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Orthokeratology (Corneal Refractive Therapy)

What Is It and How Does It Work?

Helen A. Swarbrick, Ph.D., F.A.A.O.

This article reviews current knowledge regarding orthokeratology, also known as corneal refractive therapy. Modern orthokeratology using reverse-geometry gas-permeable lenses is an effective procedure for the temporary reduction of low to moderate myopia. The use of an overnight lens-wearing protocol provides an alternative to refractive surgery for many patients. Onset of the refractive effect is rapid, with observable changes within minutes and stability of effect after 7 to 10 days of treatment. The procedure appears to be fully reversible on cessation of lens wear. The orthokeratology effect is achieved through central corneal epithelial thinning and mid peripheral stromal thickening, although the cellular basis for these changes requires further research. Because of recent reports of severe corneal infections with overnight orthokeratology, the safety of the procedure is under active investigation, and it is clear that minimal clinical standards must be promulgated internationally to ensure a future for this approach to refractive correction.

Key Words: Corneal thickness—Corneal topography—Orthokeratology—Refractive error.

WHAT IS ORTHOKERATOLOGY?

Orthokeratology (also known as OK, ortho-k, corneal reshaping, and corneal refractive therapy [CRT]) is not a new procedure, but it has undergone a resurgence of clinical and research interest in the last decade. In 1971 the International Orthokeratology Section of the National Eye Research Foundation defined orthokeratology as "the reduction, modification, or elimination of refractive anomalies by the programmed application of contact lenses." This early definition is still valid, although successful orthokeratology outcomes are now often achieved with a single lens rather than a series of progressively flatter lenses applied during a period of weeks or months.

There are unconfirmed stories that in ancient times the Chinese applied small weights or sandbags on their eyelids during sleep to reduce myopia. Certainly, the principle is similar to modern orthokeratology. In 1888 the French ophthalmologist, Eugene Kalt, used flat-fitting glass scleral lenses to flatten the cone in patients with keratoconus and thus reduce their myopia, another precursor to the modern technique of orthokeratology. Orthokeratology as we know it today, however, was first suggested by George Jessen in 1962.[1] He discovered the effect largely by accident, through application of his "orthofocus" technique for fitting polymethylmethacrylate (PMMA) lenses. In this technique, the plano lens was fitted flatter than the cornea by the amount of myopia in diopters (D), relying on the postlens tear film to provide the refractive correction. He noted improvements in uncorrected visual acuity once the lenses were removed, and orthokeratology was born. In the 1960s and 1970s a number of practitioners experimented with the technique using conventionally designed flat-fitting lenses; names associated with this period in the development of orthokeratology include May, Grant, Nolan, and Paige. Because of the difficulty in stabilizing flat-fitting lenses on the cornea, attempts were made by practitioners, including Ziff and Tabb, to manipulate lens parameters, such as optic zone diameter and secondary curve radii, to improve lens centration. Publications during this period were essentially clinical anecdote, and it was not until the late 1970s and early 1980s that attempts were made to investigate the technique more scientifically.

Four major studies were conducted by Kerns,[2] Binder et al.,[3] Polse et al.,[4] and Coon[5] to investigate the clinical efficacy of orthokeratology, and although they used different lens designs and fitting philosophies, all four studies reached similar conclusions. Reductions in myopia were indeed found, but they were modest (averaging approximately 1.00 D) and unpredictable and showed high individual variability. The major problem with the technique was induction of corneal astigmatism as a result of poor lens centration, but no other significant adverse effects were identified. Regression of the cornea toward baseline, over weeks to months, was observed on cessation of lens wear. This was regarded as a negative feature, because it had been hoped that the effect might be permanent.

Apart from a handful of enthusiasts, orthokeratology then essentially disappeared as a mainstream refractive technique until the mid 1990s. Then a number of developments combined to lead to the rebirth of the modern technique of accelerated orthokeratology. The invention of reverse-geometry lens designs by Wlodyga and Stoyan was undoubtedly a turning point. These lens designs feature a secondary curve that is steeper than the base curve, surrounded by one or more peripheral curves that align to the mid peripheral cornea. Reverse-geometry lenses show good centration despite a relatively flat base curve and appear to alter corneal shape through a combination of positive pressure at the corneal center and negative or "suction" pressure under the secondary reverse curve, which also acts to keep the lens stable and centered. These lens designs induce rapid central corneal flattening and reductions in myopia, relatively large optic (or treatment) zones, and good retention of effect with minimal daytime regression.

From the School of Optometry and Vision Science, University of New South Wales, Sydney, Australia.

Address correspondence and reprint requests to Dr. H.A. Swarbrick, School of Optometry and Vision Science, University of New South Wales, Sydney, NSW 2052, Australia.

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