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Trends in Refractive Surgery in Yemen: Consecutive Review of 1933 Cases from a Single Center

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Authors' contributions

This work was carried out in collaboration between all authors. Author MAB participated in the conception and design of this work, the analysis of the data and the writing of the manuscript. Authors SAAA and MYAS participated in the conception and design of this work and the writing of the manuscript. Author HAAA participated in the analysis of the data and the writing of the manuscript. All authors read and approved the final manuscript.

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ABSTRACT

Purpose: To study and quantify refractive surgery trends in a single refractive surgery practice.
Methods: A retrospective case series. Medical records were reviewed for all patients completing refractive surgery at Yemen Magrabi Hospital from January 01, 2008 to December 31, 2008. Patients had one of the following procedures: laser *in-situ* keratomileusis (LASIK), photorefractive keratectomy (PRK), phakic intraocular lens implants or refractive lens exchange (RLE). Corneal excimer procedures were done using the NIDEK EC-5000 and phakic intraocular lens used were Implantable Collamer Lens (ICL).
Results: Refractive surgery procedures were performed on 1021 patients (1933 eyes). Mean patient age was 26.81±6.16 years (range: 10 to 62 years). Female accounted for 55.7% (n=569) and males for 44.3% (n=452). Of the 1933 treated eyes, 60.1% (n=1162 eyes) had LASIK, 26.6% (n=515) of eyes had PRK, 10.9% (n=210) had ICL and 2.4% (n=46) had RLE.

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Conclusion: LASIK was the predominant refractive surgical procedure offered in our practice, followed by PRK, ICL and finally RLE. Patients who request refractive surgery have a variety of problems and warrant comprehensive attention to selection criteria on the part of the surgeon.

Keywords: Refractive surgery; LASIK; PRK; ICL; Yemen.

1. INTRODUCTION

Refractive surgery has been rapidly developing over the years all over the world. Laser in-situ keratomileusis (LASIK) and photorefractive keratectomy (PRK) gained widespread acceptance in the world and were introduced in Yemen in 2005 [1]. Corneal excimer laser procedures remain the cornerstone of non-cataract refractive surgery [2].

Improvements in implantable lens technology techniques, namely the phakic intraocular collamer lens implantation (ICL, STAAR, Switzerland) led to the increase in options offered to patients seeking refractive surgery [3].

We performed a retrospective case review of 1021 consecutive refractive patients in one calendar year 2008, to quantify the refractive surgery trends taking place in our practice. It was conducted at a private practice in the Yemen Magrabi Hospital in the corneal and refractive unit which is one of the main refractive surgery providers in Yemen. This study will help us to understand the current trends of refractive surgery and to compare it to other reports from America and Korea in an attempt to forecast future medical services.

2. PATIENTS AND METHODS

Refractive patients are usually recorded in a prospective database including all patients who had laser and non-laser refractive surgery since June 2005.

All refractive candidates undergo a thorough preoperative evaluation including detailed medical and ocular history; preoperative uncorrected visual acuity (UCVA), best spectacle-corrected visual acuity (BSCVA) and manifest refraction. They receive a complete eye exam including slitlamp biomicroscopy, dilated retinal evaluation and intraocular pressure measurement. The decision-making process is often multifactorial and many factors are taken into consideration namely the age of patient, corneal topography symmetry, central corneal thickness (CCT), estimated postoperative residual stromal bed (RSB), refractive error and finally the appearance of the lens on slitlamp biomicroscopy. Patients with early cataract are given the option to observe the lens changes or to have refractive lens exchange (RLE).

Corneal topographic were examined using computerized videokeratography (TMS-2, Tomey Co). Central corneal thickness (CCT) was obtained using the Nidek US 1000 pachymeter (Nidek Ltd, Kamagori, Japan). CCT of above 500 μm are offered LASIK and those below 500 μm are offered PRK. LASIK procedure is offered when the corneal topography is normal with no signs of corneal ectatic disorders, CCT at the thinnest location of more than 500 μm and the estimated postoperative residual stromal bed (RSB) is more than 300 μm.

PRK is recommended when the corneal topography is not typically normal but is not ectatic, CCT is less than 500 μm or when the RSB will be less than 300 μm.

