

**Research Article****Can vegetative injuries (*Acacia nilotica*-Babool tree) offer protection against infection in case of open globe injuries defined by BETTS?****Mehul Shah, Shreya Shah\*, Rounaq Khanna, Ruhi Gunay, Deeksha Thorat**

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**Abstract**

**Objective:** To compare the incidence of infection and damage caused by the object of injury and evaluate wooden sticks and other objects responsible for ocular injury. **Methods:** A tertiary care hospital in a rural part of central western India. This was a prospective observational cohort study designed in 2002. All open globe injuries in either eye that were diagnosed and managed between January 2003 and December 2019 were enrolled in our study. The patients were grouped according to injuries caused by sticks or other objects. Data were collected using the ISOT initial and follow-up forms and analysed. **Results:** The study comprised 1855 eyes, including 914 globe rupture and 915 penetrating injuries. Wooden sticks were one of the most common objects causing eye injury in the rural setting. Eye injuries caused by these objects were not associated with infection, and the final visual outcome in stick-injured eyes was significantly better than that in injuries caused by other objects ( $p=0.002$ ). Majority of the sticks were from the *Acacia nilotica* plant (Babool Tree). **Conclusion:** Although sticks cause a high percentage of eye injuries, the incidence of infection in stick-injured eyes is low, and the final visual outcome is good. Hence, it could be concluded that *A. nilotica* has protective properties.

**Keywords:** BETTS, object causing injury, wooden stick, open globe injury, post-traumatic endophthalmitis, vegetative material

**Introduction**

Trauma is a leading cause of ocular morbidity across the globe although the causes, objects and types of injuries may vary from one part of the world to the other. For instance, the type of domestic and professional activities and the availability of protective gears tend to differ. Few studies have addressed the issue of trauma in rural areas (Khatry et al., 2004; Abraham, DI et al., 1999; Alfaro et al., 2005; Shah M et al., 2008). The aetiology of ocular injury in the rural areas is likely to differ from that in urban areas, and is worthy of investigation (Abraham, et al., 1999; Alfaro et al., 2005; Shah et al., 2008). Both the eye trauma victims and the society bear a large, potentially preventable burden (Alfaro et al., 2005).

Open globe injury is associated with a breach in the wall of the eyeball, which may pave the way for the entry of organisms into the

globe. Vegetative injuries, particularly fungal, are known to cause infection and hamper the final visual outcome (Khatry et al., 2004; Abraham et al., 1999; Alfaro et al., 2005; Shah et al., 2008; Al-Mezaine et al., 2010; Wade et al., 2009; Yang et al., 2010; Zhang et al., 2011; Cebulla and Flynn, 2009; Andreoli et al., 2009; Viestenz et al., 2008; Wykoff et al., 2008; Gupta et al., 1997; Al-Omran et al., 2007; Chhabra et al., 2006; Gupta et al., 2008; Essex et al., 2004; Narang et al., 2004; Lieb et al., 2003; Sabaci et al., 2002; Prabhu et al., 2009).

The final visual outcome may vary depending on many factors such as the mechanism of ocular trauma, habitat, occupation and object of injury responsible for the entry of organisms into the eye. The sub-categories of open globe injuries, namely lacerations and rupture, provide different opportunities for the entry of organisms.

Wooden sticks and thorns are among the leading objects of injury in rural populations in various parts of the world (Thapa and Paudyal, 1995; Venkatesh et al., 2006; Gogate et al., 2001; Eckstein et al., 1996). Some studies have reported no infection despite injury by vegetative material (Thapa and Paudyal, 1995; Krishnaiah and Nirmalan, 2006).

The objective of this is to study the relationship between

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ocular infection and vegetative material as the object of injury.

### Patients and Methods

We obtained approval from the hospital ethical committee (XXX hospital ethical committee /AAA19/2019) to conduct this study and received written consent from the participants.

