

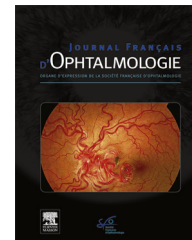


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EDITOR'S CHOICE

# Comparison of 12-month anatomic and functional results between Z6 femtosecond laser-assisted and manual trephination in deep anterior lamellar keratoplasty for advanced keratoconus



A. Blériot<sup>a,\*</sup>, E. Martin<sup>b</sup>, P. Lebranchu<sup>a</sup>,  
K. Zimmerman<sup>c</sup>, L. Libeau<sup>a</sup>, M. Weber<sup>a</sup>, B. Vabres<sup>a</sup>,  
I. Orignac<sup>a</sup>

<sup>a</sup> Ophthalmology service, Nantes university medical center, 1, place Alexis-Ricordeau, 44000 Nantes, France

<sup>b</sup> Ophthalmology service, Saint-Nazaire medical center, cité sanitaire Georges-Charpak, 11, boulevard Georges-Charpak, BP 414, 44606 Saint-Nazaire, France

<sup>c</sup> MEDICARE-HTM, 3, rue Alain-Bombard, 44800 Saint-Herblain, France

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## KEYWORDS

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**Summary** The management of severe keratoconus requires corneal transplantation, for which the gold standard is deep anterior lamellar keratoplasty (DALK), preserving the healthy Descemet's membrane and endothelium. The safety and reproducibility of corneal cuts have been improved by the evolution of femtosecond lasers in refractive surgery, and femtosecond laser in DALK would seem to provide the same advantages over the manual method. In our retrospective study, we compare functional and anatomical results of femtosecond-assisted DALK versus manual trephination DALK in patients with keratoconus in stage 4 of the Krumeich classification. It is a retrospective study including all patients with stage 4 keratoconus who underwent femtosecond laser-assisted DALK between November 2012 and November 2015 in Nantes university medical center. We compared those patients to a group of patients who underwent manual DALK in the same period, paired by age and maximal keratometry. We assessed visual acuity, pachymetry, endothelial cell density (specular microscopy), and keratometry before surgery and at 4, 8 and 12 months of follow-up. Laser settings and intraoperative complications were recorded. Nineteen patients underwent surgery by femtosecond-assisted DALK, 6 women

\* Corresponding author.

E-mail address: [alice.bleriot@gmail.com](mailto:alice.bleriot@gmail.com) (A. Blériot).

and 12 men with average age  $30.2 \pm 10.8$  years at transplantation. They were paired with a group of 17 patients who underwent manual DALK in order to compare results. Before surgery, mean visual acuity in the femtosecond group was 0.90 logMAR versus 0.89 logMAR in the manual group, showing no statistically significant difference ( $P=0.96$ ). Both groups were similar in terms of preoperative age, mean keratometry, pachymetry and endothelial cell density. Average visual acuity post-surgery was 0.27; 0.26; and 0.14 logMAR for femtosecond DALK versus 0.27; 0.17 et 0.25 for manual DALK at 4, 8 and 12 months follow-up respectively, showing no statistically significant difference. After surgery, at 4, 8 and 12 months, mean pachymetry was similar in both groups, and average endothelial cell density was 2390 cells/mm<sup>2</sup> for femto DALK versus 2531 cells/mm<sup>2</sup> for manual DALK at 12 months of follow-up, showing no statistically significant difference ( $P=0.5726$ ). The rate of Descemet's membrane microperforations during the procedure was low and similar for both groups. Our study allows for a 12-month follow-up, with assessment of visual recovery, anatomic result and endothelial safety in a series of 19 femtosecond laser-assisted DALK with no statistical significant difference versus the manual trephination group. Femtosecond laser allows for increased reproducibility of the DALK procedure without reducing adverse effects during surgery. Femtosecond laser seems to improve the technique of the DALK procedure, and future developments could improve the reproducibility of DALK even further. A medical economics study would be necessary to determine the cost-effectiveness of femtosecond laser-assisted DALK.

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## Introduction

Keratoconus is a non-inflammatory progressive corneal dystrophy involving thinning and ectasia of the corneal stroma, resulting in the development of progressive myopia and irregular astigmatism. It is a disease of young patients, for which the diagnosis has become increasingly frequent with the advent of refractive surgery and video-topography performed preoperatively. In keratoconus, there is a major deformation of the corneal stroma, which puts Descemet's membrane and the endothelium on stretch. These two structures are not affected until late in the disease, developing folds and breaks in Descemet's membrane and endothelial pleomorphism.

Penetrating keratoplasty (PK) has been progressively supplanted by deep anterior lamellar keratoplasty (DALK) [1], which has become the standard technique for corneal diseases with healthy endothelium, of which keratoconus is the primary cause [2–5]. The results in terms of postoperative visual acuity and astigmatism are comparable to the results obtained with PK, but respecting the endothelium provides multiple additional advantages [6]: performance of closed-globe surgery, preservation of the endothelium: preservation of the patient's own all-important endothelium with much less cell loss than with a graft preserved in culture medium [6], as well as immunologic safety with no risk of endothelial rejection, the primary site of rejection in PK [7], better biomechanical stability of the globe, decreasing the risk of graft dehiscence and permitting earlier suture removal at an average of 12 months vs. 18 months for PK [6], and a lower percentage of ocular hypertension thanks to a less prolonged course of steroid drops [6]. However, DALK has its own complications: the main one is the presence of interface opacities in the case of residual stroma; there is also a risk of intraoperative perforation of Descemet's/endothelium (in 9 to 39% of cases [8]) with

possible postoperative double anterior chamber or conversion to penetrating keratoplasty (which is not a disadvantage compared to planned PK [6]). The femtosecond laser has seen significant development in refractive surgery; it permits safe and reproducible corneal cuts. Its use will continue to be increasingly common in ophthalmic surgery and is being developed for corneal transplantation, in which the cutting steps represent an essential feature of the surgery. In our study, we offer a 12-month evaluation of the functional and anatomic results of patients undergoing femtosecond laser-assisted deep anterior lamellar keratoplasty, and compare these results to those in patients undergoing DALK by manual dissection (standard technique).

## Materials and methods

This is a retrospective study including all patients with keratoconus undergoing surgery between November 2012 and November 2015 at the Nantes university medical center by the technique of femtosecond laser-assisted DALK. The laser used was the LDV Z6 (ZIEMER®), assisted by the Medicare-HTM technician (insuring laser calibration, preoperative settings and preparation of the laser handpiece) within the context of on-site laser rental. The Z6 laser is an unamplified femtosecond laser, with a small footprint and very mobile, which can be easily set up in an operating room.

## Description of the procedure

### Femtosecond laser-assisted technique

The laser is set to lamellar keratoplasty mode with vertical side cuts. The following parameters are set: cut diameter (7.5 mm) and cut depth, leaving between 120 and 90 μm of residual stroma at the thinnest point on the Pentacam

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