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OCULAR INJURIES IN PICKLEBALL: CLINICAL EVIDENCE, INJURY SURVEILLANCE, PROTECTIVE TECHNOLOGY, AND PREVENTION - A NARRATIVE REVIEW

Alicja Maj *(Corresponding Author, Email: alicjamaj000@gmail.com)*
Faculty of Public Health, Medical University of Warsaw, Żwirki i Wigury 61, 02-091 Warsaw, Poland
ORCID ID: 0009-0005-2665-6889

Karol Knysak
Doctoral School of the Medical University of Warsaw, Żwirki i Wigury 61, 02-091 Warsaw, Poland
ORCID ID: 0009-0007-7159-3762

Maja Piątek
M. Skłodowska-Curie District Hospital SPZZOZ, Dubois 68, 07-300 Ostrów Mazowiecka, Poland
ORCID ID: 0009-0009-3706-1804

Michał Jastrzębski
The Infant Jesus Clinical Hospital UCC, Medical University of Warsaw, W. H. Lindleya 4, 02-005 Warsaw, Poland
ORCID ID: 0009-0008-8012-0702

Aleksandra Hejnosz
Faculty of Public Health, Medical University of Warsaw, Żwirki i Wigury 61, 02-091 Warsaw, Poland
ORCID ID: 0009-0003-3224-1001

Mateusz Szczerba
Faculty of Public Health, Medical University of Warsaw, Żwirki i Wigury 61, 02-091 Warsaw, Poland
ORCID ID: 0009-0000-1787-7405

Krystyna Wilkowska
Faculty of Public Health, Medical University of Warsaw, Żwirki i Wigury 61, 02-091 Warsaw, Poland
ORCID ID: 0009-0003-2875-7224

Wojciech Kaczorowski
Independent Public Health Care Facility in Siedlce, Kilińskiego 29, 08-110 Warsaw, Poland
ORCID ID: 0009-0004-8142-7221

Maciej Karol Michałowski
Szpital Praski pw. Przemienia Pańskiego, Solidarności 67, 03-401 Warsaw, Poland
ORCID ID: 0009-0004-9220-8788

Maria Sudomir
Szpital Praski pw. Przemienia Pańskiego, Solidarności 67, 03-401 Warsaw, Poland
ORCID ID: 0009-0002-4973-1333

Julia Strumińska-Szularz
Samodzielny Publiczny Wojewódzki Szpital Zespolony w Szczecinie, Arkońska 4, 71-455 Szczecin, Poland
ORCID ID: 0009-0007-7338-3670

ABSTRACT

Pickleball participation has expanded rapidly, while evidence on ocular and orbital injury remains dispersed across case reports, emergency-department surveillance, computational modelling, and prevention research. This narrative review aimed to synthesize the epidemiology, mechanisms, clinical spectrum, management, and prevention of pickleball-related eye injury, with particular attention to injury-surveillance methods and protective technology. PubMed/MEDLINE, Google Scholar, publisher databases, reference lists, and authoritative safety documents were searched through July 17, 2026. Direct pickleball evidence was prioritized, and studies from related racket sports were used as indirect context. Reported injuries range from corneal abrasion and traumatic iritis to hyphema, angle recession, lens or intraocular-lens displacement, retinal tears and detachment, traumatic glaucoma, eyelid laceration, and orbital fracture. Mechanism estimates depend on case definition: direct ball impact predominates in detailed globe-injury reports and one manually reviewed surveillance analysis, whereas broader eye, face, and head datasets identify a larger contribution from falls and paddle contact. Finite-element modelling supports the plausibility of damage to the angle, zonules, vitreous, and retina, but current models remain simplified. Dedicated protective-eyewear use is limited, and direct effectiveness data in pickleball are unavailable. Prevention therefore requires a combined approach involving certified eyewear, acceptable product design, player education, facility practices, and improved exposure-based surveillance.

KEYWORDS

Pickleball; Ocular Trauma; Injury Surveillance; Protective Eyewear; Sports Technology; Injury Prevention

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1. Introduction

Pickleball is a paddle sport that combines elements of tennis, badminton, and table tennis. It may be played as singles or doubles on a court substantially smaller than a tennis court, with much of competitive play occurring near the non-volley line. The sport is accessible to beginners and can provide moderate physical activity without the court coverage required in tennis. These characteristics have supported rapid adoption among recreational players, including middle-aged and older adults, while participation among younger groups has also expanded (Vitale & Liu, 2020).

The growth of participation has been accompanied by an increasing burden of injury. Early emergency department surveillance identified 300 pickleball-related cases in the National Electronic Injury Surveillance System (NEISS), corresponding to an estimated 19,012 injuries in the United States from 2001 to 2017; most injured patients were aged 50 years or older (Forrester, 2020). More recent work has shown further increases in both overall and ocular presentations (Lacher et al., 2025; Shah et al., 2026). Most research on pickleball injury has focused on fractures, falls, sprains, and other musculoskeletal conditions. Ocular trauma represents a smaller component of the total burden, but its potential consequences are disproportionate because even a single blunt impact may affect the cornea, anterior chamber, lens-zonule complex, vitreous, retina, orbit, or optic nerve.

Sports-related eye trauma is an established cause of emergency care. A nationally representative United States analysis estimated approximately 30,000 sports-related eye injury presentations annually, with projectile-based activities carrying particular short-term risk of visual impairment (Haring et al., 2016). Blunt sports trauma may cause apparently minor findings, such as a corneal abrasion or subconjunctival hemorrhage, but may also produce hyphema, traumatic glaucoma, lens dislocation, retinal tears, retinal detachment, orbital fracture, or open-globe injury (Micieli & Easterbrook, 2017). The published pickleball literature now includes examples spanning most of these anatomical compartments (Alkawally & Dang, 2021; Atkinson et al., 2022; Boopathiraj et al., 2024; Huang & Greven, 2024; Nair & Narayanan, 2025).

The evidence base, however, is difficult to interpret. Individual case reports are useful for describing the range of injury but cannot estimate risk. NEISS studies provide national weighted estimates, yet they rely on small raw case counts, overlapping study periods, broad product codes, short emergency department narratives, and no sport-specific exposure denominator (Lacher et al., 2025; Shah et al., 2026). Expert recommendations on eyewear have often preceded direct pickleball prevention data (Waisberg et al., 2024), while computational work offers mechanistic insight without reproducing the full variability of real play (Rydz et al., 2025). A clinically useful review must therefore distinguish direct observations from indirect evidence and biomechanical plausibility.

