Statistical data in the field of orthokeratology and myopia control in the U.S. and in the world

- The challenges that Korean orthokeratology community are facing
- Ways to tackle the challenges in most updated current trend and technology

Orthokeratology (also known as OrthoK) is an alternative procedure to correct refractive errors utilizing specially designed rigid gas permeable (RGP) lenses to temporarily reshape/modify the surface of the cornea.

In 1947 plastic corneal contact lenses (PMMA) was introduced by Tuhoy, eye care practitioners began to notice the vision improvement in their contact lens patients’ vision, and also the tendency to slow down the progression of myopia.

In 1955, the National Eye Research Foundation (NERF) was founded by Wesley and Jesson and held the first National/International Contact lens Congress.

In 1962, the 7th National Contact Lens Congress was held in Chicago, IL, Jessen reported an attempt to deliberately change the corneal curvature using PMMA lenses using his “orthofocus” techniques which later became known as orthokeratology.

In 1972, Grant & May reported the standardized orthokeratology techniques in IOS (International Orthokeratology Section) Contacto, “Effect of corneal curvature change on the visual system”.

오 소 미
Santa Clara, CA USA
Their techniques were followed up by many orthokeratologists nationally and internationally for many years. Over the following 20 plus years many reports and studies on orthokeratology were published. Despite the many reports and studies done, the nature of the techniques were unpredictable and produced variable results, the procedure was unfavorable in teaching institutes like schools of Optometry. Most practitioners who advocated Orthokeratology continuously refined the design and techniques.

In 1989, the first high Dk value RGP reverse geometry lens design was introduced, creating tremendous renewed interests from clinicians. It was during this time that I got involved with the NERF and very blessed to be mentored by those pioneers in orthokeratology.

I introduced the procedure to Korean Eye clinic in 1993 (Kim’s Eye Hospital, Seoul) with a help of Mr. Stoyan (Contex) who held a part of reverse geometry design patent and manufacturing lab in California, US. (Fig 1) This brought attention to a small group of ophthalmologists in Korea and Orthokeratology was introduced to Korean Contact lens Society meeting in 1994. (Fig 2)

In 2002, the first Food and Drug Administration (FDA) approval for overnight corneal reshaping was obtained by Paragon Vision Inc. for its CRT lens design. It was introduced in Global Orthokeratology Symposium, Toronto, Canada, and OAA (Orthokeratology Academy of America) was founded in place of IOS under NERF, under the leadership of Cary Hertzberg.

Soon after, FDA approved VST by Bauch & Lomb procedure in 2004, which provided more options and designs for practitioners who want to learn the art of Orthokeratology.
In 2010, OAA was renamed as AAOMC (American Academy of Orthokeratology & Myopia Control). And continuously grew to encompass members in over 20 countries, being the mother organization of IAOMC (International Academy of Orthokeratology & Myopia Control) consists of 6 separate OrthoK chapters: AAOMC, ALOCM, EUROK, IAOA, IPOS, and OSO at current time. (Fig 3)

For this article, I tried to get the current updated members and fellows of each section, but I was only able to obtain the following:
- AAOMC has 425 members, and 74 fellows
- IAO China section has 3400 basic members, 26 senior members, and 19 fellows.
- I personally know we already have more than 100 international fellows in the world, because I just sent a congratulating email to 100th fellow just few months ago.

In the Spring of 2016, I was invited to be a guest speaker for the 3rd IAO Forum and 16th COOC (Congress of Ophthalmology, Optometry of China) in Shanghai, China, and I presented the status of Orthokeratology in Korea with help of a few Korean colleagues for statistical data. I am quoting a few statistics and the survey presented by my dear colleague, Perez, from Spain during the forum.

The survey was done among IAOMC fellows and members, and the questions were:
1. Number of ophthalmologists/ Optometrists in the country who fit orthokeratology
2. Accredited professionals to fit OrthoK
3. Occasional fitters (less than 12/yr)
4. Regular fitters (more than 12/yr)
5. Reason for recommending orthoK
6. Available treatments (myopia, hyperopia, astigmatism, post lasik, presbyopia)
7. Orthok available designs, (fig 4)

The most noticable point at this survey was that China already has 1000 plus Ophthalmologists regulary fitting orthokeratology with only 3 years of history of the IAO organization vs the same numbers reported in U.S. with 50+ plus years of history.
Current Orthokeratology patient numbers in each country was estimated and reported at the 2015 EurOK conference held in Budapest, Hungary. I had an opportunity to attend that meeting as a fellow examiner.

