SCIENTIFIC CORRESPONDENCE

Vascular patterns in pterygium and conjunctival autografting: a pilot study using indocyanine green anterior segment angiography

Cordelia M L Chan, Paul T K Chew, Zainah Alsagoff, Jun Shyan Wong, Donald T H Tan

Abstract
Aims—To characterise the vasculature of pterygium using indocyanine green (ICG) anterior segment angiography and to demonstrate the pattern of revascularisation following conjunctival autografting.

Methods—ICG anterior segment angiography was performed on nine patients with pterygium. Angiography was repeated at 1–2 weeks and 2 months following conjunctival autografting in these patients.

Results—Angiography showed a single feeder vessel originating from the anterior conjunctival circulation in six cases (66.6%). This vessel branched to form the radial vessels of the pterygium. Following conjunctival autografting, reperfusion of the vessels in the conjunctival autograft was demonstrable as early as 1 week postoperatively from the episcleral bed. At 2 months postoperatively, the graft appeared well perfused with mild leakage demonstrable at the edges of the graft.

Conclusions—A single feeder vessel from the anterior conjunctival circulation branches to form the radial vessels in pterygium. Reperfusion of conjunctival autografts occurs as early as 1 week postoperatively from the episcleral bed. (Br J Ophthalmol 2001;85:350–353)

The use of fluorescein angiography in the evaluation of the anterior segment of the eye has been limited by the problem of leakage even from normal blood vessels, obscuring the arteriovenous and venous phases of the angiogram, thus making interpretation difficult. Meyer and Watson introduced the concept of low dose fluorescein angiography in 1987, overcoming the problem of leakage to a certain extent, but not eliminating the problem entirely, as extravasation is still seen from normal blood vessels in the later phases of the angiogram.1,2

The use of indocyanine green (ICG) in ophthalmology has so far been limited to angiograms of the posterior segment.3,4 ICG is a larger molecule than fluorescein (MW 775 Da) and is more highly protein bound.5 These properties would make ICG ideal for use in anterior segment angiography, as negligible extravasation through normal conjunctival and episcleral blood vessels would be expected.

Pterygium is an ocular surface disorder characterised by fibrovascular invasion of the cornea, and a significant propensity towards recurrence after surgical excision. The vascularity of pterygium tissue may have significance in terms of pterygium severity and progression. Tan et al showed that fleshiness of the body of the pterygium, denoted by obscuration of underlying episcleral vessels by the fibrovascular pterygium tissue, was a risk factor for recurrence rate after bare sclera excision,6 while the morphology of pterygium recurrence inevitably reflects a high degree of vascularity. As such, we decided to evaluate the blood supply and flow within the fibrovascular component of pterygium, and to determine whether the vascularity is derived from conjunctival or episcleral circulation.

Conjunctival autografting as a surgical option for the management of pterygium has been found to be generally safe and effective.8–10 By evaluating the revascularisation and reperfusion of the vessels in the graft, a better understanding of the disease process and factors involved in pterygium recurrence could be developed.

We therefore designed a pilot study and performed ICG anterior segment angiography on patients with pterygium and repeated the angiography following conjunctival autografting in these patients.

Materials and methods
ICG anterior segment angiography was performed on nine patients with primary pterygium, after obtaining full informed consent. The conjunctival and episcleral arterial flow patterns, collateral and venous drainage were characterised. Angiography was repeated at 1–2 weeks and then at 2 months following conjunctival autografting. Angiography was also performed on 1 patient with a normal nasal bulbar conjunctiva as a control.

ANGIOGRAPHIC PROCEDURE
Rapid intravenous injection of 7.5 ml of 50 mg/10 ml ICG Pulsion solution was administered through a butterfly cannula on the
dorsum of the hand. The angiographic images were acquired using a Topcon 50IA camera with a built-in 830 nm barrier filter, at 35 degree field coverage and maximum gain. The images were digitally processed on an IMAGEnet-H1024 digital imaging system. Angiographic images were taken immediately after injection of ICG until the first appearance of the dye was observed. Thereafter, photographs at 2 second intervals were captured for the first 2 minutes, then at 3, 5, and 10 minutes.

**TECHNIQUE OF CONJUNCTIVAL AUTOGRFTING**

Excision of the pterygium to bare sclera was performed. A free graft obtained from the superior bulbar conjunctiva was placed over the scleral defect and sutured with 8/0 virgin silk. A subconjunctival injection of dexamethasone and gentamicin was given at the end of the procedure. Postoperatively, the patients were prescribed a tobramycin-dexamethasone combination eye drop.

**Results**

NORMAL ANGIOGRAM OF THE NASAL BULBAR CONJUNCTIVA

The episcleral vessels appeared early, at 16–25 seconds following intravenous injection of ICG. These vessels were easily identified by their meandering and tortuous appearance and by correlation with the clinical picture. Vessels from the anterior conjunctival circulation appeared slightly later. These were superficial to the episcleral vessels and appeared straighter. No leakage of dye was observed even beyond 10 minutes of the angiogram.