This was a prospective observational cohort study designed in 2002. By adhering to the Birmingham Eye Trauma Terminology System (BETTS), all open globe trauma cases in either eye that were diagnosed and managed between January 2003 and December 2019 were enrolled in our study. Patients consenting to participate and not having other serious bodily injuries were included in the study.

We obtained a detailed history for each patient enrolled in our study, including details of the injury as well as information on eye treatment and surgery performed to manage past ocular trauma. Data for both the initial and follow-up reports were collected using the online BETTS format of the International Society of Ocular Trauma (Kuhn et al., 2004). Details of the surgery were also collected using a specified pre-tested online form.

The cases of trauma were grouped as open and closed globe injuries. All open globe injury cases were included in the study, and these were further categorized into lacerations and ruptures. The former was in turn classified into perforating injuries, penetrating injuries and those involving an intraocular foreign body. Sticks included tree branches, firewood and thorns but excluded human-fashioned and treated materials.

Other demographic details gathered included entry of the patient, residence, activity at the time of injury, object causing injury and previous examinations and treatments. After enrolment, all patients were examined using a standard method. Visual acuity was checked using Snellen's chart, and the anterior segment was examined using a slit lamp.

For a lens that was partially opaque, the posterior segment examination was performed with an indirect ophthalmoscope and a +20 D lens. When the optical medium was hazy, a B-scan

was performed to evaluate the posterior segment.

In all patients undergoing corneal wound repair, the traumatic cataract was managed using a second procedure.

In children younger than two years of age, both lensectomy and vitrectomy were carried out via the pars plana route, and the same surgical procedures were used to manage the traumatic cataract too. Lens implantation as part of the primary procedure was avoided in all children younger than two years of age.

All injured patients who were devoid of infections were treated with topical and systemic corticosteroids and cycloplegics. The duration of the medical treatment depended on the degree of inflammation in the anterior and posterior segments of the operated eye. The operated patients were re-examined after 24 hours, 3 days and 1, 2 and 6 weeks to enable refractive correction. Follow-up was scheduled for the third day, weekly for 6 weeks, monthly for 3 months, and every 3 months for 1 year.

All patients with infection and endophthalmitis were treated according to their clinical condition subsequent to the management of open globe wounds.

Medical treatment with intravitreal injection was followed by vitrectomy.

At every follow-up examination, visual acuity was tested. The anterior segment was examined with a slit lamp, and the posterior segment was investigated using an indirect ophthalmoscope.

During the examination, data were entered online using a specified pre-tested format designed by the International Society of Ocular Trauma (initial and follow-up forms) and exported to a Microsoft Excel spreadsheet. The data were periodically audited to ensure their completeness. The Statistical Package for Social Sciences (SPSS 22) was employed to analyse the data. The univariate parametric method was used to calculate frequency, percentage,

**Table 1.** Age and sex distribution

Age	Sex		Total
	F	M	
0-10	169	379	548
11-20	116	282	398
21-30	66	201	267
31-40	62	162	224
41-50	47	131	178
51-60	39	102	141
61-70	27	56	83
71-80	5	9	14
>80	0	2	2
<b>Total</b>	531	1324	1855

proportion and 95% confidence interval (CI). Binominal regression analysis was performed to determine the predictors of post-operative vision. The dependent variable was vision >20/60 at the 6-week follow-up after cataract surgery.

## Results

The current study cohort comprised 1855 eyes with open globe injuries. Among the participants, 531(28.6%) were females and 1324 (71.4%) were males, and their mean age was 25+/- 19.2 years (Table 1) It was noted that 914 (49.3%) injuries were globe rupture and 915 (49.3%) were penetrating. A total of 871 (47%) injuries were sustained by the paediatric age group.

Wooden stick was the most common object of injury. In 907 (48.9%) cases, wooden stick or thorn was the object of injury. Majority of the objects were from the *Acacia nilotica* plant (Babool Tree) and were either in the form of a stick or a thorn.

