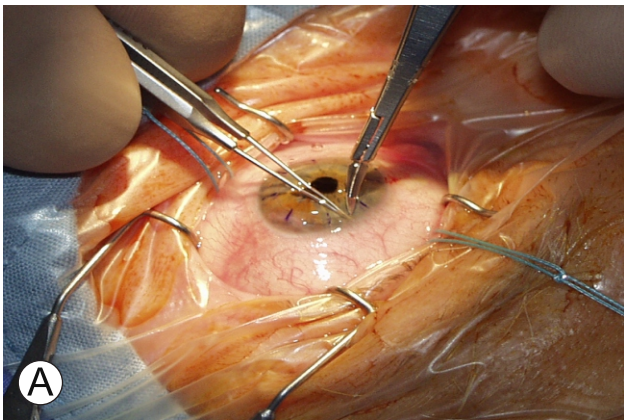
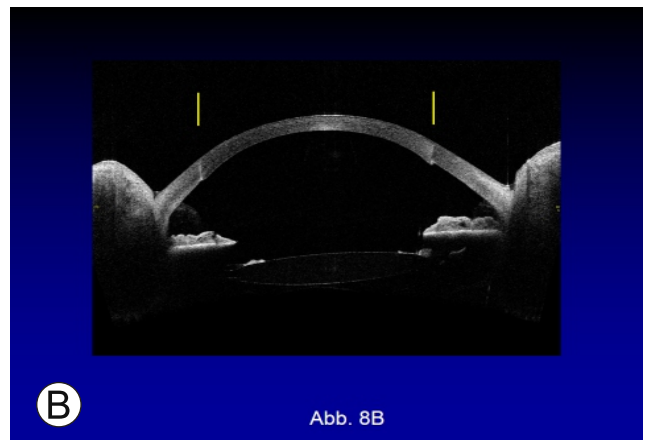
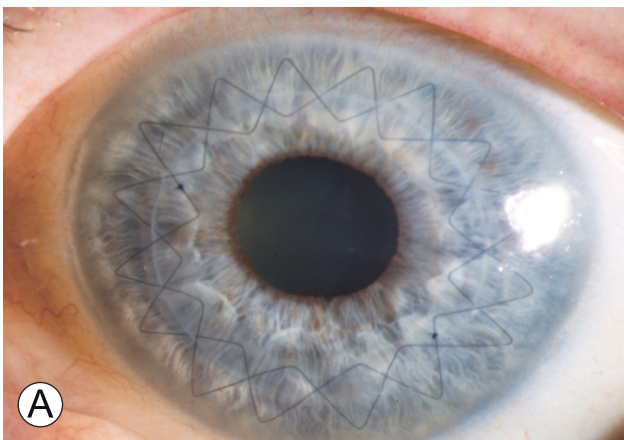




**Fig. 6:** Patients with ankylosing spondylitis (Morbus Bechterew) sometimes require a special body support to achieve **horizontal positioning of the head and limbal plane** in keratoplasty à chaud.

