Biomechanical result, topographic and anatomic patient undergoing intrastromal ring by advanced keratoconus

Resultado biomecânico, topográfico e anatômico pós anel intraestromal em ceratocone avançado

João Roberto Garcia Tardin[1,2,3], Mônica Araújo Bastos[1,4], Kleber Sampaio Fragoso Borges[5]

ABSTRACT

The intrastromal corneal ring implant surgery is becoming a surgical procedure in the treatment of keratoconus additive in order to minimize and delay the complications inherent to the pathology. Its action consists in the remodeling cornea, flattening and regulating the central corneal surface. Nowadays with the advent of new technologies, there is an important contribution in the diagnosis of keratoconus, with not only diagnosis but also more effective with better monitoring and prognosis of patients with this disorder ectatic. In this article we report the case of a young patient with advanced keratoconus in his left eye and severe in the right eye, which caused failure in adapting to rigid lenses, underwent surgery with implants intracorneals in both eyes with significant improvement of topographys indexes, anatomical and biomechanical tests as demonstrated by the ORA (ocular response analyzer), optical coherence tomography of anterior segment and corneal topography.

Keywords: *Keratoconus/surgery; Tomography, optical coherence; Prostheses and implants; Corneal topography; Biomechanics; Case reports*

RESUMO

A cirurgia de implante de anel intraestromal corneano vem se tornando um procedimento cirúrgico aditivo no tratamento do ceratocone, visando minimizar e até postergar as complicações inerentes à patologia. Sua ação consiste no remodelamento corneano, aplanando e regularizando a superfície corneana central. Atualmente com o surgimento de novas tecnologias, observa-se importante contribuição na propedêutica do ceratocone, não só com diagnóstico mais efetivo mas também com melhor acompanhamento e prognóstico dos pacientes com esta desordem ectásica. Neste artigo é relatado o caso de uma jovem paciente portadora de ceratocone avançado em olho esquerdo e severo em olho direito, o que acarretava impossibilidade na adaptação de lentes de contato rígidas, submetida à cirurgia com implantes intracorneanos em ambos os olhos com significativa melhora dos índices topogáficos, anatômicos e biomecânicos como demonstrados pelos exames de ORA (ocular response analyzer), tomografia de coerência óptica de segmento anterior e topografia corneana.

Descritores: Ceratocone/cirurgia; Próteses e implantes; Tomografia de coerência óptica; Topografia da córnea; Biomecânica; Relatos de casos

[1]Cornea, Cataract and Refractive Surgery Unit, Dr. Fragoso Borges Clinic, Petrópolis/RJ, Brazil.
[2]Physician/Preceptor, Cornea Unit, Sorocaba Eye Hospital, Sorocaba/SP, Brazil.
[3]Head of the Ophthalmology Service, Santa Teresa Hospital, Petrópolis/RJ, Brazil.
[4]Ophthalmologist, Santa Teresa Hospital, Petrópolis/RJ, Brazil.
[5]Head of the Ophthalmology Service, Dr. Fragoso Borges Clinic, Petrópolis/RJ, Brazil.

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Introduction

Keratoconus (KC) is condition in which the cornea assumes a conical shape due to non-inflammatory causes, leading to corneal thinning and protrusion. The estimated prevalence of KC is approximately 50 to 230 per 100,000 in the general population[1]. Such patients undergo tests to adapt to rigid contact lenses aiming for the best possible visual correction.

Patients with advanced KC who develop intolerance to contact lenses can undergo penetrating keratoplasty; however, they can also benefit from less invasive surgical procedures aiming not only to improve visual acuity but also to postpone or avoid the risks and the greater complexity of a penetrating keratoplasty[2,3]. Intracorneal ring implant has been proposed as a less invasive procedure for the treatment of keratoconus. The procedure flattens the central corneal curvature and provides a more regular corneal surface, thus improving visual acuity[4,5].

This paper reports the case of a patient with advanced keratoconus who underwent bilateral intrastromal ring implantation, describing its visual, anatomical, and biomechanical results.

