospective cohort studies, and 33 retrospective studies were identified. After reviewing and summarizing these articles, a step-by-step algorithm was created.

Results: Most authors advise immediate surgery when a patient presents with either a positive oculocardiac reflex or a "trapdoor" fracture. Early surgical correction is recommended in children to prevent profound muscle damage. In other scenarios, most authors recommend performing surgery within 2 weeks. The algorithm begins with the aspect of motility, including muscle entrapment assessed by computed tomography or limited movement of the extraocular muscle. When there is no abnormality in motility, the algorithm continues to the aspect of position. Generally, an orbital floor defect of more than 50% or 2 cm^2 or an enophthalmos of more than 2 mm is indicated for surgery. However, diplopia may also gradually resolve after improvement of periorbital edema or swelling.

Conclusion: We proposed a step-by-step approach to help surgeons make effective decisions concerning surgical correction for patients suffering from blowout fractures with diplopia at different time points. *(Plast Reconstr Surg Glob Open 2022;10:e4308; doi: 10.1097/GOX.0000000000004308; Published online 9 May 2022.)*

INTRODUCTION

Blowout fractures refer to traumatic orbital fractures involving the orbital floor and/or medial orbital wall where the bony structures in the orbital cavity are relatively thinner. Many symptoms may occur after blowout fractures, including diplopia, visual impairment, hypoglobus, and enophthalmos.[1–3] Diplopia is usually binocular diplopia, which means that double vision is present when looking with both eyes.[4] The incidence of diplopia after blowout fractures is reported to range from 43.6% to 83%.[1,5,6] There are various etiologies of diplopia after blowout fractures, including orbital edema, orbital hemorrhage, displacement of periorbital tissues, or injuries to associated nerves or muscles.[2,4,7] In recent years, there has been a consensus toward an observation strategy before deciding to perform surgical correction within the first 2 weeks of diplopia, except for some urgent conditions, as diplopia may gradually resolve by itself. If diplopia persists after 2 weeks of observation, surgical treatment is usually advised.[2,4,8,9] However, diplopia may still be present after surgical correction. The rate of postoperative diplopia is reported to be up to 89% and 21.6% at 1 month and 1 year after surgery, respectively.[9,10] As a result, there remains a

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clinical dilemma for surgeons to decide whether to perform surgery or not at a specific time in patients suffering from blowout fractures having diplopia. Thus, this review aimed to create an algorithm by summarizing the consensus from the literature on diplopia to assist surgeons in making accurate and effective decisions about surgical correction.

MATERIALS AND METHODS

A literature search of published articles indexed in database MEDLINE from 2013 to 2020 regarding orbital fractures was performed with the string ((“orbital fractures”[MeSH Terms] OR “blowout”[All Fields]) AND “diplopia”[MeSH Terms]). The inclusion criterion was an English published clinical study or review discussing the impacts of surgical treatments in the orbital fractures. The exclusion criteria were a clinical study having a patient number less than 30 or that the article did not state the differences regarding preoperative or postoperative diplopia. Among the identified 141 clinical studies or reviews in English, six were not eligible and four were duplicated; these articles were excluded. In the remaining 131 articles, 31 did not compare the impacts of surgical repairs/corrections and were thus excluded. Forty-eight clinical studies presented with a patient number less than 30 and were further excluded. Subsequently, eight articles were excluded because they did not specifically state the presentations of diplopia before and after primary surgical repairs/corrections. In the end, 44 publications were included for the review and are listed in Table 1. Figure 1 demonstrates the literature search and screening. After reviewing and summarizing the articles, a step-by-step algorithm was created.