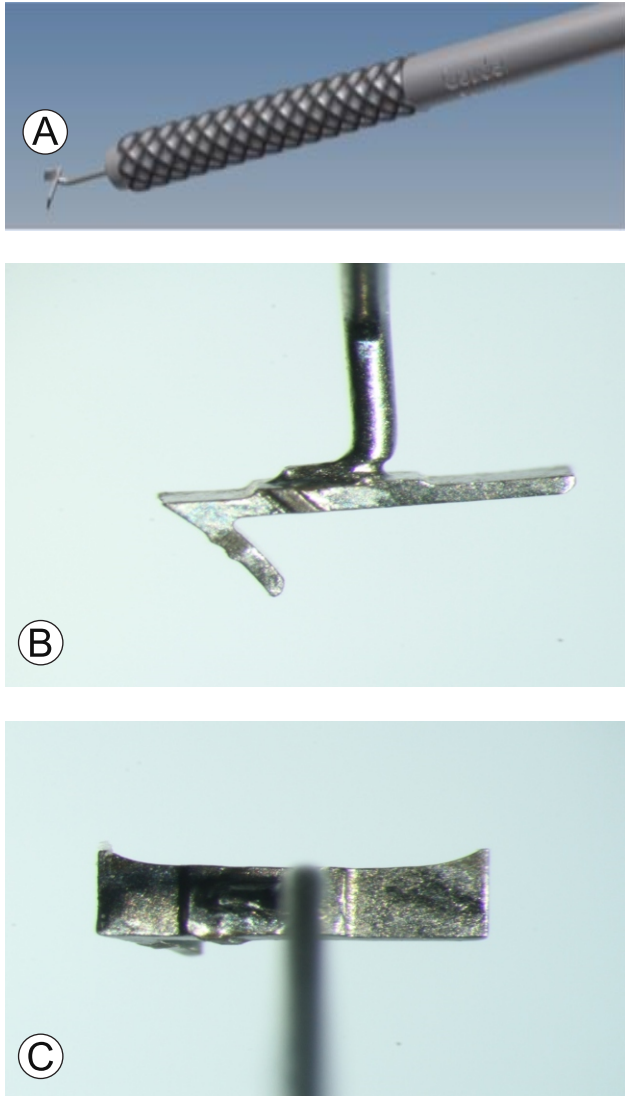


**Fig. 7: Peripheral iridotomy** (not iridectomy!) (**Figure 7A**) is used to avoid the so-called Urrrets-Zavalía syndrome, i.e. a fixed dilated pupil, iris atrophy, and secondary angle-closure glaucoma after administration of atropine in PK for keratoconus (**Figure 7B**).



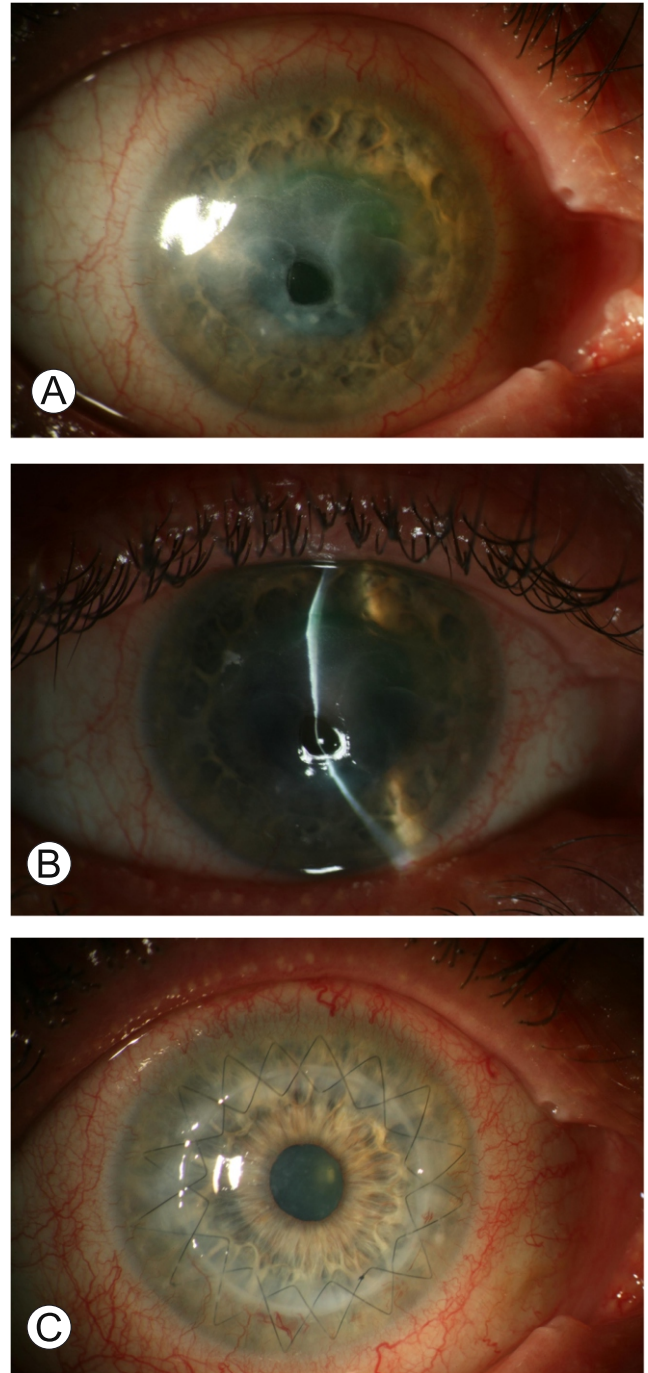
**Fig. 8A:** Double continuous **cross-stitch suture** according to Hoffmann in keratoconus.