ANGIOGRAPHIC FEATURES IN PTERYGIUM

A single feeder vessel was found in the early phase of the angiograms in six patients (66.7%). This vessel was superficial and straight, indicating its origin from the anterior conjunctival circulation. It appeared between 17.2 and 26.0 seconds after injection of ICG. It subsequently branched to form the radial vessels of the pterygium. The underlying episcleral vessels appeared later, and were highly tortuous and meandering. These appeared between 19.4 and 31.8 seconds following intravenous injection (Fig 1 (A–D)). There appeared to be no communication between the episcleral vessels and the radial vessels of the pterygium from the anterior conjunctival circulation. No leakage of dye was demonstrable from these vessels even in the late phases of the angiogram in all cases. In three cases (33.3%) avascular zones were demonstrable at the head of the pterygium.

![Figure 1 (A–D) Angiographic features in pterygium. The single feeder vessel (thick arrow) branches to form the radial vessels of the pterygium. The episcleral vessels (thin arrows) appear later.](http://www.bjophthalmol.com)
Following conjunctival autografting, angio-
graphy was performed at 2 weeks postopera-
tively in the first seven patients of our study. In
all cases (100%), the graft vessels were fully
reperfused. Perfusion of the graft vessels was
noted to commence between 27.5 seconds to
47.5 seconds following injection of the ICG.
Gross leakage of dye could be demonstrated at
the edge of the graft in six cases (85.7%),
beginning at between 1 minute 56.2 seconds
and 7 minutes 58.9 seconds following injection
of the dye. Leakage was not well demonstrated
in the seventh case due to the poor quality of
the angiogram. Granuloma formation oc-
curred in two of the seven cases and leakage
from the granuloma was noted beginning at 3
minutes 38.0 seconds in the first case and 5 minutes
49.8 seconds in the second case. The granulo-
mas resolved with topical steroid treatment
after 6 weeks.

As a result of our findings at 2 weeks postopera-
tively, a decision was made to perform the
angiogram at 1 week postoperatively in our two
remaining cases. Even at 1 week postopera-
tively, the graft appeared to be perfused,
despite obvious gaps between the graft and the
host conjunctiva in the clinical picture (Fig 2
(A–D)). This would imply early reperfusion
from the episcleral bed beneath the graft.
Reperfusion commenced at 23.2 seconds in
the first case and 35.0 seconds in the second
case.

Angiography was again repeated at 2 months
postoperatively. This consistently showed a
well perfused graft with mild leakage from the
edges.

**Discussion**
ICG is a water soluble tricarbocyanine dye pri-
marily bound to globulins As it is a larger
molecule and more highly protein bound than
fluorescein, it is not as readily extravasated
from the choriocapillaris, making ICG angio-
graphy useful in the evaluation of chorioretinal
disorders.

A pilot study by Alsagoff et al (in prepara-
tion) successfully used ICG in anterior seg-
ment angiography to characterise conjunctival
and trabeculectomy bleb vascular status, dem-
onstrating its potential usefulness as a research
or investigational tool. In our study, clear, well
deﬁned, high contrast angiograms of the
conjunctival and episcleral circulation of the
nasal bulbar conjunctiva were obtained. No
leakage from the episcleral and conjunctival
vessels was seen throughout the early and late

Figure 2 (A–D) Angiogram 1 week after conjunctival grafting. The graft is fully perfused despite obvious gaps between
the graft and host conjunctiva in the clinical picture. Leakage of dye is seen at the edges of the graft.
stages of the angiogram in our normal control. This made it possible for us to evaluate the filling patterns in pterygium.

Morphological studies on pterygium thus far include histological evaluation with the electron microscope, evaluating the epithelial ultrastructure, and morphological observation of the intraepithelial capillaries in pterygium. However, these have yet to define the blood supply and filling patterns in pterygium and it is still unclear as to whether pterygium is a disease of the conjunctival or episcleral circulation.

In our study, a single feeder vessel was seen in 66.7% of our cases. This vessel was superficial and straight and, by correlation with the clinical picture, appeared to arise from the conjunctival circulation. This would imply that pterygium derives its blood supply from the anterior conjunctival circulation and not from the episcleral circulation. However, our study is limited by its small sample size, especially when the vascular patterns in pterygium are highly variable. If significant, therapeutic ablation of this feeder vessel could be a promising treatment modality of the future.

The early reperfusion of the conjunctival autograft at 1 week postoperatively despite clinical evidence of gaps between the graft edge and host conjunctiva would mean early reperfusion of the graft from vessels of the underlying episcleral bed. Excessive cautery of the episcleral bed following excision of the pterygium should therefore be avoided, as this would delay reperfusion of the graft, and could explain the prolonged graft oedema seen in some cases postoperatively.

In our small series of nine cases, no recurrence of the pterygium occurred during our study period and so the filling patterns of recurrence could not be evaluated.

Conclusions
The blood supply of pterygium is derived from the anterior conjunctival circulation, as evidenced by the single feeder vessel appearing early in the angiograms in our study. This vessel branches to form the radial vessels seen in pterygium. More studies with a larger sample size would be required to further elucidate the nature and variable vascular patterns in pterygium. Following conjunctival autografting, the graft is perfused as early as 1 week postoperatively, from the underlying episcleral bed.

This study was performed in the Singapore National Eye Centre and the Department of Ophthalmology, National University Hospital. It was supported by a grant from Singapore Eye Research Institute.