From a technology-and-society perspective, pickleball provides a useful example of participation growth outpacing the development of mature safety practices. Injury risk is interpreted through surveillance technologies, computational models, equipment standards, and user behavior. The public-health value of these technologies depends not only on technical performance but also on case definitions, accessibility, comfort, social acceptance, and implementation by players, coaches, facilities, clinicians, and governing bodies (ASTM International, 2024; Henick et al., 2026; Rydz et al., 2025).

The objective of this narrative review is to critically synthesize the available evidence on pickleball-related ocular and orbital injuries, including epidemiology, injury mechanisms, clinical presentation, management, outcomes, vulnerable groups, and preventive strategies.

The review addresses four questions: (1) which ocular and orbital injuries have been documented in pickleball; (2) which mechanisms and player characteristics may contribute to those injuries; (3) what can be inferred from epidemiology, biomechanical research, and related racket sports; and (4) how injury-surveillance systems, protective technologies, and implementation strategies may support prevention.

2. Methodology

2.1. Review design and scope

A structured narrative review was undertaken. The objective was not to generate a pooled incidence estimate or to claim systematic-review completeness, but to identify and critically integrate the most clinically relevant direct and indirect evidence. Direct evidence was defined as research in which pickleball participation, pickleball equipment, or pickleball-related injury was the exposure of interest. Indirect evidence included ocular trauma studies in squash, racquetball, badminton, tennis, and padel; general sports-ophthalmology literature; biomechanical studies of blunt ocular impact; and official eye-protection standards.

Priority was given to original case reports and case series, national injury surveillance analyses, biomechanical modelling, and direct studies of protective eyewear behavior. Narrative and systematic reviews were used to provide context or to identify primary studies, but were not substituted for directly available original sources when specific numerical claims were reported.

2.2. Search strategy and selection

PubMed/MEDLINE, Google Scholar, journal and publisher websites, and the reference lists of key papers were searched through 17 July 2026. Search combinations included: 'pickleball' AND ('eye injury' OR 'ocular trauma' OR 'orbital fracture' OR 'retinal tear' OR 'hyphema' OR 'lens subluxation' OR 'protective eyewear'); and the terms 'sports eye injury', 'racket sport ocular injury', 'squash eye injury', 'racquetball eye injury', 'badminton ocular trauma', 'tennis ocular injury', 'padel eye injury', 'finite element eye impact', and 'racket sport protective eyewear'. Official sources were searched for current racket-sport eyewear standards and governing-body safety advice.

English-language human clinical studies, injury surveillance analyses, computational biomechanical studies, systematic or narrative reviews, and authoritative technical or organizational documents were considered. Marketing pages, retail product listings, unsourced media reports, and statements for which the underlying publication could not be verified were excluded as evidentiary sources. When only an abstract was available, only information explicitly contained in that abstract was used. Overlapping NEISS analyses were treated as related analyses of the same surveillance system rather than independent cohorts, and their national estimates were not added together.

2.3. Evidence synthesis and quality safeguards

Evidence was synthesized thematically. Each clinical diagnosis was included only when it had been documented in a pickleball case report, case series, or manually reviewed surveillance study. Potential risk factors were classified as empirically observed, suggested by case reports or indirect evidence, or biologically plausible but unconfirmed. Treatment descriptions were limited to management reported in the source cases and general principles supported by sports-ophthalmology literature.

Bibliographic details and DOI links were checked against publisher records, PubMed, or the supplied full texts. Case counts were de-duplicated when later papers summarized previously published patients. No new incidence calculations were performed from case-report numerators, and no formal risk ranking across sports was attempted because exposure denominators and case definitions differ substantially.

2.4. Use of generative artificial intelligence

Generative artificial intelligence (OpenAI, GPT-5.6 Thinking) was used only as an assistive tool for manuscript organization, language refinement, formatting, and consistency checking. Source selection, interpretation of evidence, verification of numerical data, and clinical conclusions remained the responsibility of the authors. All cited claims should be rechecked by the submitting authors against the final reference list before submission.

3. Results

3.1. Characteristics of pickleball relevant to ocular trauma

Blunt trauma is the injury pattern most consistently described in detailed pickleball ocular reports, but the precipitating event varies across data sources. A perforated plastic ball has lower mass and generally lower velocity than several projectiles used in other racket sports, but the compact playing environment and frequent close-range volleys reduce the time available for recognition, head movement, blinking, or protective arm movement. The ball can strike the eye directly, ricochet from the player's own paddle, deflect from a partner's paddle, or rebound unpredictably during rapid exchanges. Paddle contact and fall-related facial impact represent separate mechanisms, particularly in doubles play and in broader surveillance cohorts.

Published descriptions frequently cite ball speeds around 40 miles per hour and a 14-foot separation between players positioned at opposing non-volley lines (Boopathiraj et al., 2024; Huang & Greven, 2024; Rydz et al., 2025). These values should not be treated as a measured distribution of all match situations. In the most detailed biomechanical study, 40 miles per hour was the input for a single central-impact simulation rather than the result of prospective match tracking (Rydz et al., 2025). Actual speed, impact angle, ball construction, paddle technology, spin, player position, and intervening reflexes will vary.

The physical relationship between the projectile and orbit is important. A pickleball is wider than the adult orbital entrance and cannot simply enter the orbit in the manner of a much smaller projectile. Nevertheless, the ball can deform and compress exposed anterior structures against the orbital contents. The resulting anteroposterior shortening of the globe is accompanied by equatorial expansion, strain at the limbus and angle, displacement of the iris-lens diaphragm, zonular loading, and vitreoretinal traction (Micieli & Easterbrook, 2017; Rydz et al., 2025). A paddle strike may deliver force to the orbital rim and eyelids rather than the globe center, producing laceration or fracture (Nair & Narayanan, 2025). Falls can generate a third pattern through facial impact with the court or surrounding structures (Lacher et al., 2025; Shah et al., 2026).

