

CLINICAL AND ULTRASONOGRAPHIC ASSESSMENT OF POST-
TRAUMATIC OCULAR SUBATROPHY IN CHILDREN AND
ADOLESCENTS FOR REHABILITATION PLANNING

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Abstract. This article discusses the role of comprehensive clinical and ultrasonographic assessment in children and adolescents with post-traumatic ocular subatrophy when determining indications for globe-preserving rehabilitation or surgical preparation for ocular prosthetic rehabilitation. Particular attention is given to serial ultrasound biometry as a method for assessing progression of the atrophic process.

Keywords: children, adolescents, ocular trauma, post-traumatic ocular subatrophy, ultrasonography, ultrasound biometry, eyeball, ocular prosthesis, rehabilitation.

Introduction

Severe ocular trauma in childhood may lead not only to persistent visual impairment or complete loss of vision but also to gradually developing anatomical changes in the injured eye. The most unfavorable course is associated with extensive damage to intraocular structures, retinal detachment, ocular hypotony, inflammatory complications, and progressive disorganization of intraocular tissues. These changes may predispose to gradual reduction in globe size and subsequent deformation [2, 8].

Aim of the study - To determine the significance of clinical and ultrasonographic signs of post-traumatic ocular subatrophy in children and adolescents for the rational selection of a rehabilitation strategy.

Materials and Methods

A review of current literature was performed, focusing on severe ocular trauma in children, atrophic changes of the ocular globe, the role of ultrasonography in eyes with opaque optical media, and contemporary approaches to ocular prosthetic rehabilitation.

Results and Discussion

Current studies of pediatric open-globe injuries confirm that posterior segment involvement, retinal detachment, ocular hypotony, lens damage, and greater wound

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extent are associated with severe injury and an unfavorable functional outcome [1, 2]. In children, the consequences of trauma are of additional importance because facial and orbital growth is still ongoing, creating a risk of marked asymmetry and the need for prolonged medical and social rehabilitation.

It should be taken into account that the term *post-traumatic ocular subatrophy*, commonly used in ophthalmic practice in some countries, does not always correspond to the terminal stage of ocular atrophy. In contemporary English-language literature, the end-stage condition characterized by marked shrinkage, deformation, and internal disorganization of the globe is more commonly described as *phthisis bulbi*. This condition is associated with chronic hypotony, disruption of the blood–ocular barriers, inflammatory and degenerative changes, retinal and choroidal detachment, formation of cyclitic membranes, and, in advanced stages, calcification and ossification [8]. Therefore, in post-traumatic ocular subatrophy it is particularly important to determine not only whether the globe has decreased in size but also the degree of preservation of its anatomical structures and the subsequent course of the pathological process.

For a child, the consequences of severe unilateral ocular trauma extend beyond the ophthalmic diagnosis itself. Changes in the position and size of the globe, deformity of the palpebral fissure, scarring, ptosis, enophthalmos, and cosmetically visible asymmetry may adversely affect quality of life and social adaptation. A systematic analysis of pediatric ophthalmic data has shown that visual impairment and visible ocular disorders may be associated with deterioration in several aspects of quality of life, emphasizing the importance of considering not only the anatomical but also the rehabilitative outcome of treatment [5].

The choice of further management depends on the condition of the injured eye. If the eye is quiet, painless, free of signs of active inflammation, and suitable for cosmetic correction, preservation of the globe may be considered as one of the rehabilitation options. In the presence of persistent pain, chronic inflammation, marked deformation, progression of the pathological process, or inability to achieve adequate prosthetic rehabilitation, the need for surgical intervention should be determined individually [6, 8].

Thus, the absence of visual function alone should not serve as the sole indication for determining the extent of surgery. The clinical condition of the eye, the degree of

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anatomical preservation of the globe, and its suitability for subsequent cosmetic rehabilitation should all be assessed.

The clinical picture should also be interpreted in relation to the characteristics of the initial trauma. Current studies indicate that an unfavorable functional outcome in children is more often associated with extensive ocular damage, lens and posterior segment involvement, retinal detachment, and hypotony [1, 10]. These signs are important not only for the initial visual prognosis but also for understanding the severity of subsequent post-traumatic structural changes.

For cosmetic rehabilitation, preservation of the conjunctival fornices and the condition of the ocular surface are particularly important. Even in the presence of profound visual loss, a relatively stable and painless globe may retain anatomical and cosmetic value.

