P990010

SUMMARY OF SAFETY AND EFFECTIVENESS DATA

I. GENERAL INFORMATION

Device Generic Name:	Ophthalmic Medical Laser System (193 nanometer laser wavelength)
Device Trade Name:	VISX STAR S2 Excimer Laser System
Applicant's Name and Address:	CRS Clinical Research, Inc. (CRS) 7898 East Acoma, Suite 210 Scottsdale, AZ 85260 (480) 483-4079
Date of Panel Recommendation:	July 22, 1999
Premarket Approval (PMA) Application Number:	P990010
Date of Notice of Approval to Applicant:	November 19, 1999

This device was originally approved on March 27, 1996, under PMA P930016, for the limited indication for myopic photorefractive keratectomy (PRK) using a 6.0 mm ablation zone in patients 18 years of age or older with 1.0 to 6.0 diopters (D) of myopia with astigmatism of ≤ 1.0 D whose refractive change for one year prior to treatment is within ± 0.5 D.

This clinical indication was expanded in supplements 3 (approved on April 24, 1997), 5 (approved on January 29, 1998) and 7 (approved November 2, 1998) to include PRK in patients 21 years of age or older in PRK treatments for the reduction or elimination of myopia (nearsightedness) of between 0 and -12.0 D spherical myopia at the spectacle plane and up to -4.0 D of astigmatism and hyperopia (sphere only) of between +1.0 and +6.0 D spherical equivalent with no more than 1.0 D of refractive astigmatism.

In agreement with VISX, Inc., CRS submitted this PMA application to further expand the clinical indications for this laser system. The updated clinical data to support the expanded indication is provided in this summary. The preclinical test results were presented in the original PMA application for P930016. For more information on the data which supported the original indication, the summary of safety and effectiveness data (SSED) for P930016 should be referenced. Written requests for copies of the SSED can be obtained from the Dockets Management

Branch (HFA-305), Food and Drug Administration, 5630 Fishers Lane, rm. 1061, Rockville, MD 20857 under Docket # 97M-0084 (original PMA and S3), Docket # 99M-0293 (S5), and Docket # 00M-1391 (S7) or you may download the file from the internet site http://www.fda.gov/cdrh/pdf/p930016.pdf.

II. INDICATIONS FOR USE

Laser in situ Keratomileusis (LASIK) procedure using the VISX STAR S2 Excimer Laser System is intended for use:

- in patients 18 years of age or older in treatments for the reduction or elimination of myopia (nearsightedness) from 0 to -14.0 D with or without -0.50 to -5.0 D of astigmatism; and

- in patients with documented evidence of a change in manifest refraction of less than or equal to 0.5 D (in both cylinder and sphere components) per year for at least one year prior to the date of pre-operative examination.

III. CONTRAINDICATIONS, WARNINGS AND PRECAUTIONS

A. Contraindications:

LASIK surgery is contraindicated:

- In patients with collagen vascular, autoimmune or immunodeficiency diseases.

- In pregnant or nursing women.

- In patients with signs of keratoconus.

- In patients who are taking one or both of the following medications:
  - isotretinoin (Accutane)
  - amiodarone hydrochloride (Cordarone)

B. Warnings: see the labeling

C. Precautions: see the labeling

IV. DEVICE DESCRIPTION

A. Laser System

The device used in the clinical study was the VISX STAR (formerly Model C) Excimer Laser System for which a full description can be found in the SSED for supplement 5.

On March 20, 1998, in supplement 6, the VISX STAR S2 was approved for the previously approved indications of PRK for myopia with and without astigmatism. The following changes to the STAR were approved for the STAR S2: laser removal of the epithelium, visibility upgrade, swivel mounted vacuum nozzle, integrated hyperopia hardware module, variable Hertz rate from 1.5 to 10 Hertz, smoothing, and installation of software Version 2.2.

The approved labeling for this PMA is for the STAR S2, found to be comparable to the STAR in supplement 6, and the only model now in production.

B. Microkeratome

The LASIK procedure requires the use of a commercially available microkeratome that has been cleared for marketing via premarket notification. The device used in this study consists of an instrument tray which includes the shaper head, an adjustable height suction ring, handle, wrenches and test shaft. The instrument motor, handpiece, disposable blades, power supply with footswitches and power cords, applanation lens set, tonometer, optical zone marker, spatula, stop attachment, and digital thickness gauge are provided as separate components which complete the system.

V. ALTERNATIVE PRACTICES OR PROCEDURES

Conventional methods for correcting myopia and astigmatism are: spectacles, contact lenses or refractive surgery.

VI. MARKETING HISTORY

VISX has over 500 Excimer Systems located in approximately 50 countries. The VISX Excimer System has not been withdrawn from any country or market for reasons of safety or effectiveness.