Older age is relevant to this geometry but should not be described as an established causal factor solely from case reports. Older adults have greater exposure in many pickleball populations and constitute a large proportion of injured patients in surveillance studies (Lacher et al., 2025; Shah et al., 2026). Age-related changes in visual processing, balance, reaction time, vitreous separation, prior cataract surgery, and lens stiffness may alter injury susceptibility or severity. Experimental modelling of blunt ocular trauma suggests that increasing lens stiffness with age changes internal deformation and may increase injury vulnerability (Stitzel et al., 2005). Direct age-specific biomechanical validation for pickleball is still lacking.

3.2. Epidemiology of pickleball-related injuries

The earliest national injury analysis was not limited to the eye. Forrester (2020) identified 300 pickleball-related NEISS cases, representing an estimated 19,012 United States emergency department injuries over the study period. Patients aged at least 50 years accounted for 90.9% of cases, and the most frequent diagnoses were strains or sprains and fractures. These data established the broader injury burden but do not provide a reliable ocular incidence because eye-specific case ascertainment was not the primary aim.

Three recent eye-focused NEISS analyses provide complementary but overlapping evidence. Lacher et al. (2025) examined 2005-2024 and identified 73 unweighted ocular injuries, corresponding to an estimated 3,112 injuries nationally. An estimated 1,262 occurred in 2024, and regression indicated an annual increase of 405 cases from 2021 to 2024. Injuries were more frequent among patients aged 50 years or older, and severe coded or narrative diagnoses included retinal detachment, orbital fracture, globe trauma, and hyphema. Shah et al. (2026) used a narrower 2014-2023 interval and manual physician review of head, face, and eye narratives. They identified 26 raw pickleball cases corresponding to a weighted estimate of 2,573 ocular or orbital injuries. The mean age was 58.27 years.

In the Shah analysis, direct ball impact to the eye accounted for 69.23% of pickleball cases, while falls accounted for 15.38%. Corneal abrasion was the most frequent diagnosis (26.92%), followed by orbital fracture and iritis (11.54% each) and vitreous detachment (7.69%). Most injuries occurred in sports or recreational facilities, and 96.15% of patients were treated and released from the emergency department. Discharge should not be interpreted as proof of trivial injury because NEISS does not capture subsequent retinal procedures, delayed glaucoma, or outpatient follow-up.

Kamboj et al. (2026) applied broader eye, face, and head criteria to NEISS data from 2010-2023. Among 117 raw cases, falls with facial trauma were the most common mechanism (60.7%), followed by paddle impact (15.4%) and direct ball impact (10.3%). The contrast with the Shah analysis does not establish a biological disagreement; it shows that the apparent mechanism distribution changes when a cohort includes a larger proportion of periocular, facial, head, and fall-related trauma.

The national estimates from Lacher, Shah, and Kamboj should not be summed or interpreted as independent replication. All three studies use NEISS and share calendar years. Their differing raw counts, weighted estimates, and mechanism distributions reflect differences in timeframe, body-part codes, narrative inclusion, diagnostic definitions, hospital weights, and manual review (Kamboj et al., 2026; Lacher et al., 2025; Shah et al., 2026). This methodological sensitivity is itself an important finding: ocular burden is increasing, but the absolute national number and the dominant mechanism remain uncertain.

NEISS has several additional limitations. It excludes injuries managed in eye clinics, urgent care, primary care, or at home; therefore, minor injuries and delayed posterior-segment presentations may be undercounted. Conversely, weighted estimates can be unstable when a small number of sampled cases receive large weights. The database lacks playing hours, number of participants, singles versus doubles status, competitive level, eye-protection status, prior ocular history, complete examination findings, best-corrected visual acuity, and long-term outcome. Population-adjusted rates therefore describe emergency department burden in the general population rather than injury risk per player-hour.

3.3. Mechanisms of ocular and orbital injury

Direct ball impact produces rapid compression of the intact globe. At the anterior surface, contact can remove corneal epithelium and provoke traumatic inflammation. Deeper compression can disrupt vessels of the iris and ciliary body, producing hyphema, and can injure the trabecular meshwork or split the ciliary body face, producing angle recession. The immediate pressure rise may reflect blood, inflammatory material, pigment, or tissue deformation obstructing aqueous outflow. Delayed glaucoma may arise after the acute findings have resolved (Boopathiraj et al., 2024; MacEwen & McLatchie, 2010; Micieli & Easterbrook, 2017).

The lens-zonule complex is exposed to both the initial compression and the rebound phase. In the finite element model developed by Rydz et al. (2025), a 73-mm pickleball struck the central cornea at 40 miles per hour. The model predicted stress concentrations at the limbus and iridocorneal angle, posterior displacement of the iris-lens complex, and a later tensile peak as anterior structures rebounded while the lens lagged behind. Zonular stresses were greatest during this secondary motion, offering a plausible explanation for the crystalline and intraocular lens displacements reported clinically (Huang & Greven, 2024; Rydz et al., 2025).

Posterior injury may occur through vitreous displacement and traction at points of vitreoretinal adhesion. Retinal tears following direct ball impact have been described in patients without recognized high myopia, lattice degeneration, pseudophakia, or family history (Atkinson et al., 2022). The Rydz model predicted peripheral retinal strain, but the simulation assumed absent vitreoretinal adhesion and omitted the macula and optic nerve head. It therefore supports mechanical plausibility but cannot reproduce the actual probability or location of retinal tearing.

Table 1. Population-level studies relevant to pickleball-related ocular injury

Study	Database / period	Raw cases	Weighted estimate	Key ocular findings	Main strength	Major limitation
Forrester, 2020	NEISS; 2001-2017	300 overall pickleball injuries	19,012 overall injuries	Not eye-specific; established age and injury context	First national pickleball injury estimate	Ocular injuries not separately characterized
Lacher et al., 2025	NEISS; 2005-2024	73 ocular injuries	3,112 ocular injuries; 1,262 in 2024	Retinal detachment, orbital fracture, globe trauma, hyphema; ball, paddle, and fall mechanisms	Long timeframe; ocular focus	Small raw count; ED-only; overlap with other NEISS studies
Shah et al., 2026	NEISS; 2014-2023	26 pickleball ocular/orbital injuries	2,573 injuries	Ball impact 69.23%; abrasion 26.92%; orbital fracture and iritis 11.54% each	Independent physician narrative review	Small raw count; no exposure denominator or follow-up
Kamboj et al., 2026	NEISS; 2010-2023	117 eye/face/head injury cases	6,015 estimated injuries	Falls with facial trauma 60.7%; paddle impact 15.4%; ball impact 10.3%	Broad capture of ocular, periocular, facial, and head trauma	Broader case definition limits comparison with globe-focused analyses

Note. Authors' synthesis of the cited studies. NEISS = National Electronic Injury Surveillance System; ED = emergency department. Weighted estimates from overlapping NEISS analyses must not be summed.