RESULTS

In the literature, most authors advise immediate surgery to restore the displacement and reconstruct the fracture site in cases presenting with either a positive oculocardiac reflex (bradycardia or nausea while gazing upwards) or a “trapdoor” fracture in children (both suggest entrapment of the inferior rectus muscle). There is still consensus toward early surgical correction in children demonstrating diplopia from blowout fractures to prevent profound muscle damage and muscle contractures.[4,8,11-17] Interestingly, a longer operation time was found to be associated with a higher possibility of diplopia in the pediatric population.[18]

The causes for diplopia in blowout fractures can be separated into two main groups: motility and position. Besides the conditions mentioned above that demand immediate or early surgery, surgical treatment should be considered for patients having diplopia without assurance of improvement with time. Most authors recommended performing the surgery within 2 weeks.[2,4,8–10,19,20] Based on the literature review, we created the proposed algorithm detailed in Figures 2 and 3.

The algorithm begins by considering the aspect of motility (Fig. 2). First, the movement of extraocular muscles (EOMs) should be assessed in detail, including assessment with forced duction tests to see whether limitations exist. Horizontal diplopia might develop when there is entrapment of the medial rectus muscle in medial orbital wall fractures, although rare, and is indicated for surgical correction.[21,22]

Vertical diplopia may appear during upward or downward gaze. The former usually results from entrapment of the inferior periorbital tissues in orbital floor fractures, and surgery is suggested if soft tissue herniation is observed in the computed tomography (CT) scan.[1,4,10,11,21]

Takeaways

Question: When is surgery suggested for clinical diplopia after traumatic blowout fractures?

Findings: Two main considerations are motility and position.

Meaning: A step-by-step approach to help surgeons make more accurate and effective decisions regarding surgical correction even at different time points.

Table 1. Included Articles (n = 44) Discussing Surgical Correction of Diplopia in Blowout Fractures Published from 2013 to 2020

No.	Author(s)	Methods of Research	Patient No.
1	Cheung et al[43]	Review	—
2	Wu et al[44]	Retrospective study	93
3	Soejima et al[45]	Retrospective study	52
4	Pohlenz et al[42]	Retrospective study	31
5	Shah et al[7]	Retrospective study	56
6	Timoney et al[12]	Retrospective study	57
7	Berg et al[33]	Retrospective study	94
8	Alhamdani et al[34]	Retrospective study	183
9	Su et al[13]	Retrospective study	83
10	Kim et al[46]	Prospective cohort study	34
11	Bartoli et al[6]	Retrospective study	301
12	Christensen et al[19]	Review	—
13	Safi et al[2]	Retrospective study	204
14	Marano et al[49]	Prospective cohort study	64
15	Liu et al[9]	Retrospective study	92
16	Jung et al[27]	Retrospective study	181
17	Shin et al[40]	Retrospective study	37
18	Yu et al[8]	Retrospective study	421
19	Felding et al[35]	Retrospective study	100
20	Ramphul et al[1]	Retrospective study	126
21	Silverman et al[24]	Retrospective study	45
22	Firriolo et al[18]	Retrospective study	152
23	Yoo et al[14]	Retrospective study	150
24	Kim et al[47]	Retrospective study	73
25	Felding[11]	Review	—
26	Pérez-Flores et al[5]	Retrospective study	39
27	Gavin-Clavero et al[16]	Retrospective study	153
28	Kohyama et al[50]	Retrospective study	115
29	Alameddine et al[36]	Retrospective study	45
30	Barh et al[17]	Retrospective study	52
31	Seen et al[51]	Retrospective study	88
32	Ordon et al[21]	Retrospective study	78
33	Saha et al[48]	Prospective cohort study	30
34	Alafaleq et al[22]	Retrospective study	60
35	Hsu et al[23]	Retrospective study	141
36	Hartwig et al[10]	Retrospective study	53
37	Su et al[15]	Retrospective study	30
38	Bianchi et al[32]	Prospective cohort study	188
39	Homer et al[4]	Review	—
40	Balaji et al[31]	Retrospective study	44
41	Tsumiyama et al[52]	Prospective cohort study	72
42	Scolozzi et al[28]	Prospective cohort study	108
43	Jazayeri et al[20]	Review	—
44	Pankratov et al[25]	Retrospective study	52