VII. POTENTIAL ADVERSE EFFECTS OF THE DEVICE ON HEALTH

Potential adverse reactions associated with LASIK include: loss of best spectacle corrected visual acuity, worsening of patient complaints such as double vision, sensitivity to bright lights, increased difficulty with night vision, fluctuations in vision, increase in intraocular pressure, corneal haze, secondary surgical intervention, corneal infiltrate or ulcer, corneal epithelial defect, corneal edema, problems associated with the flap including a lost, misplaced or misaligned flap, retinal detachment, and retinal vascular accidents.

Please refer to the complete listing of adverse events and complication observed during the clinical study which are presented on pages 12-14 of the clinical study section.

VIII. SUMMARY OF PRECLINICAL STUDIES

Please refer to the SSED for PMA P930016 for PRK.

IX. SUMMARY OF CLINICAL STUDIES

This study of the LASIK procedure using the VISX STAR (later upgraded to STAR S2) Laser System and managed by CRS was a large, multi-center project involving 24 surgeons at 21 centers. From this population, a cohort of 1276 eyes treated at 19 centers is the subject of this PMA.

A. Study objective

The CRS LASIK Study reported here evaluated the safety and efficacy of the VISX Excimer Laser to treat 0 to -14.00 D spheroequivalent of myopia with and without astigmatism of 0.25 to 6.0 D

B. Study design

This was a prospective, non-randomized, unmasked, multi-center clinical study where the primary control was the preoperative state of the treated eye (i.e., comparison of pretreatment and post-treatment visual parameters in the same eye).

C. Inclusion and exclusion criteria

Study subjects were 18 years or older and must have signed an informed consent form. Enrollment occurred if the subject met these conditions: -1.0 to -14.0 D of myopia with up to 6.0 D of cylinder, best corrected visual acuity of 20/40 or better in both eyes, stable spherical and cylindrical portion of ≤ 0.5 D change in manifest

refraction (as documented by previous clinical records, eyeglass prescriptions, etc.) within the previous twelve months. Contact lens wearers had to abstain from contact lens use prior to baseline examination (3 days for soft lenses, 3 weeks for rigid gas permeable and PMMA lenses) and the patient must have been able to return for scheduled follow-up examinations for three months after surgery.

Subjects not meeting the above inclusion criteria were excluded from the study. In addition, subjects who exhibited any of the following conditions were excluded: previous intraocular or corneal surgery of any kind in the eye to be operated, anterior segment pathology, residual, recurrent or active ocular disease, history of herpes keratitis, autoimmune disease, systemic connective tissue diseases, or atopic syndrome.

D. Study Plan, Patient Assessments, and Efficacy Criteria

Subjects were evaluated pre-operatively, one day post-operatively, and at 1, 3, and 6 months post-treatment. The one-month post-operative visit was designated as optional in the protocol.

Pre-operatively the subjects' medical and ocular histories were recorded. Post-operatively, subjects were questioned about any visual symptoms and their satisfaction with the procedure. Objective measurements included: uncorrected and best corrected visual acuity, manifest and cycloplegic refraction, keratometry, intraocular pressure, corneal topography, clinical assessment of corneal clarity, clinical assessment of anterior chamber, vitreal, retinal and lens status, and assessment of complications or adverse reactions.

Procedure effectiveness was evaluated based on improvement in uncorrected visual acuity, predictability of the treatment, and reduction in astigmatic component. The stability of the procedure was defined in terms of the change in manifest refraction over time, starting one month after treatment.

E. Study period, investigational sites and demographic data

1. Study period and Investigational Sites

   The CRS LASIK study was conducted under an investigational device exemptions application approved October 1, 1996. This PMA includes eyes treated through June 1, 1998. There were 19 investigational sites.

2. Demographics

   Demographic characteristics with respect to patient age, race and sex are shown in Table 1.

Table 2 Demographic Information (Patients=1276)			
Category	**Classification**	**n**	**%**
Sex	Female	725	56.8
	Male	551	43.2
Eye	Right	636	49.8
	Left	640	50.2
Race	Caucasian	855	67.0
	Black	4	0.3
	Asian	31	2.4
	Other	65	5.1
	Not Reported	321	25.2
Age (in Years)	Mean	42.0	
	Standard Deviation	9.8	
	Minimum	18	
	Maximum	84	

F. Data Analysis and Results

1. Pre-operative Characteristics

Baseline characteristics for all eyes were evaluated as presented in the following tables 2-6:

Table 2 Treatment Type (n=1276)	
Sphere	267
Spherocylinder	1009

Table 3 Treatment Group (n=1276)	
<= -7 D	852
> -7 D	424

Table 4 Manifest Refraction Spherical Equivalent (n=1276)			
	Mean	**SD**	**Range**
Sphere (n=267)	-5.85	2.8	-0.63 to -13.77
Spherocylinder (n=1009)	-5.98	2.8	+0.25 to –14.50