**8B:** In **anterior segment OCT**: perpendicular cut edges after to excimer laser assisted trephination of donor and recipient

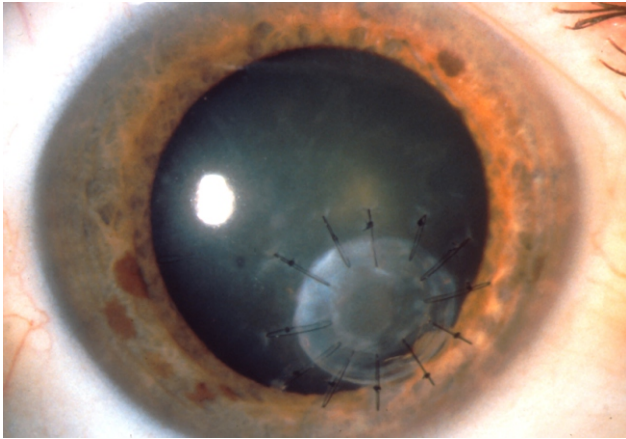


**Fig. 9: Homburg cross-stitch marker according to Suffo (by Geuder)**

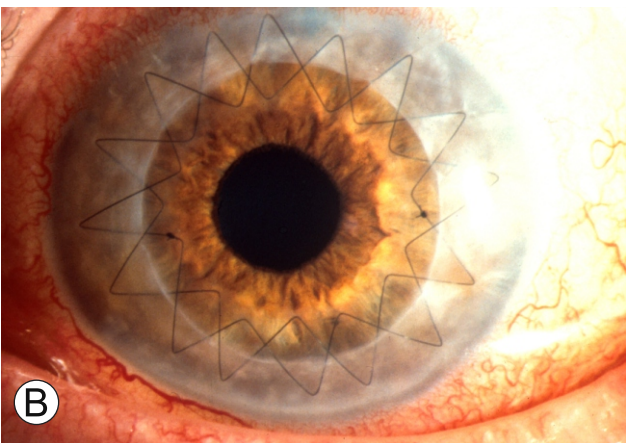
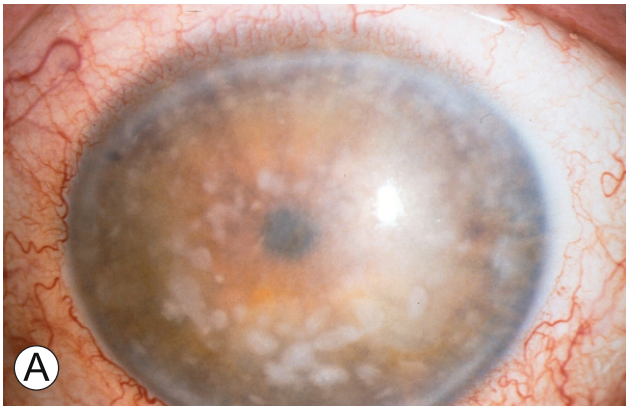
**Fig. 9A:** Overview, **9B/C:** Details, **9D:** Through correct placement in relation to the donor-host-junction and the eight cardinal sutures, two punctiform impressions marked in blue on the donor and host corneas are generated for the correct placement of the double continuous cross stitch suture according to Hoffmann (“painting by numbers”).



**Fig. 10A/B:** Ulcerative necrotising stromal keratitis with **descemetocele** of herpetic origin. **C:** 1 week after curative central round excimer laser PK à chaud.