In that meeting, 1.3 million patients in China, 200,000 in North America (US, Canada), 175,000 in Europe, 100,000 in Australia, New Zealand, 90,000 in Japan, Korea, Taiwan were reported as an estimated number of patients. As I was preparing this paper, I connected with IAO president, Dr. Xie, and she told me that the current estimated number of patients in China is 1.82 million.
Why are we getting very concerned with what goes on in the Orthokeratology community? Because MYOPIA IS EPIDEMIC. Over the past 10 to 15 years, there has been so much emphasis on myopia progression not only in the U.S., but also all over the world, especially in Asia (China, Korea, and Japan). Along with development of orthokeratology, research and studies excelled to find the way to control myopia progression. The prevalence of myopia in the U.S. increased from 25% (1971) to 46 % (1999–2004) (Fig 5). Asian countries showed much more rapid progression in myopia which promotes all sorts of research and studies. (Fig 6)

![Figure 5. U.S. myopia survey](image1)

![Figure 6. Myopia progression comparison among Asian country](image2)
Currently, the most accepted form of myopia control methods are orthokeratology, atropine therapy, and multifocal soft lenses. I, personally, am biased with atropine therapy (I simply will not be able to sleep well after I prescribe atropine to 6 years old patient), but many atropine therapy studies are out there and I encourage all eye care practitioners to objectively look into the studies for its application for the possibility of utilizing the therapy as a way of myopia control practice. Taiwan utilized atropine therapy a lot more than any other countries I am aware of, and I am sure many related studies could be looked at. In the U.S., very few clinicians are utilizing Atropine therapy and predominantly choose orthokeratology and soft multifocal lenses.

The type of designs used by the US orthokeratologists are CRT, EMERALD, WAVE, AVT, CKR, DREIMLENS, CONTEXT E, B.E., ORTHOTOOL, VIPOK, GOV and few other personal designs which never took the trade name. In the past 5 years, a few European based designs were introduced but not marketed in U.S. Seasoned orthokeratologists like myself and many others used to custom design each lenses instead of using generic parameter designs, orthokeratology therapy was expanded to encompass other refractive errors like extreme astigmatism, hyperopia, presbyopia, and post Lasik myopia regression.

Earl Smith presented in OAA congress in 2005, the peripheral refraction theory, stating that peripheral defocus induces central myopia. (Fig 7) Based on that study, many practitioners were changing designing thought process for myopia control design vs, adult orthokeratology. Also the use of multifocal lens design became very prominent part of the practice.
The challenge Korean orthokeratologists are facing now is to step up from generic branding of orthokeratology design to customization of individual design for myopia control therapy. If we know the exact spot and how much of myopic defocus to create on peripheral retina, we can then create individualized optics, very unique for that one patient only, in orthokeratology design lens (possibly in Soft lenses and spectacle also) for each patient to create the perfect peripheral myopic defocus.

The possible characteristics of the ideal optic zone would be well centering, good central visual acuity giving, positive spherical aberration increased relative to pupil size, and peripheral plus power inside the pupil. If we figure out the way to design this way, I am sure we will increase the myopia controlling percentage.

Of course, we already know that myopia progress due to genetics, environmental, and behavioral influences from parents, time spent outdoor, and hours of near work including computers, iPad, and cellular phones, video games, plus optical factor as mentioned above.

Currently some clinical, academic studies reported that Orthokeratology therapy slowed myopia progression 40% to 60% compared to glasses or soft lenses—conventional spherical. The myopia control study done at the University of Michigan, Dept. of Ophthalmology reported recently 67% slowing progression in 3 years. It is impressive but still we are not at 100% control. It also tells us some patients still progress.

Based on this kind of OrthoK myopia control result, a new breed of Soft orthokeratology myopia control lenses were just released in the US among the orthokeratology community. The SoftOrthoK lenses are made looking like simulated post OrthoK corneal surface. It creates the peripheral myopic defocus thru lens wearing.

As clinicians we need to continue to prescribe OrthoK for the purpose of myopia control, and we need new and innovative research to find a scientific way to prescribe the perfect optics,