A contemporary systematic review of ultrasound biomicroscopy in pediatric ophthalmology has emphasized the value of ultrasonographic techniques in corneal opacities and anterior segment disease, when structures located behind opaque tissues cannot be directly visualized [3]. Two-dimensional B-scan ultrasonography remains an important method for evaluating the posterior segment when ophthalmoscopic visualization is impossible. A 2025 meta-analysis also confirmed the diagnostic value of B-scan ultrasonography for posterior segment disorders [11].

In post-traumatic ocular subatrophy, two interrelated diagnostic objectives should be addressed. Ultrasound biometry allows quantitative assessment of globe dimensions, particularly the axial length of the injured eye, whereas two-dimensional ultrasonography provides information on the internal structure of the globe.

A single measurement, however, has limited value because it reflects the condition of the eye only at the time of examination. Serial ultrasound biometry may therefore provide more clinically meaningful information.

If the axial dimension remains relatively stable on repeated examinations, this may indicate the absence of rapid globe shrinkage during the observation period. Continued reduction in globe size, particularly when accompanied by clinical deterioration, warrants closer assessment of the activity and progression of the pathological process.

Accordingly, clinical evaluation should include not only the absolute axial length but also its change over time. For research purposes, it may be useful to calculate the



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difference between the injured and fellow eye as well as the magnitude of change in this parameter during serial examinations.

The main practical question is not simply how pronounced the ultrasonographic abnormalities are, but how they influence further rehabilitation planning.

When the globe remains anatomically preserved, quiet, and painless, removal solely because of absent vision should be approached with particular caution. Contemporary literature describes the use of cosmetic scleral shells or similar prosthetic devices over a deformed, non-functioning eye. In carefully selected patients with *phthisis bulbi*, this approach may provide an acceptable cosmetic result without removal of the globe [9].

At the same time, the evidence base supporting this approach remains limited. A recent survey of ophthalmologists, optometrists, and ocular prosthetic specialists demonstrated considerable variation in the use of scleral shell prostheses and a lack of unified evidence-based recommendations regarding indications, contraindications, and wearing regimens [12]. Therefore, the feasibility of globe-preserving prosthetic rehabilitation should be assessed on an individual basis.

Clinical factors that may limit this approach include significant pain, active inflammation, marked ocular surface sensitivity, shallow conjunctival fornices, severe globe deformity, and inability to achieve stable positioning of the prosthesis.

Persistent ocular pain requires separate assessment. A contemporary review of the management of the painful blind eye emphasizes that the choice between medical, minimally invasive, and surgical treatment depends on the cause of pain, the condition of the globe, and the effectiveness of previous treatment [6]. Therefore, pain should not be regarded solely as a cosmetic issue.

Rehabilitation in children differs fundamentally from that in adults because continued growth of the orbit and surrounding tissues must be considered. An ocular prosthesis that fits well at one stage of childhood may subsequently require adjustment or replacement.

The review by Jain et al. showed that custom ocular prostheses in children require periodic assessment, relining, or replacement because of orbital growth and changes in the shape of the prosthetic bed [4]. A contemporary review of pediatric ocular prosthetics also emphasizes the importance of close cooperation between the

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ophthalmologist, ocularist, child, and parents, particularly in patients with complex anatomy and cicatricial changes [7].

Therefore, rehabilitation does not end with fitting the first prosthesis. Long-term follow-up should include assessment of prosthesis position and mobility, the condition of the conjunctiva and eyelids, the depth of the fornices, symmetry of the palpebral fissures, and continued correspondence between the prosthesis and the growing orbital tissues.

For children, an acceptable cosmetic appearance at the time of initial prosthetic fitting is not the only objective. It is equally important to maintain satisfactory facial and orbital symmetry throughout growth.

Conclusion

Clinical and ultrasonographic assessment allows objective evaluation of the post-traumatically altered eye and supports selection of an appropriate rehabilitation strategy. Management decisions should be based on the combined findings of clinical examination, ultrasound biometry, and ultrasonographic imaging. In a stable, painless eye without active inflammation, a globe-preserving approach should be considered. In progressive ocular subatrophy, marked deformity, pain, or inflammation, management should be individualized. In children, serial follow-up with repeated ultrasound biometry is particularly important.

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