Paddle trauma differs from ball trauma. The paddle edge or face may strike the eyelid and orbital rim, causing laceration, hematoma, fracture, or globe injury. In the reported orbital case, a partner's paddle produced a lower-eyelid laceration and minimally displaced medial wall fracture without entrapment (Nair & Narayanan, 2025). Surveillance data also identify paddle contact and falls, emphasizing that prevention cannot focus on the ball alone (Lacher et al., 2025).

Comparable mechanisms are documented in other racket sports. In a classic prospective series of 67 squash and 18 racquetball injuries, both balls and rackets caused severe anterior and posterior segment trauma; hyphema was the most common serious injury, and some patients sustained retinal detachment, macular damage, cataract, or persistent glaucoma (Easterbrook, 1981). The size, elasticity, speed, court geometry, and partner proximity differ across sports, so these findings should be treated as mechanistic analogues rather than direct risk estimates for pickleball.

3.4. Clinical manifestations

3.4.1. Ocular surface and anterior segment injuries

The first published anterior-segment case involved a 39-year-old man struck by a ball that ricocheted from his own paddle. Examination showed eyelid edema, a small subconjunctival hemorrhage, a large peripheral corneal abrasion with loose epithelium, and 2+ anterior chamber cells without hyphema or posterior injury. Following epithelial debridement, placement of a cryopreserved amniotic membrane, cycloplegia, and short-course anti-inflammatory treatment after epithelial recovery, the abrasion and iritis resolved. Uncorrected visual acuity was better than 20/15 by day 10 (Alkawally & Dang, 2021). This favorable outcome illustrates the regenerative capacity of corneal epithelium but should not imply that all surface injuries are uncomplicated.

Hyphema and acute ocular hypertension have been directly documented. Boopathiraj and colleagues described a 47-year-old man with a 1-mm hyphema, visual acuity of 20/100, and intraocular pressure of 62 mmHg. Intensive medical treatment included oral acetazolamide and multiple topical agents; the hyphema resolved and pressure was controlled within five days. A second patient had subconjunctival hemorrhage, streak hyphema, pigment on the anterior lens capsule, commotio retinae, and later gonioscopic angle recession. Retinal edema resolved by one month, but angle recession necessitated awareness of future traumatic glaucoma.

Traumatic iritis has appeared as an isolated anterior-chamber reaction and in association with zonular injury (Alkawally & Dang, 2021; Huang & Greven, 2024). Symptoms may include pain, photophobia, redness, and blurred vision. Iris sphincter tear, transillumination defects, and angle recession indicate deeper deformation than uncomplicated iritis. The acute intraocular pressure can be normal, elevated, or occasionally reduced depending on the balance between inflammation, outflow obstruction, and ciliary body injury (Micieli & Easterbrook, 2017; Toldi & Thomas, 2020).

3.4.2. Lens, vitreous, and retinal injuries

Huang and Greven (2024) reported two severe lens-zonule injuries in older adults. A 77-year-old pseudophakic man developed displacement of the intraocular lens-capsular bag complex into the vitreous cavity after a ball ricocheted from his partner's paddle. Lens exchange with scleral fixation restored corrected visual acuity to 20/25 at three months. A 76-year-old woman developed traumatic iritis, iris sphincter injury, ocular hypertension, and 180-degree zonular dialysis with crystalline lens subluxation. Pars plana vitrectomy and lensectomy with scleral-fixated lens implantation initially improved vision, but cystoid macular edema and mixed-mechanism glaucoma complicated follow-up. At 2.5 years, advanced traumatic glaucoma was associated with best-corrected visual acuity of 20/100.

The retinal case series described a 66-year-old man with posterior vitreous detachment, mild vitreous hemorrhage, a symptomatic retinal tear, and localized retinal detachment nine days after direct impact. Cryopexy was followed by resolution of hemorrhage and detachment and recovery to 20/20. A 60-year-old woman presented one month after trauma with posterior vitreous detachment and a symptomatic horseshoe tear, which was treated with laser retinopexy; symptoms improved and vision remained approximately 20/25 (Atkinson et al., 2022). The authors appropriately noted that posterior vitreous detachment is common in this age group and that temporal association supports, but does not prove, causality.

Commotio retinae has also been reported after pickleball impact. It represents transient outer retinal disruption after blunt trauma and may resolve without structural sequelae when the macula is not severely affected. Nevertheless, flashes, new floaters, central distortion, a curtain-like field defect, or reduced vision after impact require urgent dilated retinal examination because symptoms of a tear or detachment may be delayed (Atkinson et al., 2022; Micieli & Easterbrook, 2017; Toldi & Thomas, 2020).

3.4.3. Orbital and periocular injuries

Periocular injury can arise from ball impact, falls, or paddle contact. The first dedicated orbital case involved a 54-year-old man struck by a teammate's paddle. Findings included eyelid hematoma, lower-eyelid laceration, subconjunctival hemorrhage, and periorbital edema. Imaging showed a minimally displaced medial orbital wall fracture without muscle entrapment or bony impingement. The laceration was repaired, while the fracture was observed because diplopia and enophthalmos were absent (Nair & Narayanan, 2025).

National surveillance also identified orbital fractures among pickleball presentations (Lacher et al., 2025; Shah et al., 2026). Clinicians should assess visual acuity, pupils, ocular motility, facial sensation, globe position, and orbital rim tenderness. Diplopia, restricted movement, enophthalmos, afferent pupillary defect, marked visual loss, severe pain, or suspected open globe warrants urgent specialist assessment and imaging as appropriate (Micieli & Easterbrook, 2017; Toldi & Thomas, 2020).