Case Report

Our patient was a 25-year-old female student born in Petrópolis/RJ. She had no systemic diseases and was referred to our clinic for a second medical opinion. The patient had signs of advanced keratoconus in both eyes, having been diagnosed 10 years earlier. On ophthalmic examination, visual acuity with best correction with rigid contact lenses was 20/60 and 20/30, but the patient could no longer adapt properly to contact lenses due the progression of keratoconus. Refraction was -8.50 D, -7.50 D Cyl x 10 in the right eye (RE) and -5.75 D, -4.00 D Cyl x 160 in the left eye (LE). Biomicroscopy in both eyes showed significant corneal ectasia without opacities. These findings were confirmed by optical coherence tomography (OCT) of the anterior segment. Pachymetry mapping found 405 microns (RE) and 441 microns (LE) in the central region. Biomechanical evaluation and non-contact tonometry (ORA) found IOPcc 13,2 mmHg, CH 5.7 mmHg and CRF 3.7 mmHg in the RE, and IOPcc 11.7, CH 7.0 and CRF 4.7 in the LE (Figure 1). Corneal topography showed a central corneal curvature of 64.00 @ 99 and 57.25 @ 9 in the RE, and 58.62 @ 69 and 50.50 @ 159 in the LE. Fundus examination was normal. Based on these findings, intrastromal ring implantation was indicated in the LE. We chose to operate the left eye first due to its better surgical prognosis. This eye showed good visual, refractive, anatomical, and biomechanical results over the first three postoperative months, with a visual acuity of 20/25 with glasses and a refraction of -2.25 D, -0.50 D cyl x 100 and significant corneal flattening on the axis of greater curvature, as observed in the differential map comparing the pre and postoperative cornea (Figure 2). OCT showed appropriate positioning of the rings in the corneal stroma (Figure 3). ORA found an increase in corneal resistance, with CH 8.5 mmHg, CRF 5.5 mmHg, and IOPcc 8.7 mmHg (Figure 4). Based on the assumption that this is a less invasive procedure than corneal transplantation, 6 months later we performed the same procedure on the right eye. Three months after surgery, the RE had a visual acuity of 20/40 with correction (glasses) and a refraction of -6.75 D, -1.75 D cyl x 75. The patient showed better adaptation to rigid contact lenses than before surgery, achieving a visual acuity of 20/25p. Optical coherence tomography of the anterior segment showed good positioning of the rings in the corneal stroma, and ORA found CH 6.0 mmHg and 5.0 mmHg, with IOPcc 16.0 mmHg.

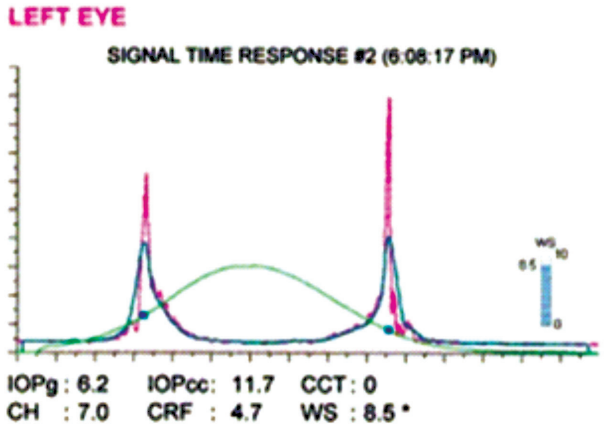

Figure 1: Chart showing the ORA - preoperative

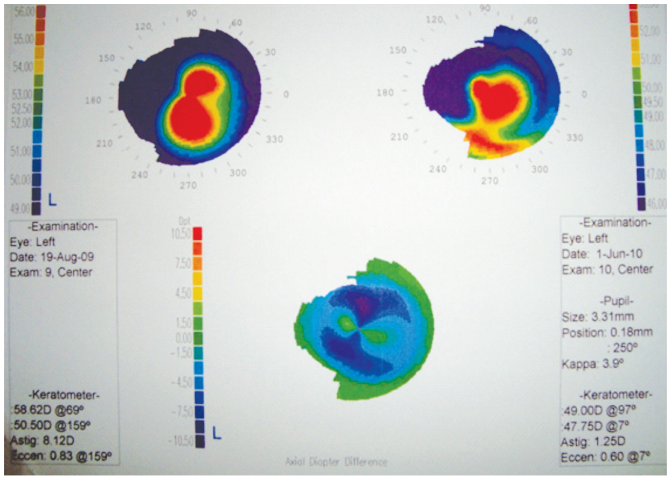

Figure 2: Differential topographic map, observing the measures of pre-and postoperative

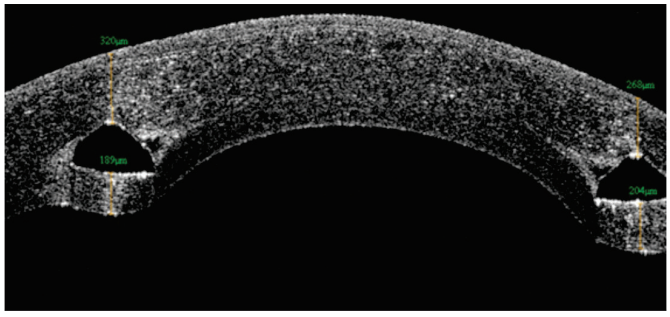

Figure 3: Tomography postoperative anterior segment optical coherence

At the time of writing, 1 year after the left eye and 6 months after the right eye were operated, the patient's refractive, anatomical, and biomechanical indices remain stable.