Table 5 UCVA (n=1276)		
	<= -7D	> -7D
20/20 or better	0.0%	0.0%
20/25 to 20/40	1.2%	0.0%
>20/40 to 20/80	3.3%	0.0%
>20/80 to 20/160	17.9%	0.7%
20/200 or worse	77.7%	99.3%

Table 6 BSCVA (n=1276)		
	<= -7D	> -7D
20/20 or better	91.4%	77.4%
20/25 to 20/40	8.6%	22.4%
>20/40 to 20/80	0.0%	0.4%
>20/80 to 20/160	0.0%	0.0%
20/200 or worse	0.0%	0.0%

2. Post-operative Characteristics and Results

a. Patient Accountability

Any retreated patient was considered eligible for examination and inclusion in effectiveness analyses until retreatment; after retreatment those eyes were followed separately. All eyes treated are included in the accountability table below (Table 7).

Table 7 Accountability of All Eyes Eyes Eligible for Follow-Up		
Category	**3 Month**	**6 Month**
Eyes Enrolled	1276	1276
Drop-Outs		
Retreated	47	105
Withdrew	2	20
Not Yet Due for Exam	0	0
Total Eyes Eligible	1227	1151
(Minus) **Not Examined** (or Missed Visit)	227	123
Accountability **# Follow-Up Exams**	1000	1028
% Follow-up **of Eligible Eyes**	81.5% 1000/1227	89.3% 1028/1151

b. Effectiveness Outcomes

(1) Stability

Tables 8 and 9 present the mean change in manifest refraction spherical equivalent (MRSE) for all eyes seen at all follow-up exams (1, 3 and 6 months). Based on MRSE data, stability of treatment appears to be reached between 3 and 6 months with those eyes with refractive error of ≤ -7 D reaching stability before those eyes with refractive error of > -7 D.

Table 8 - LASIK: Stability of Manifest Refraction with ± 1.00 D (1 to 3 M)

From 1 to 3 M						
Full Cohort	**All Eyes**		**≤7D**		**>7D**	
	n/N	**%**	**n/N**	**%**	**n/N**	**%**
MRSE Change ≤1.00 D	424/453	93.6	294/309	95.1	130/144	90.3
Mean Difference	-0.05 D		-0.09 D		0.03 D	
SD	0.55 D		0.50 D		0.65 D	
95% CI	91.3% to 95.9%		92.7% to 97.5%		85.4% to 95.1%	
Spheres	**All Eyes**		**≤7D**		**>7D**	
	n/N	**%**	**n/N**	**%**	**n/N**	**%**
MRSE Change ≤1.00 D	92/101	91.1	69/72	95.8	23/29	79.3
Mean Difference	-0.02 D		-0.11 D		0.20 D	
SD	0.71 D		0.58 D		0.94 D	
95% CI	85.5% to 96.6%		91 .2% to 100.4%		64.6% to 94.1%	
Spherocylinders	**All Eyes**		**≤7D**		**>7D**	
	n/N	**%**	**n/N**	**%**	**n/N**	**%**
MRSE Change ≤1 .00 D	332/352	94.3	225/237	94.9	107/115	93.0
Mean Difference	-0.06 D		-0.08 D		-0.02 D	
SD	0.50 D		0.47 D		0.56 D	
95% CI	91.9% to 96.7%		92.1 to 97.7%		88.4% to 97.7%	

Table 9 - LASIK: Stability of Manifest Refraction with ± 1.00 D (3 to 6 M)

From 3 to 6 M						
Full Cohort	**All Eyes**		**≤7D**		**>7D**	
	n/N	**%**	**n/N**	**%**	**n/N**	**%**
MRSE Change ≤1.00 D	426/453	94.0	297/309	96.1	129/144	89.6
Mean Difference	-0.05 D		-0.04 D		-0.05 D	
SD	0.51 D		0.43 D		0.64 D	
95% CI	91.9% to 96.2%		94.0% to 98.3%		84.6% to 94.6%	
Spheres	**All Eyes**		**≤7D**		**>7D**	
	n/N	**%**	**n/N**	**%**	**n/N**	**%**
MRSE Change ≤1.00 D	97/101	96.0	70/72	97.2	27/29	93.1
Mean Difference	-0.08 D		-0.09 D		-0.06 D	
SD	0.44 D		0.39 D		0.55 D	
95% CI	92.2% to 99.8%		93.4% to 101.0%		83.9% to 102.3%	
Spherocylinders	**All Eyes**		**≤7D**		**>7D**	
	n/N	**%**	**n/N**	**%**	**n/N**	**%**
MRSE Change ≤1 .00 D	329/352	93.5	227/237	95.8	102/115	88.7
Mean Difference	-0.04 D		-0.03 D		-0.05 D	
SD	0.53 D		0.45 D		0.67 D	
95% CI	90.9% to 96.0%		93.2 to 98.3%		82.9% to 94.5%	

(2) Day-1 Uncorrected Visual Acuity (UCVA)

Table 10 shows the amount of early visual recovery after LASIK.