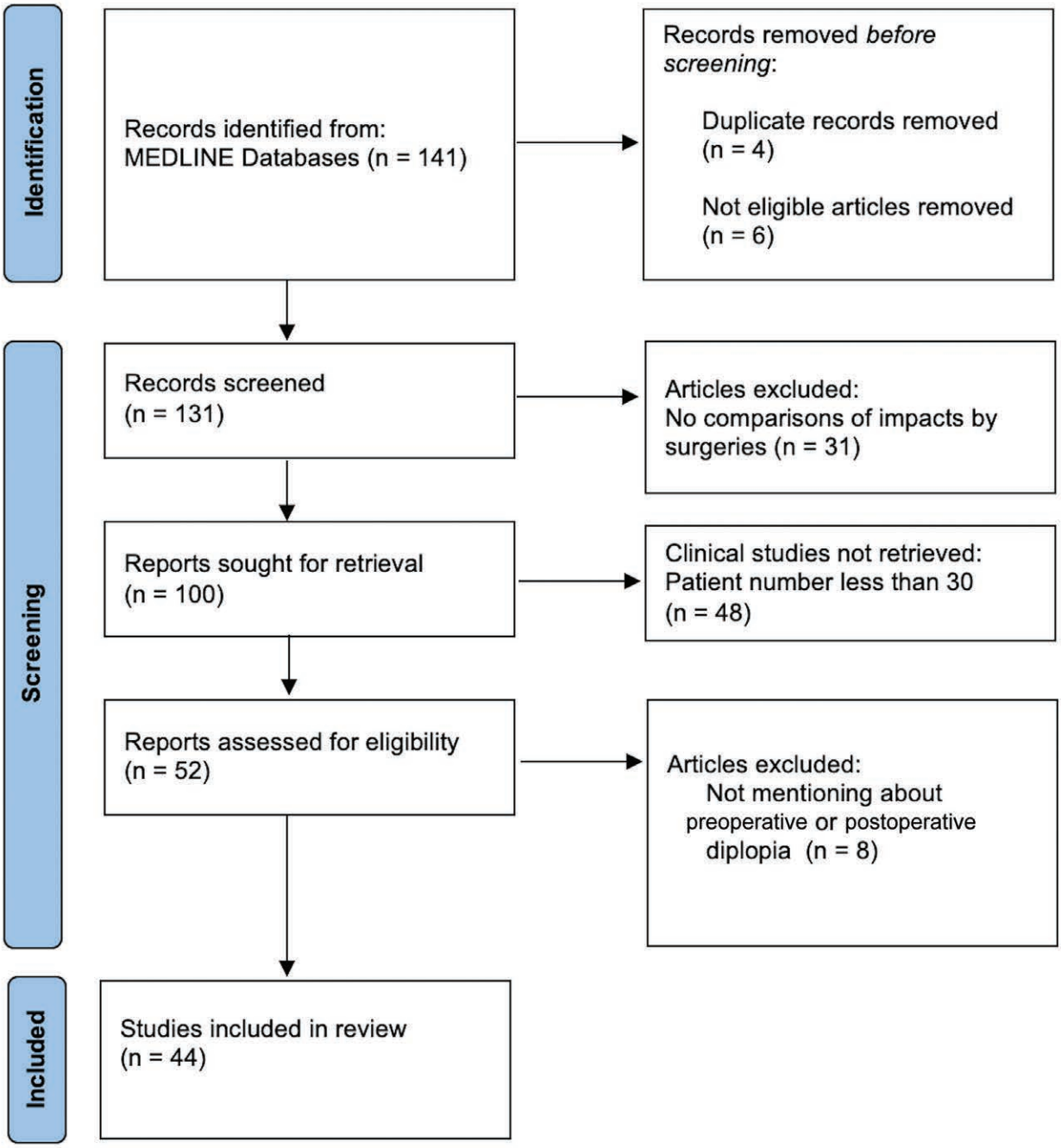

Fig. 1. Literature search and screening.