Table 2. Published clinical reports of pickleball-related ocular and orbital injury

Author, year	Country	Design	Patients	Age	Mechanism	Diagnosis	Treatment	Outcome	Protective eyewear
Alkawally and Dang (2021)	USA	Case report	1	39	Ball ricocheted from own paddle to eye	Large corneal abrasion; traumatic iritis; eyelid edema; subconjunctival hemorrhage	Epithelial debridement; amniotic membrane; cycloplegia; topical anti-inflammatory therapy	Complete epithelial and inflammatory resolution; VA >20/15 by day 10	Not reported
Atkinson et al. (2022), case 1	USA	Case series	1	66	Direct ball impact	PVD; mild vitreous hemorrhage; retinal tear; localized retinal detachment	Cryopexy	Symptoms and detachment resolved; VA 20/20 at 3 weeks	No
Atkinson et al. (2022), case 2	USA	Case series	1	60	Direct ball impact	PVD; symptomatic horseshoe retinal tear	Laser retinopexy	Photopsias/floaters resolved; VA 20/25+2	No
Huang and Greven (2024), case 1	USA	Case series	1	77	Ball ricocheted from partner paddle	IOL-capsular bag dislocation into vitreous; mild vitreous hemorrhage	IOL exchange and scleral fixation	Corrected VA 20/25 at 3 months; IOP 17 mmHg without drops	Not reported
Huang and Greven (2024), case 2	USA	Case series	1	76	Direct ball impact	Iritis; iris sphincter tear; 180-degree zonular dialysis; lens subluxation; later CME and traumatic glaucoma	Topical therapy; pars plana vitrectomy/lensectomy; scleral-fixated IOL; sub-Tenon triamcinolone; glaucoma therapy and later SLT	CME resolved, but advanced traumatic glaucoma; BCVA 20/100 at 2.5 years	Not reported
Boopathiraj et al. (2024), case 1	USA	Case series	1	47	Ball impact	1-mm hyphema; IOP 62 mmHg	Oral acetazolamide; topical steroid, cycloplegic and pressure-lowering agents	Hyphema resolved and IOP controlled by day 5	No
Boopathiraj et al. (2024), case 2	USA	Case series	1	48	Ball impact	Subconjunctival hemorrhage; streak hyphema; pigment dispersion; angle recession; commotio retinae	Topical prednisolone; observation and gonioscopic follow-up	Retinal edema resolved by 1 month; IOP and optic disc normal at reported follow-up	No
Nair and Narayanan (2025)	India/USA affiliation	Case report	1	54	Teammate paddle struck face	Lower-eyelid laceration; hematoma; subconjunctival hemorrhage; medial orbital wall fracture	Laceration repair; conservative fracture management	No diplopia or enophthalmos reported; conservative course	Not reported

Note. Authors' synthesis. BCVA = best-corrected visual acuity; CME = cystoid macular edema; IOL = intraocular lens; IOP = intraocular pressure; PVD = posterior vitreous detachment; SLT = selective laser trabeculoplasty; VA = visual acuity.

3.5. Management and clinical outcomes

Initial assessment should begin with the injury mechanism and symptoms, followed by visual acuity in each eye, pupil examination, ocular alignment and motility, external inspection, and assessment for globe integrity. Slit-lamp examination with fluorescein is appropriate for suspected surface injury. Dilated fundus examination is required when symptoms or mechanism suggest vitreoretinal traction. Orbital computed tomography is indicated when fracture, intraocular foreign body, marked motility restriction, or other orbital injury is suspected (Micieli & Easterbrook, 2017; Toldi & Thomas, 2020). If open-globe injury is possible, pressure on the eye and unnecessary manipulation must be avoided; a rigid shield and urgent ophthalmic referral are appropriate (Micieli & Easterbrook, 2017).

Management in published pickleball cases has ranged from observation and topical medication to retinal procedures and complex intraocular surgery. Corneal abrasion and iritis resolved with local treatment in the first anterior-segment report (Alkawally & Dang, 2021). Hyphema and severe ocular hypertension were controlled medically in one case (Boopathiraj et al., 2024). Retinal tears were treated with cryopexy or laser retinopexy (Atkinson et al., 2022). Lens and intraocular lens displacement required pars plana surgery and scleral fixation (Huang & Greven, 2024). The eyelid laceration in the orbital case was repaired, while the minimally displaced fracture was managed conservatively (Nair & Narayanan, 2025). These case-specific treatments should not be interpreted as a universal protocol; management depends on injury depth, pressure, visual acuity, retinal status, open-globe risk, and patient comorbidity.

Short-term visual recovery was favorable in several reports, but the literature also demonstrates delayed morbidity. Retinal tears presented nine days and one month after injury (Atkinson et al., 2022). Angle recession may remain clinically silent before traumatic glaucoma develops. In the most consequential published outcome, a patient developed mixed-mechanism glaucoma and advanced damage despite surgery and pressure-lowering treatment (Huang & Greven, 2024). Therefore, apparent resolution of pain, hyphema, or retinal whitening does not eliminate the need for appropriate follow-up after deeper blunt trauma.

Symptoms that should trigger urgent assessment include reduced vision, diplopia, photophobia, new flashes or floaters, a visual-field defect, severe pain, an irregular pupil, restricted motility, or pain with nausea and vomiting (Micieli & Easterbrook, 2017; Toldi & Thomas, 2020). Players may underestimate injury because the sport is considered non-contact and the external appearance may be mild. Education should emphasize that posterior injury can occur without a dramatic anterior finding.

3.6. Risk factors and vulnerable groups

Older age is the most consistent demographic characteristic in direct epidemiologic data. Both Lacher and Shah found a predominance of middle-aged and older patients, and Shah reported a mean age of 58.27 years (Lacher et al., 2025; Shah et al., 2026). This finding demonstrates who presents with injury, not necessarily a higher per-exposure risk, because age-specific playing hours were unavailable. Older players may have reduced reaction speed, balance, contrast sensitivity, or neuromuscular coordination, but these mechanisms remain incompletely measured in pickleball.