Slitlamp biomicroscopy, dilated fundal exam, pupil size measurement and cycloplegic refraction was also performed in all cases. Specular microscopy is not available in Yemen and was not done for cases that had phakic ICL implantation.

Clinical characteristics of patients completing laser (LASIK and PRK) and non-laser refractive surgery (phakic IOL and refractive lens exchange RLE) were identified and examined. Age, gender and surgical plan were extracted. The recommended procedure for each patient was also examined. Patients were offered one of the following procedures: LASIK, PRK, phakic ICL intraocular lens implants, or refractive lens exchange (RLE).

Corneal refractive laser procedures were performed with the NIDEK EC 5000 (Nidek Ltd, Kamagori, Japan). The diameter of the ablation zone used was usually 6.0 mm (ranges from 5.5 to 6.5 mm) with a 1.0 mm transitional zone. The minimal ablation zone used was 5.5 mm and the corneal thickness of less than 500 μm and the

estimated postoperative residual stromal bed (RSB) is less than 300 μm, LASIK was not performed. The amount of ablation used depends on corneal thickness, estimated postoperative residual stromal bed thickness and required correction. All LASIK flaps were created with the Moria M2 microkeratome (Antony, France) with a superior hinge flap and an intended mean flap thickness of 90 – 120 μm.

Phakic intraocular lens implantation were done for those not suitable for LASIK or PRK and the lens used in our practice is implantable collamer lens (ICL, STAAR, Switzerland). ICL phakic intraocular lens is offered when the refractive error is above -8.00 D or when the corneal thickness and/or topography are not suitable for LASIK or PRK. Patients with high risk for ectasia are also offered ICL implantation. Cases with forme fruste keratoconus and stable cornea are also offered ICL phakic implantation. For cases that have lens opacities refractive lens exchange (RLE) was offered and the lens implanted was monofocal aspheric lenses.

Data were entered into a spreadsheet, statistically analyzed with Microsoft Excel 2003 (Microsoft Corp, Redmond, Wash) and trends were reported. The study was approved by the Research and Ethics Committee of Yemen Magrabi Hospital and the procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional or regional) and with the Helsinki Declaration of 1975, as revised in 2000.

3. RESULTS

The choice of refractive surgery was based on a number of factors, but mostly on the refractive error, age, central corneal thickness and the pattern of topographic symmetry.

Of the 1933 eyes (1021 patients) evaluated, 60.1% (n=1162 eyes) had laser *in situ* keratomileusis (LASIK), 26.6% (n=515) of eyes had photorefractive keratectomy (PRK), 10.9% (n=210) had phakic implantable collamer lens (ICL) and 2.4% (n=46) had refractive lens exchange (RLE) (Fig. 1). 86.7% (n=1677 eyes) were considered candidates for corneal excimer laser procedures (LASIK and PRK). Some patients were offered a different procedure to each eye according to the refraction, thickness and lens clarity. Table 1 shows comparisons of refractive surgery trends with America and Korea.

Females accounted for 55.7% (n=569) and males for 44.3% (n=452). Mean patient age was 26.81±6.16 years and ranged from 10 to 62 years. Table 2 shows characteristics of patients who had refractive surgery in this study and their refractive powers. Table 3 shows intraoperative and early postoperative complications after LASIK, PRK, ICL and RLE.

Table 1. Comparisons of refractive surgery trends

Country	LASIK	PRK	Phakic IOL	RLE	Conductive keratoplasty	Reference
Korea, 2006	39%	18%	31%	12%	0%	21
USA, 2007	69%	6%	4%	16%	5%	20
Yemen, 2008	60.1%	26.6%	10.9%	2.4%	0%	This study

LASIK = Laser in situ keratomileiusis; PRK = Photorefractive keratectomy;
Phakic IOL = Phakic intraocular lens implantation; RLE = Refractive lens exchange

Table 2. Characteristics of patients who had refractive surgery in Yemen (2008)