**Fig. 11: Eccentric mini-keratoplasty** with single interrupted sutures for focal corneal penetration.



**Fig. 12: (A) Macular corneal dystrophy** with acid mucopolysaccharides involving all (!) layers of the cornea including the endothelium **(B)** 6 weeks after excimer laser PK (7.5/7.6 mm) with double running cross stitch suture according to Hoffmann.

**10. Excessively large, and especially excessively small transplants** in comparison to the recipient bed should be avoided to prevent stretching or compression of the peripheral donor tissue. It does not seem to be justified to compensate myopia in keratoconus by using a smaller graft than the recipient opening!

**11.** In cases of doubt, **limbal centration** should be preferred over pupil centration (the optical displacement of the pupil must be taken into consideration, especially in keratoconus) [Langenbacher 1999].

**12.** A peripheral iridotomy at **12 o'clock** serves as prophylaxis of a so-called Urrets-Zavalía syndrome (**Figure 7**).

**13.** As long as the Bowman's layer is intact, a **double continuous cross-stitch suture according to Hoffmann (Figure 8)** is preferred, since it results in higher topographic regularity, earlier visual rehabilitation and a lower rate of suture loosening. The **Homburg cross-stitch marker according to Suffo** (manufactured by Geuder) (**Figure 9**) allows in particular inexperienced surgeons, who still lack an optimal sense

of proportion, to determine the exact point of entry and exit for the cross stitches [Suffo 2019].

**14. Intraoperative keratotomy** should be applied after removal of the eye speculum and fixation sutures.

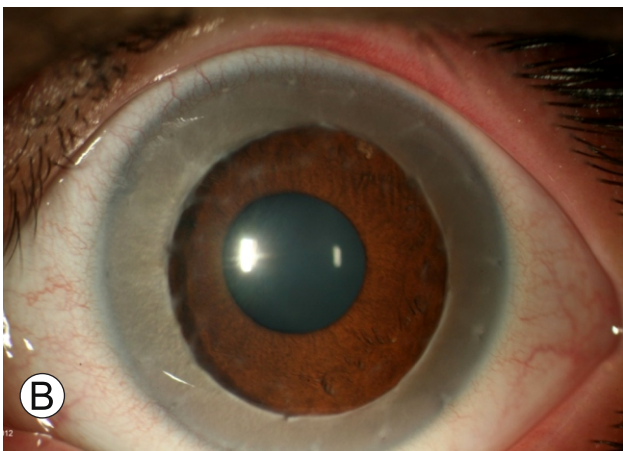
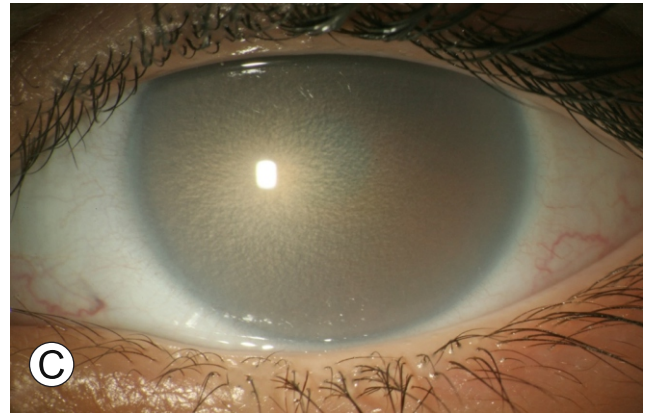
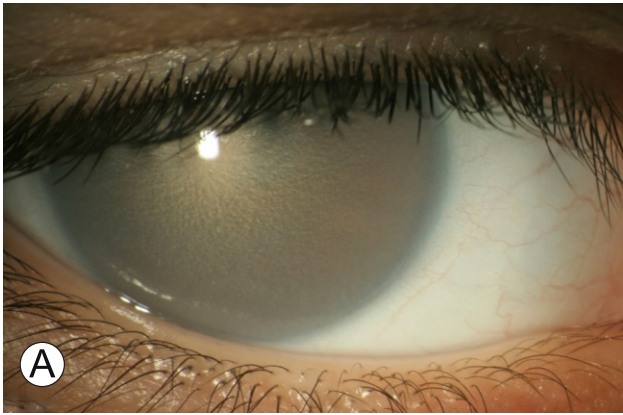
#### **Indications for routine penetrating keratoplasty – and “beyond routine”**