Previous ocular surgery and intraocular lenses are suggested risk modifiers. One severe case involved dislocation of a pseudophakic lens-capsular bag complex (Huang & Greven, 2024). Pseudophakia and prior retinal pathology are established clinical considerations after blunt trauma, but the pickleball case literature is too small to estimate their independent effects. Similarly, high myopia, lattice degeneration, prior retinal tear, and family history of retinal detachment are biologically relevant when counselling players, yet the two retinal-tear patients did not have recognized predisposing factors (Atkinson et al., 2022).

Doubles play is a plausible situational factor. Ricochets from a partner's paddle caused a severe lens injury, and a teammate's paddle caused the orbital fracture (Huang & Greven, 2024; Nair & Narayanan, 2025). Badminton provides indirect support: in a series of 85 ocular injuries, most occurred during doubles play, and partner-related mechanisms were common (Yu et al., 2020). Nevertheless, doubles versus singles risk has not been quantified in pickleball after adjustment for participation exposure.

Lack of certified protective eyewear is repeatedly documented but cannot yet be quantified as a pickleball-specific relative risk. Both retinal-tear patients and both cases reported by Boopathiraj played without eye protection (Atkinson et al., 2022; Boopathiraj et al., 2024). Other reports did not consistently state eyewear status. Ordinary prescription spectacles should not be classified as protective eyewear because lens and frame materials may not be designed or tested for sports impact.

Experience level and style of play remain uncertain. Experienced players may exchange faster volleys close to the net, whereas novice players may have less predictable paddle control and poorer positioning. Lacher and colleagues suggested that an influx of casual players may contribute to the recent injury trend, but NEISS cannot directly test experience as a risk factor (Lacher et al., 2025). Prospective studies should record skill level, singles or doubles play, court position, impact source, protective equipment, and previous ocular disease.

3.7. Protective eyewear and prevention

The strongest rationale for eye protection comes from the preventable nature of projectile injury and experience in other racket sports. Historical squash and racquetball series documented severe injury in unprotected players, injuries through open-style guards, and failures of ordinary prescription lenses (Easterbrook, 1981; Napier et al., 1996). A modern systematic review of racket-sport eyewear found that the large majority of reported injuries occurred when no protective eyewear was worn; however, the included studies were heterogeneous and largely observational (Mazarelo et al., 2024). These findings support protection while also showing that design, coverage, retention, and compliance matter.

Direct pickleball effectiveness data are not available. A 2026 study evaluated behavior rather than injury prevention. Eyewear was observed in 20% of 175 professional players and self-reported by 45.27% of 148 amateur players. Among amateurs reporting eyewear use, 61.19% used regular glasses rather than dedicated sports protectors. Discomfort and failure to recognize the risk of eye injury were important barriers. These findings indicate a substantial implementation gap and caution against treating any spectacle use as equivalent to certified protection.

The applicable technical framework has recently changed. ASTM F3164-24 covers eye protectors for racquetball, squash, tennis, and pickleball and addresses products intended to reduce injury from racket, paddle, and ball impact. It includes plano and prescription devices and classifies protectors by design (ASTM International, 2024). The standard does not imply elimination of all risk and does not protect the remainder of the head. When recommendations are made, they should specify eyewear compliant with a relevant racket-sport standard rather than generic plastic glasses.

Polycarbonate is commonly favored because of impact resistance and low weight, but protection depends on the complete device. A strong lens in a poorly retained or incompletely covering frame may fail to prevent contact or may itself transmit force. Wraparound or goggle-style coverage, secure retention, compatibility with prescription correction, adequate peripheral vision, anti-fog performance, and comfort are relevant to adherence. Open eye guards were associated with injuries in early squash and racquetball experience (Easterbrook, 1981).

Behavioral interventions can increase use. A venue-based squash promotion strategy combining education, availability, and environmental prompts increased protective-eyewear adoption (Eime et al., 2005). In women's lacrosse, a national eyewear mandate was associated with a marked reduction in eye injuries without evidence of compensatory increases in other injuries (Lincoln et al., 2012). These studies cannot establish the exact effect in pickleball, but they demonstrate that education alone may be less effective than combining accessible equipment, role modelling, venue policies, and governing-body guidance.

USA Pickleball currently states that proper eye protection is highly recommended for all players (USA Pickleball, n.d.), while eyewear is not generally mandatory for casual or professional play (Lacher et al., 2025). A proportionate prevention approach would prioritize education and access, especially in community centers, older-adult programs, coaching sessions, and tournament environments. Players with one functional eye, previous retinal detachment or tear, high myopia, prior intraocular surgery, or other ocular vulnerability merit individualized counselling from an eye-care professional.

Table 3. Evidence on ocular injury prevention in pickleball and related sports

Sport / setting	Study or guideline	Evidence type	Main preventive finding	Relevance to pickleball	Major limitation
Pickleball	Henick et al., 2026	Professional observation and amateur survey	Eyewear use was 20% among professionals and 45.27% among amateurs; many amateurs used regular spectacles	Direct evidence of low or inadequate uptake and behavioral barriers	Not an injury-effectiveness study; settings and ascertainment differed
Pickleball / racket sports	ASTM International (2024)	Technical standard	Includes performance requirements for racquetball, squash, tennis, and pickleball protectors	Current technical basis for specifying certified equipment	Full testing details require the standard; compliance does not eliminate risk
Pickleball	USA Pickleball (n.d.)	Governing-body guidance	Proper eye protection is highly recommended for all players	Supports education and venue messaging	Recommendation rather than comparative evidence or mandate
Squash	Eime et al., 2005	Community promotion intervention	A multifaceted venue strategy increased protective-eyewear use	Shows that access, prompts, and education can change behavior	Different sport and older eyewear context
Racket sports	Mazarelo et al., 2024	Systematic review	Most reported eye injuries occurred without protective eyewear; certified sports eyewear was favored over ordinary spectacles	Best synthesis of indirect prevention evidence	Heterogeneous, mostly observational evidence; no pickleball effectiveness trial
Women's lacrosse	Lincoln et al., 2012	Policy before-after analysis	Mandatory eyewear was associated with substantial reduction in eye injuries	Illustrates effect of enforceable equipment policy	Different projectile, rules, population, and protective standard
Squash / racquetball	Easterbrook, 1981	Prospective surveillance	Open guards and ordinary prescription lenses did not reliably protect; carefully designed guards were advocated	Highlights importance of full coverage and device design	Historical equipment and reporting practices

Note. Authors' synthesis. Evidence transferred from sports other than pickleball is indirect and should not be interpreted as a sport-specific effect estimate.

