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ORIGINAL ARTICLE

Effects of femtosecond and excimer lasers on implanted KAMRA corneal inlay in animal models☆

Effets de femtosecondes et excimer lasers sur implantés KAMRA cornéenne inlay dans les modèles animaux

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KEYWORDS
KAMRA inlay;
Femtosecond laser;
Excimer laser;
Presbyopia

Summary
Purpose. — To evaluate the effect of femtosecond laser and excimer laser on an intracorneal inlay (KAMRA®) implanted in animal models.
Methods. — Femtosecond laser was used to create corneal intrastromal pockets at 250 μm depth in five porcine eyes. Four intact KAMRA inlays, examined by slit-lamp biomicroscopy and light microscopy, were implanted in the pocket of four eyes. A standard LASIK flap was created above each implanted inlay in the four eyes using a femtosecond laser with flap thicknesses of 150 μm, 130 μm, 110 μm and 90 μm. In the fifth porcine eye, a LASIK flap was created using femtosecond laser at 110 μm depth, and a fifth inlay was then implanted in the 250 μm pocket. Excimer laser ablation was performed under the flap targeting a −3.00 refraction. The inlay was then explanted, examined and reimplanted in the same pocket followed by a second similar excimer laser ablation.

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Results. — Significant burn, shrinkage and distortion of microholes were noted in all the first four inlays following the femtosecond laser flap creation at all the various flap thicknesses. The damage was noted to be more prominent as the distance between the flap and inlay decreased. No apparent effect was noted on the fifth inlay following repeated excimer laser ablations.
Conclusion. — Unlike excimer laser, femtosecond laser appears to be hazardous and damaging to the intracorneal KAMRA inlay when applied above it.

MOTS CLÉS
Implant KAMRA ;
Laser femtoseconde ;
Laser excimer ;
Presbytie

Résumé
Objectif. — Évaluer l'effet du laser femtoseconde et du laser excimer sur l'implant intra-cornéen (KAMRA®) implanté dans des modèles animaux.
Méthodes. — Le laser femtoseconde a été utilisé pour créer des poches intrastromales cornéennes à 250 μm de profondeur dans cinq yeux porcins. Quatre implants KAMRA intacts, examinés à la lampe à fente et par microscopie optique, ont été implantés dans les poches de quatre yeux. Un lambeau LASIK standard a été créé au-dessus de chaque implant dans les quatre yeux en utilisant un laser femtoseconde avec des épaisseurs de lambeaux variables de 150 μm, 130 μm, 110 μm et 90 μm. Dans le cinquième œil porcin, un lambeau LASIK a été créé en utilisant un laser femtoseconde à 110 μm de profondeur, et un cinquième implant a ensuite été implanté dans la poche située à 250 μm. L'ablation par laser excimer a été effectuée sous le lambeau ciblant une réfraction de −3,00 dioptries. L'implant a été ensuite explanté, examiné et réimplanté dans la même poche, suivie d'une seconde ablation similaire par le laser excimer.
Résultats. — Des brûlures importantes, un rétrécissement et une distorsion des micro-trous ont été notés au niveau des 4 premiers implants suite à la création des lambeaux à des épaisseurs différentes par le laser femtoseconde. Les dommages étaient inversement proportionnels à la distance entre le lambeau et l'implant. Aucun effet apparent n'a été noté sur le cinquième implant après les ablations répétées au laser excimer.
Conclusion. — Contrairement au laser excimer, le laser femtoseconde semble être dangereux et peut endommager l'implant intra-cornéen KAMRA lorsqu'il est appliqué sur sa surface d'implantation.

Introduction

The correction of presbyopia by refractive surgery remains a challenge. One of the procedures currently used is the intracorneal inlay implantation that was first introduced in the 1940s by Barraquer [1,2]. Early versions were successful in treating the refractive error, however, corneal necrosis and extrusion of the inlay were major complications [2,3]. The development of more biocompatible materials and improvement in laser technology, such as femtosecond lasers have allowed corneal inlay technology to become a favorable option. The major advantages are reversibility and possible combination with other refractive procedures. Currently, there are several types of corneal inlays used to correct presbyopia. KAMRA inlay by AcuFocus (USA), one of the most studied among corneal inlays, increases the depth of focus and improves uncorrected near and intermediate vision while minimally affecting distance vision [4]. The inlay is a 5 mm thin biocompatible polyvinylidene fluoride disk with a 1.6 mm central annulus which acts as a pinhole, and an outer diameter of 3.8 mm. Long-term studies have shown the efficacy and safety of this inlay for the treatment of presbyopia [5]. Its use for treatment of glare secondary to traumatic mydriasis has also been reported [6]. Patients with an implanted corneal inlay may require sometimes an enhancement procedure for residual or consecutive refractive error; therefore, it is essential to thoroughly understand the effects of any laser intervention on the inlay and its safety.

The purpose of this study is to evaluate the effects of femtosecond and excimer lasers on the implanted corneal inlay and to determine whether any precautions need to be taken when treating patients who have an implanted KAMRA inlay.

Materials and methods

Five fresh porcine eyes with clear corneas were used in this study. Femtosecond laser (Femto LDV, Ziemer, Germany) was used to create a corneal intrastromal pocket at 250 μm depth in all 5 eyes. Five intact KAMRA corneal inlays were examined by slit-lamp biomicroscopy (SLB) under high magnification and light microscopy (LM) (Fig. 1). Four of them