When we compared the pre- and post-treatment scenarios, we detected that the difference was significant ( $p=0.000$ , Table 2). We also observed that infection had a significant impact on the visual outcome ( $p=0.000$ ). When we studied how visual outcome varied with the object of injury, we found that the outcome was better when the object of injury was a wooden stick ( $p=0.049$ ).

Overall, 77 (4.2%) eyes had infections in open globe injuries. When we compared the rate of infection among the sub-

categories of open globe injuries, the difference was significant ( $p=0.04$ , Table-3), and the globe rupture category had a higher incidence of infection.

When we compared the rate of infection on the basis of the object of injury, we found that the rate was significantly lower when the object of injury was a wooden stick or thorn ( $p=0.048$ , Table 4). Wooden sticks and thorns accounted for 30 (39%) infections and were found to cause infections less frequently than the other objects (47, 61%).

When we explored the visual outcomes of various sub-categories of open globe injuries, we perceived that penetrating injuries had significantly better outcomes ( $p=0.000$ ).

When we studied a group of infected eyes with open globe injuries, we discerned that our treatment had a significant impact on the visual outcome ( $p=0.002$ , Table 5). When we compared the visual outcomes of the infected group, no significant difference was noted based on the object of injury ( $p=0.579$ , Table 6). However, when we investigated the sub-categories of open globe injuries in the infected group, globe rupture exhibited a significantly better outcome ( $p=0.002$ ).

The current study unearthed that although the incidence of

**Table 2.** Comparative study of visual outcome pre and post treatment in open globe injuries

Post treatment vision	Pre treatment vision							Total
	<1/60	1/60-3/60	6/60-6/36	6/24-6/18	6/12P-6/9	6/6-6/5	Uncoop	
<1/60	655	37	43	19	19	4	3	780
1/60-3/60	104	25	4	4	2	0	0	139
6/60-6/36	153	23	32	7	4	0	2	221
6/24-6/18	180	31	19	13	2	2	0	247
6/12-6/9	230	27	20	21	12	2	1	313
6/6-6/5	92	11	10	6	9	3	1	132
LF	12	1	2	1	0	0	0	16
Uncooperative	0	1	0	0	0	0	4	5
<b>Total</b>	1426	156	130	71	48	11	11	1853

**Table 3.** Comparative study of incidence of infection according to categories of open globe injuries

Incidence of Infection	Open Globe Injuries		Total
	Globe Rupture	Other	
<b>Infection</b>	46	31	77
<b>No Infection</b>	868	910	1778
<b>Total</b>	914	941	1855

p-0.039

**Table 4.** Comparative study of incidence of infection with wooden stick as object of injury

Incidence of infection	Categories Wooden Stick		Total
	Wooden Stick	Other	
Infection	30	47	77
No Infection	877	901	1778
Total	907	948	1855

p=0.048

**Table 5.** Comparative study of visual outcome pre and post treatment in eyes with infection in open globe injuries

Post Treatment Vision	Pre Treatment Vision				Total
	<1/60	1/60-3/60	6/60-6/36	6/12P-6/9	
<1/60	42	2	2	3	49
1/60-3/60	2	1	0	0	3
6/60-6/36	6	1	1	1	9
6/24-6/18	3	1	1	0	5
6/12-6/9	4	0	1	1	6
6/6-6/5	2	0	0	0	2
LF	2	0	0	0	2
<b>Total</b>	61	5	5	5	76

P=0.002

**Table 6.** Comparative study of visual outcome pre and post treatment in eyes with infection in open globe injuries in reference to object of injury

Post Treatment Vision	Wooden Stick		Total
	Wooden Stick	Other	
<1/60	23	26	49
1/60-3/60	0	3	3
6/60-6/36	4	5	9
6/24-6/18	1	4	5
6/12-6/9	1	5	6
6/6-6/5	1	1	2
LF	0	2	2
<b>Total</b>	30	46	76

P= 0.351

infection was low in case of wooden stick injury, there was no significant difference in the outcome (p=0.351).