In the absence of soft tissue herniation identified by CT, the limitation of EOM while gazing upward might be due to neurogenic or myogenic causes, resulting in dysfunction of the periorbital muscles.[1,23] If evidence of muscle extrusion is observed on CT, vertical diplopia while gazing downward may occur and surgery should be considered.[5,8,24] Posttraumatic inflammation, whether being presurgery or postsurgery, and the subsequent formation of scars and fibrosis at inferior periorbital tissue sites might produce adhesions and thus restrict normal movement of the EOM when the eyeballs gaze downward.[1,23,25–27] When there is no abnormality regarding motility, the algorithm continues to the aspect of position (Fig. 3). Generally, an orbital floor defect larger than 50% or 2 cm^2 is indicated for a surgical correction.[4,11,23,28] Additionally, an enophthalmos of more than 2 mm, which is commonly related to substantial herniated orbital tissues inferiorly after orbital floor fracture, is an indication for surgery.[4,21,23] However, diplopia may also gradually resolve after improvement of periorbital edema or swelling.

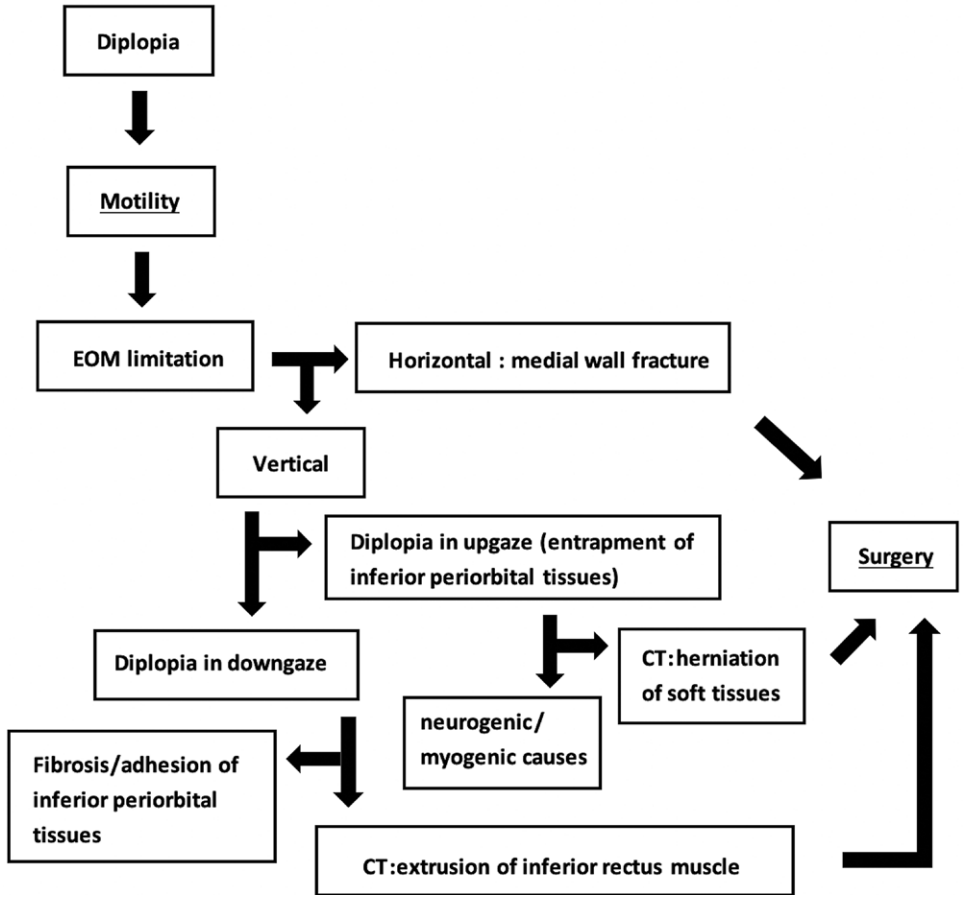

Fig. 2. The algorithm begins with the consideration of motility.