Table 10 **One Day UCVA (n=718)**		
	<= -7D	**> -7D**
20/20 or better	37.2%	14.0%
20/25 or better	60.8%	31.7%
20/30 or better	78.7%	56.9%
20/40 or better	88.6%	69.3%
20/80 or better	99.3%	94.0%
20/200 or better	99.8%	98.8%

(3) Long Term UCVA

Table 11 presents the UCVA at all post-operative intervals (1, 3, and 6 months) among eyes targeted for emmetropia. These improvements in UCVA support the effectiveness of the device.

Table 11 UCVA in Eyes Intended to be Fully Corrected (Plano Target)			
UCVA All Eyes	**1 Month (n=744)**	**3 Months (n=903)**	**6 Months (n=808)**
20/20 or better	46.2% (344/744)	48.1% (434/903)	54.1% (437/808)
20/40 or better	90.5% (673/744)	92.0% (831/903)	95.4% (771/808)

(4) Predictability of Manifest Refractive Spherical Equivalent (MRSE)

Predictability of outcome was determined by comparing the intended MRSE with the achieved MRSE at each visit, as shown in Table 12, for all eyes over the full range of treatment, within ± 1.0 D and ± 2.0 D. Furthermore, at six months within ± 0.50 D, the predictability was 72.5 % (612/844).

Table 12 Predictability of Manifest Refraction			
Predictability All Eyes	**1 Month (n=793)**	**3 Months (n=969)**	**6 Months (n=844)**
± 1.00 D	85.9% (681/793)	87.2% (845/969)	90.6% (765/844)
± 2.00 D	96.2% (763/793)	97.7% 947/969)	98.9% (835/844)

(5) Vector Analysis

Table 13 lists a summary of the vector analysis results for all eyes undergoing cylinder correction. The ratio of SIRC/IRC (surgically induced refractive correction/intended refractive correction) indicates the ratio of the vector cylinder change induced compared with the targeted amount. A ratio of 1.0 would indicate that the surgical correction exactly matched the targeted correction. Smaller ratios indicate that the cylinder correction was less than planned, and ratios > 1.0 indicate a cylinder overcorrection. The mean ratio of SIRC/IRC was 1.03 ± 0.32 D. The minimum was 0.00 and the maximum 2.81 D. The minimum and maximum numbers occurred in eyes with relatively small IRC's, as would be expected.

Table 13 Vector Analysis for Eyes Undergoing Cylinder Correction (Excluding Eyes with Intended Refractive Change of ≤ 0.50 D) Results reported at 6 Months (n=510)					
	Preoperative	**Postoperative**	**IRC**	**SIRC**	**SIRC/IRC**
Mean	-1.54	-0.33	-1.47	-1.48	1.03
SD	0.77	0.43	0.71	0.75	0.32
Min	-4.75	-3.00	-4.50	-4.48	0.00
Max	-0.75	0.00	-0.56	0.00	2.81

SIRC=Surgically induced refractive vector change
IRC=Intended refractive vector change

Table 14 stratifies the cylinder correction efficacy according to the preoperative cylinder amounts for all eyes undergoing cylinder correction. Small astigmatic errors tend to be overcorrected and large errors tend to be undercorrected.

Table 14 Cylinder Correction Efficacy Stratified by Preoperative Cylinder at 6 Months				
	Percent Reduction of Absolute Cylinder (Not a Vector)		**Attempted versus Achieved Vector Magnitude Ration (SIRC/IRC)**	
Pre-op Cyl	**Mean**	**SD**	**Mean**	**SD**
≤ 1.0 D	61.1%	57.4%	113.9%	55.4%
1.1 - 2.0 D	79.4%	26.7%	101.4%	29.4%
2.1 - 3.0 D	79.6%	25.1%	91.4%	26.3%
3.1 - 4.0 D	73.7%	15.0%	93.8%	22.4%
4.1 – 5.0 D	94.4%	7.9%	91.5%	3.72%

c. Safety Outcomes

(1) Loss of Best Spectacle Corrected Visual Acuity (BSCVA)

Table 15 shows loss of more than 2 lines of BSCVA at 1, 3 and 6 month intervals stratified by treatment group.