Variant	Total	LASIK	PRK	ICL	RLE	Combination
No. of patients	1021	612 (59.94%)	261 (25.56%)	103 (10.09%)	25 (2.45%)	20 (1.96%)
No. of eyes	1933	1162	515	210	46	
Preoperative spherical equivalent (eyes)						
Low myopia -0.25 – -4.75	1197	679	508	7	3	
Moderate myopia: (-5.00 – -8.50)	553	478	7	55	13	
High Myopia: > -8.50	176	3	0	148	25	
Hyperopia: +0.25 - +4.00	7	2	0	0	5	

LASIK = Laser in situ keratomileusis; PRK = Photorefractive keratectomy;
ICL = Intraocular collamer lens; RLE = Refractive lens exchange;
Combination = Each eye had different refractive procedure

Table 3. Intraoperative and early postoperative complications after LASIK and PRK in Yemen study

Type of complication	Eyes
Microkeratome-related complications	(n = 6)
Button hole	2
Thin flap	1
Incomplete cut or pass	1
Epithelial Defect	2
First day LASIK postoperative complications	(n = 10)
Non-specific interface flap deposits (no intervention)	3
Significant interface deposits (needed wash under flap)	1
Mild to moderate DLK (no intervention)	4
Macro-striae (needed repositioning)	1
Displaced flap (needed repositioning)	1
Late LASIK Postoperative complications	(n = 7)
Severe Dry eye	2
Epithelial ingrowth	1
Decentered ablation	2
Ectasia	2
PRK Postoperative complications	(n = 15)
Sterile infiltrates	5
Delayed healing (more than one week)	2
Severe dry eye	1
Mild Haze	5
Severe Haze	2
ICL Postoperative complications	(n = 4)
Lens rotation	1
Anterior subcapsular cataract	2
Retinal Detachment	1
RLE Postoperative complications	(n = 10)
Posterior capsule opacity	9
Retinal Detachment	1
Total complications	(n = 52)

LASIK = Laser in situ keratomileiusis; PRK = Photorefractive keratectomy; ICL = Intraocular collamer lens; DLK = Diffuse lamellar keratitis

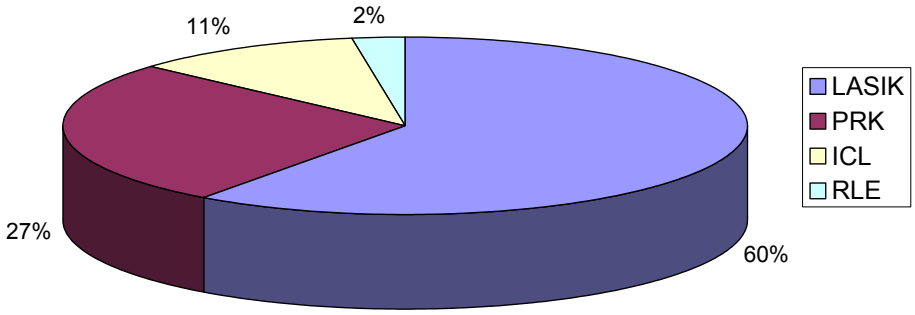

Fig. 1. Type of refractive surgery recommended in Yemen, 2008
LASIK = Laser in situ keratomileiusis; PRK = Photorefractive keratectomy; ICL = Intraocular collamer lens; RLE = Refractive lens exchange

4. DISCUSSION

Laser *in situ* keratomileusis (LASIK) is the predominant refractive surgical procedure offered in our practice [1]. Borderline cases are offered surface procedure namely photorefractive keratectomy (PRK) [4]. Phakic intraocular lens implantation used in our center

are implantable collamer phakic lenses (ICL, STAAR, Switzerland) which are a posterior chamber phakic intraocular lens. Refractive lens exchange (RLE) is done for cases with lens opacities (cataract) or who are not suitable to other three procedures.

Corneal topography is used for screening for ectatic disorders and is evaluated using the TMS-2 Smolek-Klyce keratoconus screening system [5]. If the keratoconus index (KCI) in the TMS-2 was more than 5%, LASIK was a contraindication and patient offered other alternative procedure. So all patients who had abnormality in the keratoconus screening in the TMS-2, even if it was minimal they were rejected from having LASIK [1,5].