DISCUSSION

In many published studies, marked improvement in diplopia and motility is reported after surgery and generally continues over time. For example, Liu et al reported significant differences with respect to diplopia and EOM movement at 3 months compared with one month after surgery.[9,10] As noted by Ramphul and Hoffman, there is also a greater possibility of postoperative diplopia among patients with initial diplopia after trauma and before surgery. [1,29]

At present, CT scans are readily obtained for patients with facial trauma. However, CT is not a completely reliable indicator of muscle entrapment in blowout fractures owing to a 9%–10% false-negative rate.[30] As delayed treatment of actual muscle entrapment may result in permanent dysfunction of the eyeball,[31] it is critical to make a timely and accurate decision regarding surgery. A certain percentage of patients with blowout fractures recover from diplopia when posttraumatic edema and swelling subside several days later.[11,32] Furthermore, incidence of persistent postoperative diplopia has been reported at a rate as high as 86% at 1 month after surgery.[1,5,6,10,26,33–36] Although diplopia diminish gradually in most, some patients experience long-lasting diplopia (>1 year).[1,6,32,34] Furthermore, some patients acquire diplopia after surgery even with no previous diplopia before.[10,16] As a result of these complications, decision-making for surgical correction of blowout fractures can be challenging, while the clinical symptoms usually vary with time.

The algorithm proposed here after reviewing the literature aims to assist surgeons in making decisions regarding surgery for traumatic diplopia in a meticulous way by using a step-by-step approach at different time points. By assessing the movement of EOMs, diplopia could occur in a horizontal or vertical direction.[37] Nevertheless, not all cases would present with extrusion of periorbital soft tissues or muscles in CT scans; in such circumstances, a surgical correction would be considered. Merely an injury to motor nerves innervating orbital muscles or a direct orbital muscle injury or subsequent fibrosis could produce a dysfunction of orbital motility.[1,23,38,39] On the other hand, swelling or fibrosis surrounding the eyeball, especially in the inferior aspect, could cause changes of orbital motility and result in diplopia when the eyeballs gaze downward.[1,23,25–27] Although motility dysfunction is found, surgery is recommended only when there is a compatible defect in imaging. Although diplopia may gradually resolve after the improvement of periorbital edema or swelling in some patients, most surgeons verify either the presence of an orbital floor defect larger than 50% or 2 cm^2 or an enophthalmos greater than 2 mm to be indicated for a surgical correction.[4,11,23,28]