Table 15 Change in Best Spectacle Corrected Visual Acuity			
Loss of > 2 lines All Eyes	**1 Month**	**3 Months**	**6 Months**
All Eyes	0.3% (2/793)	0.3% (3/979)	0.0% 0/850
≤ -7 D	0.2% 1/502	0.0% 0/660	0.0% 0/590
> -7 D	0.3% (1/291)	0.9% (3/319)	0.0% (0/260)

(2) BSCVA of 20/40 or Worse

As shown in Table 16, the percentage of eyes with a baseline visual acuity of 20/20 or better having a BSCVA worse than 20/40 is below the 1% target value for all groups.

Table 16 Best Spectacle Corrected Visual Acuity Worse Than 20/40	
BSCVA Worse than 20/40 All Eyes	**6 Months**
All Eyes	0.4% (3/850)
≤ -7 D	0.2% (1/590)
> -7 D	0.8% (2/260)

(3) Adverse Events and Complications

Twelve hundred and seventy-six (1,276) eyes were used for safety analyses of which 867 eyes were followed for at least 6 months. Adverse events and complications were classified as intra-operative and postoperative. One adverse event (0.1%) occurred prior to surgery and unrelated to the LASIK treatment. It was a case of trauma involving an unrelated piece of equipment in the room that injured the patient.

Intra-operative complications are presented below in Table 17.

Table 17. LASIK Intra-Operative Complications (n = 1276)

Damage to Epithelium	7 (0.5%)
Epithelial Defect	8 (0.6%)
Free Cap	54 (4.2%)
Oval Keratectomy	9 (0.7%)
Small Flap	2 (0.2%)
Small Flap with Thin Flap	1 (0.1%)
Surgery Aborted: Inadequate Flap	2 (0.2%)
Thin Flap	4 (0.3%)

With regard to post-operative adverse events and complications, persistent staining indicating a corneal epithelial defect occurred in 1.2% (12/962) of eyes at 3 months and in 2.6% (17/652) at 6 months. Since the database did not allow for specification of staining type (e.g., cap edge versus simple SPK or superficial punctate keratopathy) it is not possible to say whether these eyes truly had a surgical-related complication.

The following adverse events and complications occurred at a rate of less than 1% at 6 months: interface epithelium (0.9%); loss of 2 or more lines of BSCVA (0.5%); BSCVA worse than 20/40 (0.4%); BSCVA less than 20/25 when the pre-operative eye was 20/20 or better (0.4%); stromal edema (0.3%); and wrinkling of the cap (0.3%). Flap edema did not occur after the 1 month examination.

The following adverse events and complications did not occur in this clinical study: increase of 2.0 D or more of cylinder; uncontrolled intraocular pressure (IOP); corneal infiltrate or ulcer; melting of the flap; late onset of haze with loss of BSCVA; retinal detachment; and retinal vascular accidents.

(4) Changes in Intraocular Pressure (IOP)

Since the post-operative management of LASIK does not involve the prolonged use of steroids, increases in IOP were rare. As shown in Table 18, most eyes experienced a decrease in the measured IOP, due to the distorted applanation readings that result from the change in corneal thickness and contour. Only one eye experienced a rise of 10 mm Hg or greater at any interval, and less than 1% experienced a rise of greater than 5 mm Hg. In summary, IOP rises after LASIK were not a safety problem in this series.

Table 18 Change in IOP			
All Eyes (mm Hg)	**1 Month**	**3 Months**	**6 Months**
Decrease > 10	0.5%	0.9%	0.4%
Decrease 6 to 10	10.0%	6.7%	12.2%
Decrease 1 to 5	41.1%	52.4%	53.4%
No Change	19.5%	20.0%	15.7%
Increase 1 to 5	28.9%	19.6%	17.5%
Increase 6 to 10	0.0%	0.4%	0.8%
Increase > 10	0.0%	0.1%	0.0%

Table 19 lists the responses to questions about patient subjective complaints. They were obtained from a patient questionnaire that was administered pre-operatively and at 3 months post-operatively.

Table 19 Patient Survey				
All Eyes	**Preoperative**		**3 Months**	
	None/Mild	Marked/ Severe	None/Mild	Marked/ Severe
Glare	63% (480/764)	37% (284/764)	73% (353/483)	27% (130/483)
Halo	73% (556/764)	27% (208/764)	75% (364/483)	25% (119/483)
Visual Fluctuations	88% (675/764)	12% (89/764)	87% 420/483)	13% 63/483)

Severe glare was reported in 9% of subjects pre-operatively while 6% of subjects complained of severe glare at 3 months post-operatively. Severe halos were reported in 9% of subjects pre-operatively while 4% of subjects complained of severe halos at 3 months post-operatively. Four percent of subjects reported severe fluctuations pre-operatively while 2% of subjects complained of severe fluctuations at 3 months post-operatively.

d. Retreatments

105 eyes were retreated; 103 for refractive causes and 2 for non-refractive causes. Retreatments were, in general, successful. Post-operative information was available on 103 of these cases. In 89.3% (92/103) of eyes, the distance UCVA was 20/40 or better at the last visit.