### Discussion

The current study cohort comprised 1855 eyes with open globe injuries, and 48.9% of those injuries were caused by wooden sticks and thorns. Similar findings have been reported by many other

authors. For instance, Thapa et al. documented that the wooden stick served as the object in 36% of the cases. Venkatesh et al. reported injuries with wooden sticks in 20% of the cases. According to Memon et al. (1995) wooden stick injuries accounted for 31.7% of the cases in Pakistan. In Andhra Pradesh Eye Diseases study, Krishnaiah S discovered

that vegetable matter such as thorns, branches of trees and plant secretions were responsible for 45.3% of the injuries. Gogate et al. noted that in 45.1% of the cases, wooden sticks and thorns were the culprits. Gradin also reported similar findings in East Africa (Thapa and Paudyal, 1995; Memon et al., 2006; Gogate et al., 2001; Eckstein et al., 1996).

It is noteworthy that all these studies have not documented the incidence of infection despite the objects of injury being vegetative in nature. The current study observed infection in 4.2% eyes even though the object of injury was vegetative in 48.9% of the cases.

Our study identified the presence of infection in 4.2% of the open globe injuries. Thapa noticed positive vitreous infiltration in 12.8% cases (Thapa and Paudyal, 1995). Callegan MC spotted the incidence of post-traumatic infection in 3–17% of the cases. Variable incidences have been reported by different authors (Callegan et al., 2002; Boldt et al., 1989; Kunimoto et al., 1999; O'Brien and Choi, 1995; Schemmer and Driebe, 1987; Thompson et al., 1993).

The present study uncovering a very low rate of infection (4.2%) despite 48.9% of the open globe injuries being caused by vegetative material has been answered by many studies, suggesting the anti-microbial properties of commonly available plants.

We could not find any study which has compared the wooden stick as an object of injury and the incidence of ocular infection as well as the subgroup of open globe injuries.

We witnessed that most of the injuries were caused by *A. nilotica* and its thorns. This tree is quite common in western central India (Pilania et al., 2013).

Various authors such as Shekar et al. (2015), Khan et al. (2009) have asserted the anti-microbial properties of *A. nilotica* (Shekar et al. 2015; Khan et al., 2009) Geneviève Zabr ea et al. (2017) have discussed the anti-helminthic effects of the tree (Genevi ve Zabr ea, b et al 2017).

Sharma and his co-authors have documented that aqueous extracts made from the leaves of *A. nilotica* exhibit anti-microbial activities against different pathogens. Mohammed Shaibu has also come up with similar findings (Mohammed Shaibu Auwal et al., 2014; Ahmad et al., 1998).

The key observation made in this study warrants further research to understand how the society at large can be benefited from the search for antimicrobials among the higher plants seen in this area. It has been widely observed that the local tribes, who constituted 89% of the patients in the study, use various ingredients prepared from the stem bark, leaves and roots of the plant. The search for antimicrobial agents has mostly been limited to lower plants, fungi and bacteria (Abad et al., 2007;

Grayer and Harborne, 1994). The presence of saponins, tannins, alkaloids and steroids in the plant's part is an indication of its pharmacological importance (Hostettmann et al., 1995; Keay et al., 1964).

Only limited research has been conducted on antimicrobials from higher plants. Since the advent of antibiotics in the 1950s, the use of plant derivatives as antimicrobials has been virtually non-existent. However, the interest in using plant extracts for treating microbial infections surged in the late 1990s as conventional antibiotics became ineffective. Investigations on the use of plants in traditional medicine for treating skin afflictions might provide us with new tropical antiseptics that are urgently needed.

### Conclusion

Although sticks and thorns account for a high percentage of open globe injuries, the incidence of infection is minimal in the injured eyes as majority of the sticks are from *A. nilotica*, a plant which has protective properties. This plant is found in all countries of the Asian and African continents. Besides, the vision improved significantly after effective management of the injury.

### Conflict of interests

None to declare

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