3.8. Comparison with other racket sports

Squash and racquetball provide the clearest historical analogy for severe closed-globe injury. Their smaller, denser balls and enclosed courts permit high-speed rebounds, and the classic Canadian surveillance series documented frequent hyphema, vitreous hemorrhage, retinal detachment, cataract, angle recession, and permanent visual loss (Easterbrook, 1981). Mandatory or strongly embedded eyewear policies in these sports reflect a long history of preventable injury. Pickleball uses a larger, lighter perforated ball and a different court, so a direct ranking of risk is not justified.

Badminton differs because the shuttlecock is not spherical and has an initial high speed followed by rapid deceleration. Its cork base can concentrate force on the eye, while close partner positioning in doubles creates racket and shuttlecock hazards. The 85-case study and subsequent systematic review associated injury with doubles play, shuttlecock impact, and absence of eye protection (Hoskin et al., 2023; Yu et al., 2020). Recent clinical series continue to report hyphema, angle injury, lens damage, and posterior segment complications (Dewhurst et al., 2024; Guo et al., 2023). These data strengthen concern about partner-related mechanisms in pickleball but do not establish identical risk.

Tennis uses a larger, deformable ball and generally greater player separation. A United States NEISS analysis covering 2000-2019 reported ocular injuries across age groups and a declining temporal trend (Patel et al., 2023). Tennis remains relevant to impact mechanics and eyewear standards, but the longer distances and different volley patterns distinguish it from close-range pickleball exchanges.

Padel is a particularly useful contemporary comparator because it combines a compact enclosed court, frequent rebounds, and close player positioning. Swedish data identified padel as an increasing and eventually leading cause of sports-related eye injury, with a small proportion of severe outcomes (Kasiga & Bro, 2024). A prior three-case report described retinal tears and detachments requiring surgery after ball impact (Thörnland & Jakobsson, 2021). As in pickleball, rapid popularity growth can expose limitations in surveillance and prevention before mature safety practices develop.

Across sports, the consistent themes are projectile impact, unexpected rebound, partner proximity, inadequate eyewear, and delayed recognition of posterior injury. The relative importance of each factor depends on equipment dimensions, stiffness, velocity, court architecture, level of play, and exposure. Comparative tables should therefore be interpreted qualitatively rather than as a hierarchy of danger.

3.9. Gaps in evidence and future research

The first major gap is the absence of exposure denominators. National emergency department estimates cannot determine injury per participant, per match, or per player-hour. Prospective surveillance should record participation frequency, age, sex, level, singles or doubles format, position on court, indoor or outdoor ball type, paddle characteristics, and protective eyewear.

Second, case definitions are inconsistent. Some analyses include only intraocular injury, while others include the eye, adnexa, face, head, and orbit. A standardized pickleball-related ocular trauma definition should distinguish surface injury, closed-globe injury, open-globe injury, adnexal injury, orbital fracture, and fall-related facial trauma. Severity should include best-corrected visual acuity, surgical requirement, return to play, and long-term complications.

Third, the literature is geographically concentrated in the United States, with individual reports from other countries. International registries are needed because equipment, court access, player demographics, medical pathways, and protective policies differ. Eye clinics and retinal practices should be included because emergency department datasets miss delayed tears, outpatient procedures, and traumatic glaucoma.

Fourth, protective eyewear requires direct evaluation. Observational studies should distinguish certified racket-sport protectors, ordinary prescription spectacles, sunglasses, open lensless guards, and no eyewear. Laboratory impact testing should incorporate ball type, paddle-generated velocities, oblique impacts, frame retention, prescription lens geometry, and ageing or previously operated ocular models. Real-world studies should evaluate adherence, fogging, comfort, field of view, and injury outcomes.

Finally, biomechanical work should move beyond a single idealized central impact. Models should include age-dependent tissue properties, vitreoretinal adhesion, macula and optic nerve, variable angle and speed, paddle impact, orbital fracture, and protective eyewear. Clinical validation should be based on prospectively documented injuries rather than matching a limited published case spectrum.

4. Discussion

This review shows that pickleball-related ocular trauma is no longer represented by isolated minor surface injuries. The documented spectrum includes corneal abrasion, inflammation, hyphema, pressure elevation, angle recession, commotio retinae, vitreous hemorrhage, retinal tear and detachment, lens and intraocular lens displacement, cystoid macular edema, traumatic glaucoma, eyelid laceration, and orbital fracture. Clinical outcomes range from complete recovery within days to persistent visual reduction years after injury (Alkawally & Dang, 2021; Atkinson et al., 2022; Boopathiraj et al., 2024; Huang & Greven, 2024; Nair & Narayanan, 2025).

The strongest direct epidemiologic conclusion is that emergency department presentations have increased recently and disproportionately involve middle-aged and older adults (Lacher et al., 2025; Shah et al., 2026). The evidence does not establish the individual probability of injury because participation exposure is unavailable. Nor can the available studies determine whether the rise reflects only increased participation, more casual players, changing paddle technology, improved recognition, or a true increase in risk per player-hour. Statements that pickleball is either inherently safe or exceptionally dangerous are therefore not supported.

The convergence of case reports, surveillance data, and finite element modelling is clinically meaningful. Case reports identify specific injuries; surveillance shows that the relative contribution of ball impact, paddle contact, and falls varies with the anatomical scope and case definition; modelling explains how rapid globe compression and rebound could load the angle, zonules, and peripheral retina (Alkawally & Dang, 2021; Atkinson et al., 2022; Boopathiraj et al., 2024; Huang & Greven, 2024; Kamboj et al., 2026; Lacher et al., 2025; Nair & Narayanan, 2025; Rydz et al., 2025; Shah et al., 2026; Waisberg et al., 2024). Each evidence type compensates partly for the others, but none alone establishes causality or incidence. The Rydz model is particularly useful for hypothesis generation, although its single impact condition and simplified posterior segment require caution (Rydz et al., 2025).