Table 20 addresses the timing of retreatments after the initial LASIK surgery.

Table 20 Cohort Retreatments (n = 64)	
Time of Retreatment	**# Eyes**
Before 1-Month Follow-Up	3
Before 3-Month Follow-Up	47
Before 6-Month Follow-Up	105

e. Conclusions

The key safety and effectiveness variables are presented for sphere and spherocylindrical corrections of ≤ -7.0 D and > -7.0 D in the four tables 21-24.

Table 21. LASIK: 6-Month Post-Operative Results (≤ -7 D) for Spheres

Spheres	0 to <1.00 D	>1.00 to 2.00 D	>2.00 to 3.00 D	>3.00 to 4.00 D	>4.00 to 5.00 D	>5.00 to 6.00 D	>6.00 to 7.00 D	Cum. Total ≤7.00 D
	n/N (%)	n/N (%)	n/N (%)	n/N (%)	n/N (%)	n/N (%)	n/N (%)	n/N (%)
Efficacy Variables								
UCVA 20/20 or better*	1/1 (100)	7/8 (87.5)	15/18 (83.3)	11/16 (68.8)	15/27 (55.6)	16/26 (61.5)	12/17 (70.6)	77/113 (68.1)
UCVA 20/40 or better*	1/1 (100)	8/8 (100)	18/18 (100)	16/16 (100)	27/27 (100)	26/26 (100)	16/17 (94.1)	112/113 (99.1)
MRSE ± 0.50 D	1/1 (100)	7/8 (87.5)	17/17 (100)	14/18 (77.8)	18/27 (66.7)	20/28 (71.4)	13/18 (72.2)	90/117 (76.9)
MRSE ± 1.00 D	1/1 (100)	8/8 (100)	17/17 (100)	17/18 (94.4)	26/27 (96.3)	25/28 (89.3)	17/18 (94.4)	111/117 (94.9)
MRSE ± 2.00 D	1/1 (100)	8/8 (100)	17/17 (100)	18/18 (100)	27/27 (100)	27/28 (96.4)	18/18 (100)	116/117 (99.1)
Safety Variables								
Loss of ≥ 2 Lines BSCVA	0/1 (0.0)	0/8 (0.0)	0/17 (0.0)	1/18 (5.6)	0/27 (0.0)	0/31 (0.0)	0/18 (0.0)	1/120 (0.8)
BSCVA Worse than 20/40	0/1 (0.0)	0/8 (0.0)	0/17 (0.0)	0/18 (0.0)	0/27 (0.0)	0/31 (0.0)	0/18 (0.0)	0/120 (0.0)
Increase >2 D Cylinder$^{\Psi}$	0/1 (0.0)	0/9 (0.0)	0/20 (0.0)	0/19 (0.0)	0/29 (0.0)	0/35 (0.0)	0/18 (0.0)	0/131 (0.0)
BSCVA Worse than 20/25 if 20/20 or Better Preoperatively	0/1 (0.0)	0/8 (0.0)	0/17 (0.0)	0/18 (0.0)	0/26 (0.0)	0/28 (0.0)	0/17 (0.0)	0/115 (0.0)

*For all eyes minus those intentionally undercorrected.

$^{\Psi}$For eyes treated for spherical corrections only.