In addition to methodological problems with lamellar techniques, there are a number of indications that still generally require PK today (**Table 1**). These indications can be classified into elective (optical vs. tectonic) and curative emergency interventions (PK à chaud). A peripheral/eccentric tectonic corneoscleroplasty is required in a block excision, for example, due to malignant melanoma of the ciliary body or an epithelial implant cyst [Al Saraji 2017], in ‘traumatic iridencleisis’ or rheumatoid melting at the limbus. The central round 12 mm tectonic corneoscleroplasty may be useful in keratoglobus or advanced keratotorus.

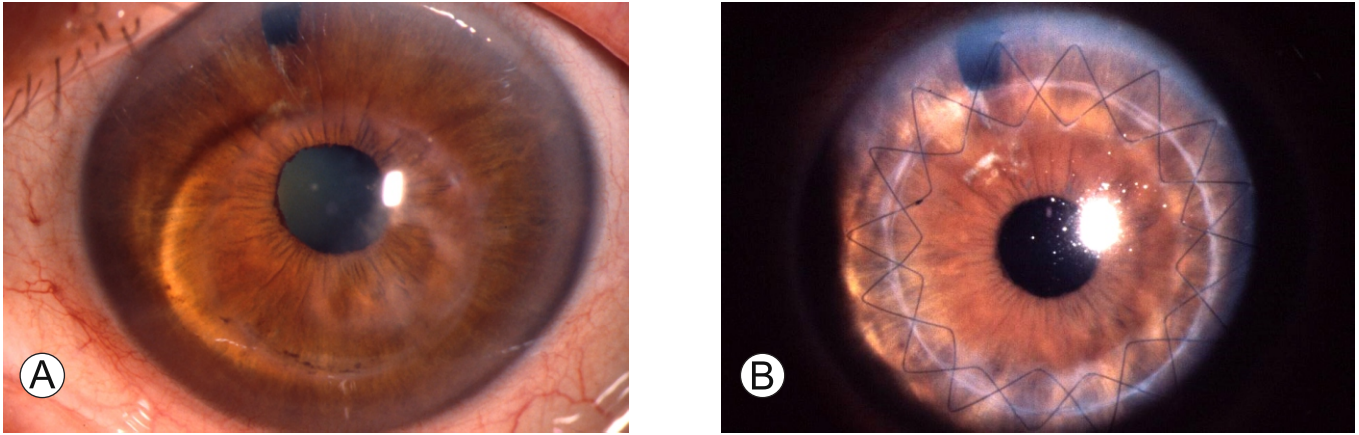
An infectious or rheumatoid descemetocele (**Figure 10**) or corneal penetration requires PK à chaud after sclerotomy to restore the integrity of the globe of the eye. In exceptional cases, an eccentric mini-keratoplasty à chaud may be sufficient for localised penetration (**Figure 11**).