Older players deserve targeted attention. The surveillance signal may partly reflect exposure, but ageing can also influence reaction time, balance, vitreous status, lens stiffness, retinal vulnerability, and prevalence of pseudophakia. Importantly, severe injury also occurred in patients in their forties (Alkawally & Dang, 2021; Boopathiraj et al., 2024), so prevention should not be framed as relevant only to seniors. A universal recommendation for certified eye protection may be easier to communicate and implement than risk-based rules that require players to understand ophthalmic comorbidity.

The preventive case is persuasive but indirect. No study has measured pickleball injury rates in certified-eyewear users versus non-users. Nevertheless, the injury mechanism involves a foreseeable projectile, most detailed case reports involve no documented protection, sports eyewear has a current pickleball-inclusive ASTM standard, and other racket sports provide substantial observational support (ASTM International, 2024; Atkinson et al., 2022; Boopathiraj et al., 2024; Easterbrook, 1981; Mazarelo et al., 2024). The correct conclusion is not that eyewear guarantees safety, but that certified, well-fitted protection is a reasonable low-burden intervention while direct effectiveness research is developed.

Implementation deserves as much attention as device mechanics. Henick et al. (2026) found low use among professionals and less than half among surveyed amateurs; many users relied on ordinary glasses. Professional role modelling, facility signage, loan or rental programs, retailer education, prescription-compatible products, anti-fog design, and coach-led safety messages may be needed. A recommendation that is uncomfortable, visually intrusive, or difficult to obtain will have limited population effect.

Clinical education should accompany player education. A corneal abrasion may be immediately painful, while retinal tears or angle recession can present later. Emergency and primary-care clinicians should recognize the need for ophthalmic referral after flashes, floaters, visual distortion, field loss, hyphema, irregular pupil, marked pressure elevation, or significant orbital symptoms (Micieli & Easterbrook, 2017; Toldi & Thomas, 2020). Eye-care professionals should ask about the exact mechanism, eyewear, prior surgery, high myopia, and retinal history, and should arrange follow-up appropriate to the injury.

The review has limitations. The literature search was structured but not designed as a formal systematic review, and no risk-of-bias instrument was applied. Several recent studies were available only through abstracts or publisher summaries, so detailed claims were restricted to verifiable content. Publication bias is likely because unusual or severe cases are more likely to be reported. Direct clinical reports include very few patients and cannot identify independent risk factors. NEISS analyses overlap and depend on small raw samples. Finally, evidence transferred from squash, racquetball, badminton, tennis, padel, and lacrosse may not fully apply to pickleball.

4.1. Technology, implementation, and public-health implications

Three forms of technology shape the current understanding and governance of pickleball eye safety. First, national surveillance systems can detect emerging patterns, but the apparent distribution of mechanisms changes when researchers use different body-part codes and anatomical inclusion criteria. Classification choices therefore influence which injuries become visible to clinicians, policymakers, and sporting organizations. Harmonized definitions and transparent narrative review are necessary before surveillance estimates can support regulation or resource allocation (Kamboj et al., 2026; Lacher et al., 2025; Shah et al., 2026).

Second, finite-element modelling offers access to internal ocular stresses that cannot be measured directly during injury. Its principal value is hypothesis generation and equipment design, not prediction of individual clinical outcomes. Future models should incorporate age-dependent tissues, prior ocular surgery, oblique ball and paddle impacts, and certified protectors, followed by validation against prospectively documented injuries (Rydz et al., 2025; Stitzel et al., 2005).

Third, protective equipment is a socio-technical intervention. A compliant lens and frame can reduce exposure to direct impact only when the device is available, correctly fitted, retained during play, and accepted by users. Low uptake, reliance on ordinary spectacles, discomfort, and limited risk awareness show that standards alone are insufficient. Product design, professional role modelling, facility-level availability, and clear governing-body communication must operate together if protective technology is to produce population-level benefit (Eime et al., 2005; Henick et al., 2026; Mazarelo et al., 2024).

4.2. Practical implications

Players should consider certified racket-sport eye protection during both recreational and competitive play, not ordinary spectacles alone. New flashes, floaters, reduced vision, photophobia, diplopia, severe pain, or visible blood in the anterior chamber after impact should prompt urgent assessment. Players with one seeing eye, high myopia, previous retinal tear or detachment, prior intraocular surgery, or other ocular disease should discuss sport-specific protection with an ophthalmologist.

Coaches and facility operators can reduce risk by normalizing eyewear, maintaining adequate lighting and background contrast, teaching safe spacing and paddle awareness in doubles play, and ensuring that beginners understand ball and partner-paddle hazards. On-site protocols should include immediate removal from play after significant eye impact and referral pathways for urgent eye assessment.

Clinicians should document visual acuity, pupils, motility, slit-lamp findings, intraocular pressure when safe, dilated fundus findings, imaging, and eyewear status. Follow-up should account for delayed retinal tears and angle-recession glaucoma. Governing bodies and tournament organizers should support standardized education, facilitate access to compliant eyewear, and collect injury data before considering proportionate regulatory changes.

5. Conclusions

Pickleball-related ocular trauma encompasses a clinically important spectrum from superficial corneal injury to retinal detachment, lens dislocation, orbital fracture, and delayed traumatic glaucoma. Recent national surveillance studies indicate a rapid increase in emergency department presentations, particularly among middle-aged and older adults, but the absolute burden and individual risk remain uncertain because raw case counts are small and participation exposure is unavailable.

Mechanism depends on the outcome definition. Direct ball impact predominates in detailed reports of globe injury and in the Shah analysis, whereas broader surveillance including eye, face, and head trauma may identify falls as the most frequent event; paddle strikes are an additional cause of periocular and orbital injury (Kamboj et al., 2026; Shah et al., 2026). Case reports and biomechanical modelling provide complementary evidence that rapid globe compression and rebound can affect the anterior chamber angle, zonules, vitreous, and retina. Prompt ophthalmic evaluation and appropriate follow-up are required when symptoms suggest deeper injury.

Certified protective eyewear is a rational preventive strategy supported by injury mechanics, current ASTM coverage of pickleball, behavior data showing low uptake, and evidence from related racket sports. It should be promoted without claiming complete protection or pickleball-specific proven effectiveness. Prospective injury registries, exposure-based studies, age-sensitive biomechanical models, and direct evaluations of eyewear are necessary to guide future recommendations and policy.

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