Table 22. LASIK: 6-Month Post-Operative Results (≤ -7 D) for Spherocylinders

Spherocylinders	0 to <1.00 D	>1.00 to 2.00 D	>2.00 to 3.00 D	>3.00 to 4.00 D	>4.00 to 5.00 D	>5.00 to 6.00 D	>6.00 to 7.00 D	Cum. Total ≤7.00 D
	n/N (%)	n/N (%)	n/N (%)	n/N (%)	n/N (%)	n/N (%)	n/N (%)	n/N (%)
Efficacy Variables								
UCVA 20/20 or better*	5/8 (62.5)	23/39 (59.0)	30/58 (51.7)	58/89 (65.2)	54/84 (64.3)	37/82 (45.1)	48/94 (51.1)	255/454 (56.2)
UCVA 20/40 or better*	8/8 (100)	38/39 (97.4)	56/58 (96.6)	88/89 (98.9)	80/84 (95.2)	79/82 (96.3)	89/94 (94.7)	438/454 (96.5)
MRSE ± 0.50 D	6/6 (100)	29/33 (87.9)	51/61 (83.6)	79/91 (86.8)	71/89 (79.8)	60/91 (65.9)	69/97 (71.1)	365/468 (78.0)
MRSE ± 1.00 D	6/6 (100)	31/33 (93.9)	57/61 (93.4)	90/91 (98.9)	84/89 (94.4)	84/91 (92.3)	89/97 (91.8)	441/468 (94.2)
MRSE ± 2.00 D	6/6 (100)	33/33 (100)	61/61 (100)	91/91 (100)	89/89 (100)	91/91 (100)	97/97 (100)	468/468 (99.1)
Safety Variables								
Loss of ≥ 2 Lines BSCVA	0/7 (0.0)	0/34 (0.0)	1/61 (1.6)	0/93 (0.0)	0/88 (0.0)	1/91 (1.1)	0/96 (0.0)	2/470 (0.4)
BSCVA Worse than 20/40	0/7 (0.0)	0/34 (0.0)	0/61 (0.0)	0/93 (0.0)	0/88 (0.0)	1/91 (1.1)	0/96 (0.0)	1/470 (0.2)
Increase >2 D Cylinder$^{\Psi}$	0/0 (0.0)	0/0 (0.0)	0/0 (0.0)	0/0 (0.0)	0/0 (0.0)	0/0 (0.0)	0/0 (0.0)	0/0 (0.0)
BSCVA Worse than 20/25 if 20/20 or Better Preoperatively	0/7 (0.0)	0/33 (0.0)	0/57 (0.0)	0/88 (0.0)	0/78 (0.0)	0/79 (0.0)	0/87 (0.0)	0/429 (0.0)

*For all eyes minus those intentionally undercorrected.

$^{\Psi}$For eyes treated for spherical corrections only.

Table 23. LASIK: 6-Month Post-Operative Results (> -7 D) for Spheres

Spheres	>7.00 to 8.00 D	>8.00 to 9.00 D	>9.00 to 10.00 D	>10.00 to 11.00 D	>11.000 to 12.00 D	>12.00 to 13.00 D	>13.00 to 14.00 D	Cum. Total >7.00 D
	n/N (%)	n/N (%)	n/N (%)	n/N (%)	n/N (%)	n/N (%)	n/N (%)	n/N (%)
Efficacy Variables								
UCVA 20/20 or better*	6/10 (60.0)	5/7 (71.4)	5/10 (50.0)	1/5 (20.0)	0/2 (0.0)	1/3 (33.3)	1/4 (25.0)	19/41 (46.3)
UCVA 20/40 or better*	10/10 (100)	5/7 (71.4)	10/10 (100)	4/5 (80.0)	2/2 (100)	3/3 (100)	4/4 (100)	38/41 (92.7)
MRSE ± 0.50 D	12/15 (80.0)	3/7 (42.9)	6/9 (66.7)	0/6 (0.0)	1/2 (50.0)	2/3 (66.7)	2/5 (40.0)	26/47 (55.3)
MRSE ± 1.00 D	13/15 (86.7)	5/7 (71.4)	8/9 (88.9)	5/6 (83.3)	1/2 (50.0)	3/3 (100)	5/5 (100)	40/47 (85.1)
MRSE ± 2.00 D	15/15 (100)	7/7 (100)	9/9 (100)	5/6 (83.3)	2/2 (100)	3/3 (100)	5/5 (100)	46/47 (97.9)
Safety Variables								
Loss of ≥ 2 Lines BSCVA	0/15 (0.0)	0/7 (0.0)	0/9 (0.0)	0/6 (0.0)	0/2 (0.0)	0/3 (0.0)	0/5 (0.0)	0/47 (0.0)
BSCVA Worse than 20/40	0/15 (0.0)	1/7 (14.3)	0/9 (0.0)	1/6 (16.7)	0/2 (0.0)	0/3 (0.0)	0/5 (0.0)	2/47 (4.3)
Increase >2 D Cylinder$^{\Psi}$	0/17 (0.0)	0/10 (0.0)	0/10 (0.0)	0/6 (0.0)	0/2 (0.0)	0/3 (0.0)	0/5 (0.0)	0/53 (0.0)
BSCVA Worse than 20/25 if 20/20 or Better Preoperatively	0/12 (0.0)	0/5 (0.0)	0/6 (0.0)	0/5 (0.0)	0/1 (0.0)	0/2 (0.0)	0/1 (0.0)	0/32 (0.0)

*For all eyes minus those intentionally undercorrected.

$^{\Psi}$For eyes treated for spherical corrections only.

