AMNIOTIC MEMBRANE
Versatile biomaterial suitable for treating acute ocular traumatic injuries
by Dermot McGrath in Geneva

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The future is likely to see increasing use of amniotic membrane in battlefield scenarios, where its physical properties as a versatile, pliable and durable biomaterial make it suitable for treating acute ocular traumatic injuries, according to Major Gerry Clare FRCOphth.

“Amniotic membrane is already widely used in ophthalmology, but its interest in terms of military use derives from the fact that it can be dried and transported and stored at room temperature, which makes it a light, handy and easy biomaterial to use in conflict zones,” Dr Clare said.

Addressing delegates attending a special joint meeting of the European Society of Ophthalmology (SOE) and the American Academy of Ophthalmology, Dr Clare said that the ophthalmic use of amniotic membrane, which is the innermost layer of the placenta and consists of a layer of epithelium overlying a basement membrane and an avascular stromal matrix, is not a recent innovation.

“Foetal membranes were first used as a skin substitute in 1910 and as a conjunctival substitute in 1938 by de Röth; prior to that, oral mucous membrane had been advocated by Denig as a surgical treatment for ocular burns, highlighting the need for a comfortable, biocompatible ocular surface dressing. In 1941, Brown published a paper on the treatment of ocular lime burns by covering the entire ocular surface with rabbit peritoneum to promote healing, but this proved unsuccessful. Sorsby and others subsequently used ‘amnioplastin’, chemically processed amniotic membrane, as a temporary patch for treating ocular burns. Although it was recommended for military use in 1949, there were subsequently very few Western publications on amniotic membrane use until it reappeared in the 1990s, when it became available as a frozen product,” he said.

Dr Clare noted that improved methods of processing and preserving amniotic membrane have led to a resurgence of interest in its use as a biomaterial for treating ocular surface burns and acute injuries.

“There are currently over 20 indications for amniotic membrane use in ophthalmology, the commonest ones being persistent epithelial defects, bullous keratopathy and ocular surface reconstruction. It can be obtained frozen or dried and it can be used as a graft or a patch. It can be used directly on the eye or it can be used as a substrate to expand stem cells from the limbus. There is some controversy as to whether it should be used intact with the epithelial layer still on the basement membrane or whether it would be better to remove that first in order to expand the cells,” he said.

In terms of battlefield injuries, Dr Clare said that amniotic membrane might be indicated in cases of ocular injury associated with associated burns resulting from an improvised explosive device.

“It may be used as a localised multilayered graft for small or impending perforations and also for infectious keratitis. For acute burns it may be used to prevent synechiae, either as a partial patch over the damaged tissue or as a complete ocular surface dressing, secured with bolsters coming out into the skin or with a ring conformer placed in the fornices,” he said.

However, there is a lack of randomised controlled trials concerning amniotic membrane use in ocular burns. Although the observed clinical effects of amniotic membrane treatment in some studies have included facilitation of epithelialisation and reduction of inflammation, vascularisation and scarring, high quality evidence for its benefit in treating burns is lacking.

“There has been some interesting work on the use of amniotic membrane in infectious keratitis. While it is doubtful that therapeutic amniotic membrane can retain intrinsic anti-microbial properties, Prof Harminder Dua has surmised that it may act as a kind of reservoir for antibiotic action over time, resulting in healed ulcers after amniotic membrane transplantation,” Dr Clare said.

One of the major advantages of using amniotic membrane is its versatility, said Dr Clare. It can be used as substitute tissue, functioning as a substrate for corneal epithelial cells or as a multilayered scaffold for stromal tissue ingrowth. It may also act as a ‘spacer’ to keep burnt tissues apart and can shield the cornea from ingrowing conjunctiva if required.

While there has been much speculation on the supposed biological action of amniotic membrane, more research is needed before any firm conclusions can be drawn, said Dr Clare.

“We know that it has numerous biochemical components within it, but what we really do not know is whether they work in sufficient quantity to be active on the eye and treat human disease,” he said. “In many cases, biological properties do not need to be inferred to explain the functionality of amniotic tissue as a physical membrane.”

He also noted other limitations associated with amniotic membrane usage.

“There is a lack of RCTs concerning amniotic membrane and many studies have poorly defined criteria of success and failure, so it is not clear what difference the amnion made. There are reports of corneal thinning, fungal keratitis and frank failure after amniotic membrane transplantation. It is also possible that patients may become sensitised if they have repeated exposure to amnion from the same donor. Moreover, it is a heterogeneous tissue, there being variations in biochemical and physical properties between donor membranes and even between samples from the same donor membrane. Methods of preparation and surgical application also vary, and it is often unclear exactly when and how amnion should be applied to the eye for best results,” he concluded.

Despite these limitations, Dr Clare said that the self-evident physical properties of amniotic membrane, particularly its pliability and its durable and versatile nature, are likely to see its increasing use in conflict zones in the future.