#### **Table 1: Timeless indications for penetrating keratoplasty PK**

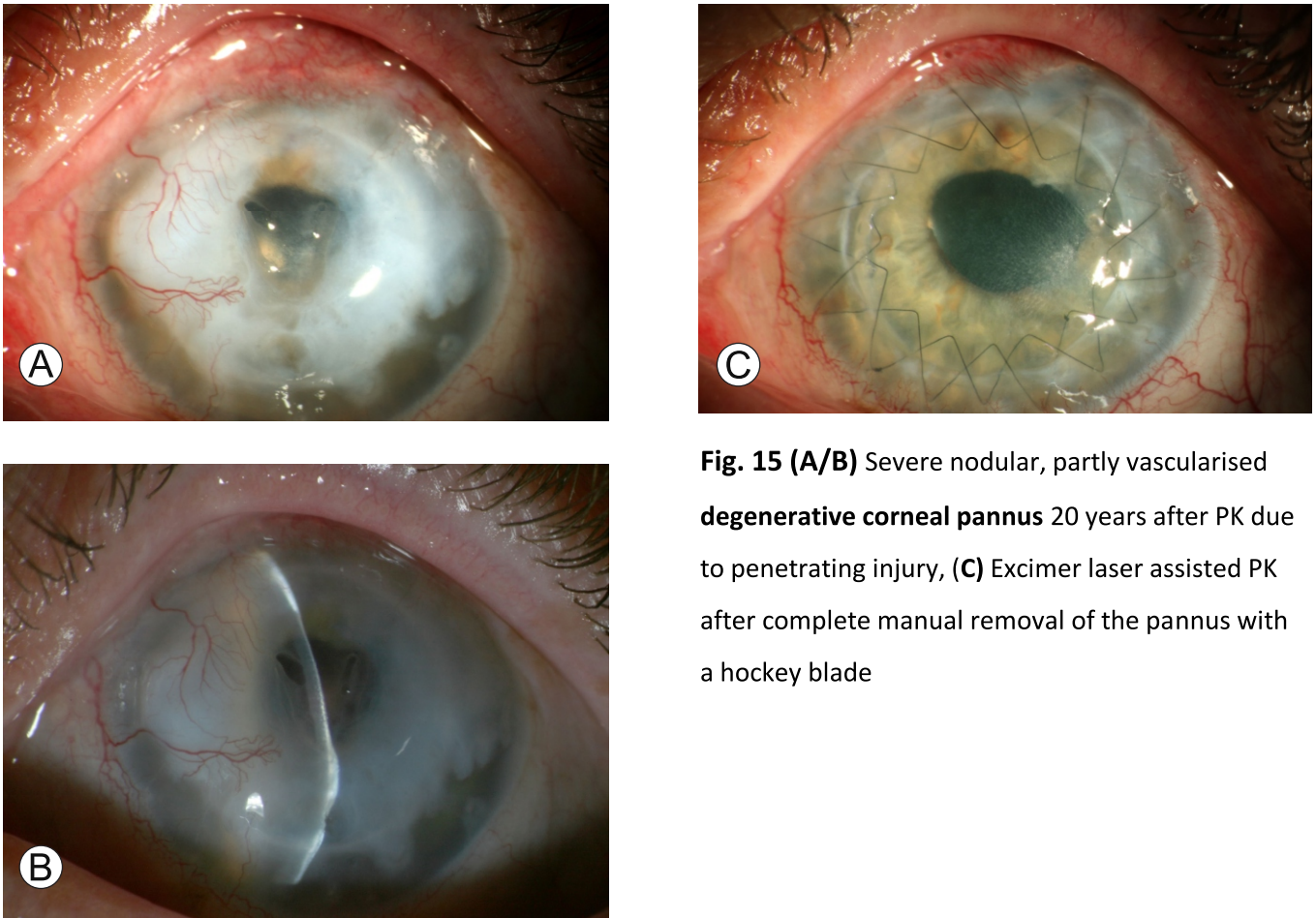
- Dystrophies that affect all layers of the cornea (e.g. Macular dystrophy, congenital stromal dystrophy)
- High and/or irregular astigmatism after PK (with/without endothelial decompensation)
- Patients with advanced keratoconus (in each case after acute keratoconus = corneal hydrops with rupture of the Descemet membrane)
- Central oversized corneoscleroplasty in severe keratotorus or keratoglobus
- Unstable cornea (e.g. after radial keratotomies, iatrogenic keratectasia after LASIK, descemetocele, perforated ulcer)
- Aphakia, simultaneous IOL implantation (always with Flieringa ring!)
- Ipsilateral and contralateral autologous keratoplasty [Ahmedova 2015]
- Acanthamoeba or fungal keratitis
- Semilunar eccentric corneoscleroplasty
- Block excision with tectonic corneoscleroplasty
- Traditionally, elective optic central PK is required for severe corneal pathologies, such as macular dystrophy (**Figure 12**) or congenital stromal dystrophy (**Figure 13**), repeat keratoplasty for high astigmatism or recurrent keratoconus due to a graft that is too small (**Figure 14**).