Table 24. LASIK: 6-Month Post-Operative Results (>-7 D) for Spherocylinders

Spherocylinders	>7.00 to 8.00 D	>8.00 to 9.00 D	>9.00 to 10.00 D	>10.00 to 11.00 D	>11.000 to 12.00 D	>12.00 to 13.00 D	>13.00 to 14.00 D	>14.00 to 15.00 D	Cum. Total >7.00 D
	n/N (%)	n/N (%)	n/N (%)	n/N (%)	n/N (%)	n/N (%)	n/N (%)	n/N (%)	n/N (%)
Efficacy Variables									
UCVA 20/20 or better*	23/57 (40.4)	24/60 (40.0)	18/41 (43.9)	12/25 (48.0)	2/4 (50.0)	3/5 (60.0)	4/7 (57.1)	0/1 90.0)	86/200 (43.0)
UCVA 20/40 or better*	51/57 (89.5)	56/60 (93.3)	39/41 (95.1)	21/25 (84.0)	4/4 (100)	4/5 (80.0)	7/7 (100)	1/1 (100)	183/200 (91.5)
MRSE ± 0.50 D	43/63 (68.3	39/66 (59.1)	24/40 (60.0)	15/24 (62.5)	3/5 (60.0)	2/6 (33.3)	5/7 (71.4)	0/1 (0.0)	131/212 (61.8)
MRSE ± 1.00 D	52/63 (82.5)	53/66 (80.3)	34/40 (85.0)	19/24 (79.2)	5/5 (100)	4/6 (66.7)	6/7 (85.7)	0/1 (0.0)	173/212 (81.6)
MRSE ± 2.00 D	60/63 (95.2)	65/66 (98.5)	39/40 (97.5)	22/24 (91.7)	5/5 (100)	6/6 (100)	7/7 (100)	1/1 (100)	205/212 (96.7)
Safety Variables									
Loss of ≥ 2 Lines BSCVA	0/63 (0.0)	0/66 (0.0)	0/40 (0.0)	1/25 (4.0)	0/5 (0.0)	0/6 (0.0)	0/7 (0.0)	0/1 (0.0)	1/213 (0.5)
BSCVA Worse than 20/40	0/63 (0.0)	0/66 (0.0)	0/40 (0.0)	0/25 (0.0)	0/5 (0.0)	0/6 (0.0)	0/7 (0.0)	0/1 (0.0)	0/213 (0.0)
Increase >2 D Cylinder$^{\Psi}$	0/0 (0.0)	0/0 (0.0)	0/0 (0.0)	0/0 (0.0)	0/0 (0.0)	0/0 (0.0)	0/0 (0.0)	0/0 (0.0)	0/0 (0.0)
BSCVA Worse than 20/25 if 20/20 or Better Preoperatively	1/52 (1.9)	1/51 (2.0)	1/34 (2.9)	0/21 (0.0)	0/5 (0.0)	0/2 (0.0)	0/3 (0.0)	0/1 (0.0)	3/169 (1.8)

*For all eyes minus those intentionally undercorrected.

$^{\Psi}$For eyes treated for spherical corrections only.

f. Device Failures

There were no device failures reported during this study period.

X. CONCLUSIONS DRAWN FROM THE CLINICAL STUDIES

The data in this application support reasonable assurance of the safety and efficacy of this device when used in accordance with the indications for use.

XI. PANEL RECOMMENDATIONS

On July 22, 1999, the Ophthalmic Devices Advisory Panel recommended that the premarket approval application for the VISX STAR S2 laser for the LASIK procedure in the treatment of myopia with or without astigmatism be considered approvable with conditions. The conditions recommended by the panel were to:

- modify the refractive ranges for approval;
- stratify safety and effectiveness data by 1 diopter increments;
- add cautionary language related to poorer outcomes in higher degrees of myopia and astigmatism;
- add information regarding individual nomogram adjustment;
- add precautionary language that ablation of the corneal stroma to less than 250 microns from the endothelium may result in corneal ectasia;
- add labeling regarding patients having had prior incisional surgery; and
- add a precaution that visual performance (i.e., glare and halos) in patients with larger pupils may be worse in conditions where their pupils are dilated.

XII. FDA DECISION

Because the total combined accountability for the application at 6 months was unsatisfactory, FDA believed that additional follow-up would be necessary to develop adequate labeling for the VISX laser. CDRH issued a major deficiency letter dated August 12, 1999 requesting that CRS submit updated 6-month data with satisfactory accountability and the appropriate key safety and effectiveness tables presented for the combined cohorts for final labeling.

The PMA was amended on August 30, 1999. After statistical and clinical review of the amendment, CDRH concurred with the Ophthalmic Devices Panel's recommendation of July 22, 1999, and worked with the company at the October 19, 1999 labeling meeting (and in subsequent facsimiles) to address the labeling concerns raised by the panel. FDA issued an approval order on November 19, 1999.

XIII. APPROVAL SPECIFICATIONS

- Postapproval Requirements and Restrictions: see Approval Order

- Hazards to Health from Use of the Device: see Indications, Contraindications, Warnings, Precautions, and Adverse Events in the labeling

- Directions for Use: see the labeling