Discussão

Implantation of intrastromal corneal ring segments induces changes in the shape and curvature of the cornea. The rings are implanted in the mid-peripheral cornea and promote significant central flattening, preserving its positive sphericity. The amount of flattening is directly proportional to the thickness of the

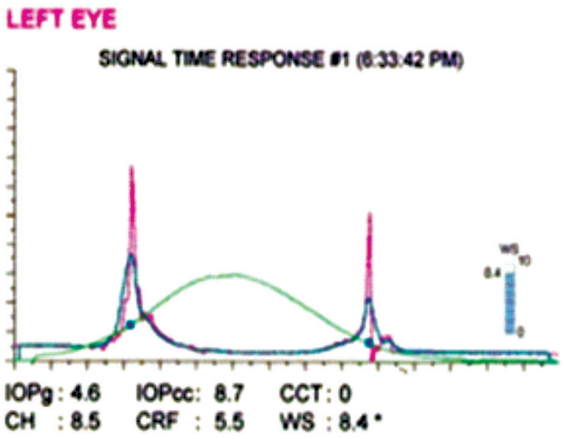

Figure 4: Chart showing the ORA - postoperative

implant and inversely proportional to its diameter[6,7]. Patel et al. studied different mathematical models in order to predict the effect of intracorneal implants to correct myopia in relation to corneal sphericity and spherical aberrations of the eye, implanting thinner segments of larger diameter (intacts). The authors concluded that such segments are important to reduce corneal curvature, but they do not act by inducing and correcting spherical aberrations, such as thicker segments of smaller diameter, which is important to a successful outcome in eyes with keratoconus[8].

Implantation of 5 mm diameter rings provides better flattening of the central corneal curvature, being more effective in the correction of keratoconus. Examples of such rings are the ones we implanted in the patient described here, which are different from the ones the previously mentioned.

In simplified terms, considering that the cornea of a patient with keratoconus is more elastic than the cornea of a myopic patient, the corneal flattening response will be more pronounced in patients with ectasia, leading to greater regularisation after intrastromal implantation[9].

Regarding the biomechanics of the cornea, our patient showed a satisfactory response in terms of corneal rigidity, with postoperative improvement of CH and CRF in both eyes, as observed by ORA. This test provides efficient and reproducible in vivo measures of the biomechanics of cornea by assessing CRF and CH, which are related to the cornea's viscoelastic properties[10].

Ortiz et al. found a statistically-significant reduction of both CRF and CH after refractive surgery (LASIK) with corneal flap by femtosecond laser, suggesting that in LASIK, the flap, ablation, or both may alter the cornea's ability to absorb or dissipate energy[11]. In patients with keratoconus, corneal hysteresis and resistance are reduced in comparison with normal eyes and even with eyes already submitted to refractive surgery[11]. Assessment of the biomechanical properties of the cornea using measures such as hysteresis and the corneal resistance factor represents a new method to diagnose keratoconus.

Future studies on the influence of refractive surgery techniques will be able to evaluate the biomechanical properties of these new parameters (corneal hysteresis and resistance factor) to distinguish patients with keratoconus and those at a high risk of corneal ectasia after LASIK[11].

In our case it was also possible to observe the anatomy of intrastromal implants by optical coherence tomography (OCT) of the anterior segment (Figure 3). Since the anterior segment was assessed with the non-contact technique, no changes were produced on the corneal surface during examination. The device's high-speed assessment is done using a fixed reference mirror. In older systems the assessment speed was limited due to mechanical constraints in data collection[9]. Anterior segment OCT eliminates this restriction, collecting signals over the entire range with accurate pachymetric measurements. There are two theoretical reasons for its effectiveness in measuring corneal thickness: Firstly, OCT assesses the average central corneal thickness, instead of the thickness of a single point, thus being more reliable; secondly, the method is so fast that it is not affected by eye movements, which could cause wrong measurements[12].

In our case, the patient had a satisfactory visual outcome despite the progression and complexity of the condition. Pre and post-operative testing with corneal topography, anterior segment OCT and ORA was important for anatomical and biomechanical evaluation and to provide greater security in the analysis of results.

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Corresponding author:
João Roberto Garcia Tardin
Rua Santos Dumont, 420 – CentroCEP: 25625-090 - Petrópolis - RJ, Brazil
Tel/Fax: +5524 2237 5556E-mail: jrgtardin@yahoo.com