**Fig. 13: Congenital hereditary stromal dystrophy CHSD before/after excimer laser assisted PK (7.5/7.6mm) (OD/OS) in a 2-year-old Greek boy.**



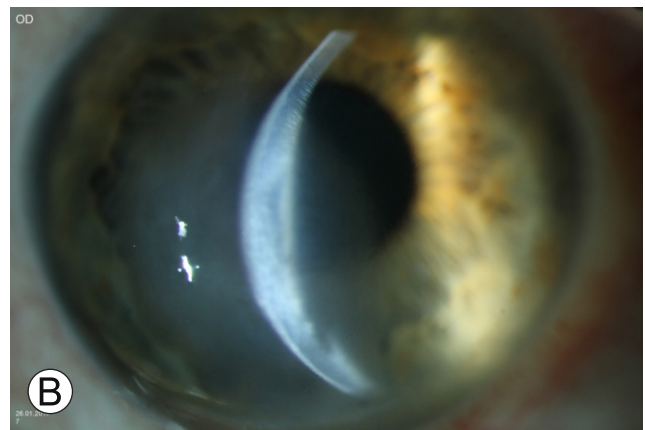
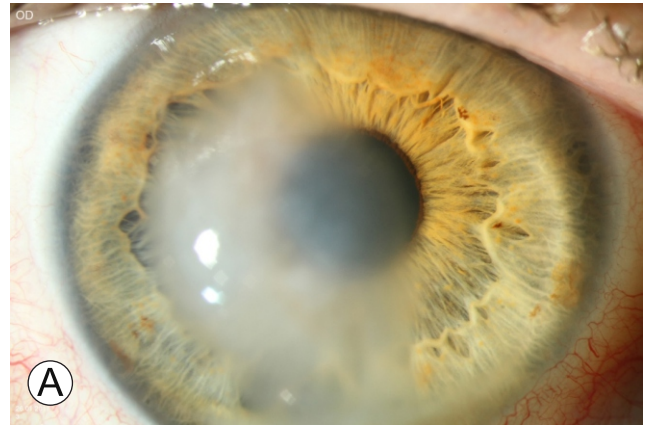
**Fig. 14 (A)** 'Repeat keratoconus' in a far too small decentered transplant. **(B)** Excimer laser-assisted repeat PK with optimal graft size (8.5/8.6 mm) and optimal centration for complete excision of the first transplant.



**Fig. 15 (A/B)** Severe nodular, partly vascularised **degenerative corneal pannus** 20 years after PK due to penetrating injury, **(C)** Excimer laser assisted PK after complete manual removal of the pannus with a hockey blade

In small decentralised transplants with high irregular astigmatism often only the centred larger diameter repeat keratoplasty (maximum 8.5 mm, preferably excimer laser trephination) is an advisable option [Szentmáry 2005]. Also requiring PK: scars after acute keratoconus with Descemet membrane defect, penetrating corneal scars after penetrating injury (**Figure 5**), status post radial keratotomies, long-standing endothelial-epithelial decompensation with severe, partially vascularised pannus and stromal scars – always after complete manual removal of the pannus with the hockey blade (**Figure 15**). In acute keratoconus (= corneal hydrops) PK is contraindicated, but deep predescemetal 10.0 nylon single interrupted suture (so-called “Muraire sutures”) have been shown to rapidly reduce stromal oedema (**Figure 16**) [Schießl 2018].

The herpes simplex virus can persist in the endothelium, so that neither DALK nor ipsilateral autologous rotational keratoplasty is indicated here. Acanthamoeba keratitis (**Figure 17**) or fungal keratitis (particularly fusarium or aspergillus, **Figure 18**) sometimes require very large graft diameters and a large number of single interrupted sutures to remove the pathogens as much as possible and preserve the globe of the eye (**Table 2**).



**Fig. 16 (A/B) Acute keratoconus = corneal hydrops, (C) Anterior segment OCT shows the thickening of the cornea to > 1000 µm with pronounced intrastromal fluid-filled lacunae due to a linear defect of Descemet membrane.**