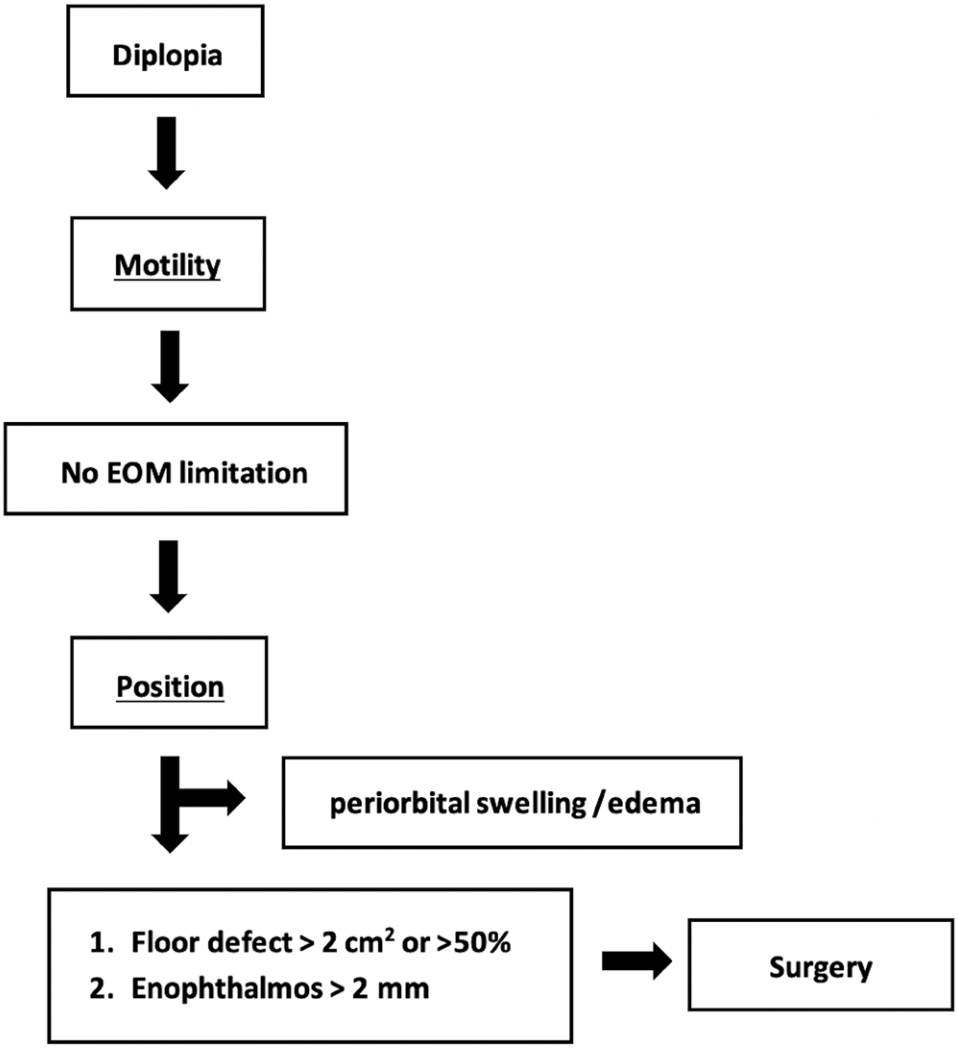

Fig. 3. After considering motility dysfunction, the algorithm considers position.

Enophthalmos and change of eyeball position might not occur prominently in the first few weeks after trauma due to the increased volume in the injured orbital cavity.[15,20] This is the reason why the motility of the injured orbit is checked first rather than position in our proposed algorithm. Navigation-assisted surgery has been developed and used for orbital floor reconstructions; Shin et al[40] reported no complications, including diplopia, in 37 cases of orbital fractures. Besides, diplopia occurred less often in pure medial orbital wall fractures that were generally treated conservatively. When there was evidence of soft tissue entrapment or symptoms, surgery was still recommended for medial orbital wall fractures, and the results were overall good.[22,41] Pohlenz et al[42] described that only one of 31 cases that received reconstructions mostly at the medial orbital wall showed diplopia, which was resolved after 12 months.

The articles reviewed here mainly made suggestions based on retrospective studies and correlation analyses, which is one of the limitations of this work. In addition, the diverse extent of the traumas and surgical methods included in these studies may lead to varying results—some studies revealed no permanent postoperative diplopia.[33,36,43–47] Some authors also noted different outcomes using disparate materials for reconstruction of the orbits.[12,31,42,46–52] Moreover, there were insufficient objective data, such as exophthalmometry to measure the positions of the eyeballs or a binocular single vision test for quantification,[21,34] in most of the studies. Further large prospective clinical studies should be performed to clarify these issues, and this algorithm could provide some direction.

CONCLUSIONS

When identifying clinical diplopia after traumatic blowout fractures, it can be challenging to decide to perform surgery because the symptoms usually vary with time. We proposed a step-by-step approach to help surgeons make more accurate and effective decisions regarding surgical correction even at different time points.

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