Special attention is given to the keratometry values with attention to inferior steepening. Keratometry values above 48 D are not offered corneal laser refractive surgery and in a study done by Piñero et al. [6] they found that corneas that have a significantly higher steepest keratometry (K) reading have a higher risk of corneal ectasia after LASIK. Keratometry values between 46 and 48 are offered surface ablation (PRK). Suspicious cases especially in young ages are usually observed for 6 to 12 months before taking a decision. Other contraindications for LASIK were keratoconus, forme fruste keratoconus and pellucid marginal degeneration because of the high risk of keratectasia [7,8].

Unfortunately the average CCT in Yemeni patients is still thin compared to other populations [9]. The mean CCT in the group of patients that were studied and presented for refractive surgery was 521.67 µm with a standard deviation (SD) of 31.62 [9]. This is thinner compared to Spain 548.2 [10], Saudi Arabia 543.8 [11], Iran 555.6 [12], China 534.5 [13] and USA 556 [14].

In a previous study conducted in our center, 21% of patients were advised not to have LASIK or PRK. The most common reasons for not performing the surgery were high myopia >-11.00 Diopters (19%), keratoconus (18%), suboptimal central corneal thickness (15%), cataract (12%) and keratoconus suspect (forme fruste keratoconus) (10%) [4].

ICL phakic intraocular lens is offered when the refractive error is above -8.00 D or when the corneal thickness and/or topography are not suitable for LASIK or PRK [3,4,6]. Patients with high risk for ectasia are also offered ICL implantation. Cases with forme fruste keratoconus and stable cornea are also offered ICL phakic implantation. In these cases anterior chamber depth (ACD) and white to white (WTW) measurements are usually calculated using the "IOL master (Carl Zeiss Meditec, Jena, Germany)". For refractive errors between -6.00 and -8.00 diopters and all other investigations are within normal limits patients are given the choice between LASIK and ICL phakic lenses [15].

Cases with cataract are offered refractive lens exchange (RLE) with the implantation of aspheric monofocal lenses. No multifocal lenses were implanted in this group of patients because multifocal lenses were not available in the Yemeni market during the study period. Proper patient selection, preoperative measurements, intraoperative technique, and postoperative management lead to excellent outcomes and improves patient acceptance of this effective technique.

Patients with keratoconus or topographic patterns demonstrating inferior steepening or "crab-claw" patters were considered not suitable for corneal excimer refractive surgery and were recommended to have crosslinking using ultraviolet light with riboflavin [16] and one year later ICL phakic intraocular lens implantation [17].

Presbyopic patients are given the choice of using glasses after LASIK, PRK, ICL or RLE. Presbyopia correction still remains one of the main challenges amongst eye professionals. Refractive lens exchange has become more accepted in recent years with advancements in lens technology and improvements in surgical techniques [18]. The limitations of keratorefractive surgery have led to a resurgence of lens exchange surgery for patients with prescriptions outside the limits of corneal refractive procedures, in addition to patients with routine refractive errors requesting a surgical procedure to achieve emmetropia and also address presbyopia [19].

By comparing the results from our study with the American [20] and Korean [21] (Table 1) we can understand the differences in trends offered to patients seeking refractive surgery. In the American and Korean study, LASIK accounted for the majority of refractive surgery offered to their patients which is same as our study but

with differences in percentages were the American do 69% and the Korean 39% LASIK cases. In our study PRK is done at higher rate (26.6%) compared to both studies mostly due to suboptimal corneal thickness of Yemen patients [1,4,9]. Phakic IOL are done at a higher rate in the Korean study at a percentage of 31% but at a very low rate in the American study at 4% while our study comes between both studies at 10.9%. RLE is not a common choice in our study (2.4%) but accounted for 16% and 12% in the American and Korean study respectively. Majority of our patients who come for refractive surgery and have cataract they are usually not keen to do RLE and loose the accommodation and prefer to delay it until the cataract becomes bothersome to their vision. But with the introduction of multifocal lenses we expect more patients to accept RLE as a choice for refractive surgery.

5. CONCLUSION

LASIK was the predominant refractive surgical procedure offered in our practice, followed by PRK, ICL and finally RLE. Patients who requested refractive surgery have a variety of problems and warrant comprehensive attention to selection criteria on the part of the surgeon. Corneal topographies and pachymetry of refractive surgery candidates need to be read cautiously.

CONSENT

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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