1977

Investigation of corneal changes associated with orthokeratology

Becky Collier
Pacific University

Chris Card
Pacific University

Louise Akiyama
Pacific University

Investigation of corneal changes associated with orthokeratology

Abstract

Investigation of corneal changes associated with orthokeratology

Degree Type

Thesis

Degree Name

Master of Science in Vision Science

Committee Chair

William M. Ludlam

Subject Categories

Optometry

INVESTIGATION OF CORNEAL CHANGES ASSOCIATED WITH ORTHOKERATOLOGY

by

Becky Collier, Chris Card, Louise Akiyama

SUBMITTED AS PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE
DOCTOR OF OPTOMETRY
PRESENTED TO THE FACULTY OF
THE COLLEGE OF OPTOMETRY
PACIFIC UNIVERSITY

ACCEPTED BY THE FACULTY

OF THE COLLEGE OF OPTOMETRY

PACIFIC UNIVERSITY

IN PARTIAL FULFILLMENT

OF THE REQUIREMENTS FOR

THE DOCTOR OF OPTOMETRY DEGREE

ADVISORS FOR THESIS

William M Ludlam O.D.

CHAIRMAN OF THESIS

ACKNOWLEDGEMENTS

We wish to thank Dr. William M. Ludlam member of the Faculty of the College of Optometry at Pacific University for the use of some of his equipment and for his assistance thoughout this project.

We also wish to thank Dr. Roger Tabb for his ideas and his assistance with the contact lens fittings.

We are grateful to Dr. George Butterfield and Butterfield laboratory for supplying the contact lenses.

Also much appreciation is given to Wesley-Jessen, Inc. for donating P.E.K. readouts.

Finally, we wish to thank the Oregon Optometric Association for partial funding of this project.

INTRODUCTION

For many years, professionals in the eye care field have contented themselves with the use of external devices as a means of overcoming visual deficiencies due to refractive errors. As the contact lens field broadened, exciting discoveries as to the stabilization and reducing effects upon progressing myopia and astigmatism caught the attention of many a practitioner. This active approach to refractive problems has been established as a specialty within the last ten years in to what is now known as orthokeratology. By definition, orthokeratology is the reduction, modification, or elimination of refractive anomalies by the programmed application of contact lenses or other related procedures.

There are over two hundred publications investigating the effects of contact lenses on corneal integrity, curvature, topography, and changes in the refractive error of the eye. Many researchers agree upon the decrease in corneal curvature in time with a standard apical alignment contact lens fit.

One of the first documented studies was carried out by Nolan, who reported 80% of young myopic subjects showed either a reduction or stabilization of myopia with his standard method of fitting. Several other researchers have found similar results. Crossen has compared the effects of two types of lens fits, large "on K" lenses and small steep lenses. He found that both types generally flattened the corneal curvature, but the steep lens had a less marked effect.

There are conflicting opinions as to the effects of contact lenses on myopia control. Some conclude that contact lenses are very effective in halting myopia progression while others say that they are ineffective.

Rengstorff's early studies concluded that the process of myopic changes cannot be attributed soley to corneal curvature changes; a number of other variables must be involved. Changes in corneal thickness, posterior corneal curvature, crystalline lens curvature, lens thickness, refractile index changes of the cornea or lens, and axial length may play an important role in myopia regression.

Clinical research in orthokeratology over the past ten years has led to the observation of an interrelationship between refractive error, visual acuity, and corneal curvature changes. In a study conducted by May and Grant, it was shown that refractive error changes in a 2:1 ratio with respect to corneal curvature changes. This departure from the expected 1:1 ratio suggests a change besides corneal curvature.

At the present time, there have been several articles published on orthokeratology. Many are redundant. Others present inconsistent, ambiguous, or incomplete data. One goal of this study is to present additional investigation and documentation of corneal and refractive error changes associated with orthokeratology.

Analysis of possible ocular changes that may occur, indicate that small changes in axial length, anterior corneal curvature, and crystalline lens index of refraction can produce major refractive changes. The lenticular refractive index changes (as associated with diabetes) do not occur with other hard contact lens wearers just as it is unlikely to find a change in axial length of the globe occuring with orthokeratology hard lenses any different than due to a conventional hard lens fit. The cornea is the major refractive element affected by contact lenses, therefore, the researchers of this study will concentrate their investigation here.

It is proposed that a one to one relationship between corneal curvature changes and refractive error changes may be shown by more accurate instrumentation for measuring than keratometry. Polse found that the major refractive changes occured within the central 3 mm. of the cornea; the keratometer does not measure this area.

A new method to measure the corneal curvature based on moiré fringes will be used. Moiré fringes occur in nature when two screens or sets of rulings of regular period are superimposed. If the characteristics of the gratings are known, the moiré pattern is predictable and can be used as a measuring system. This system has the advantage of measuring the small central area of the cornea though which the visual axis passes. Also, simple inspection reveals distortions from corneal sphericity. Photographs are taken of the reflected image off the subject's cornea of a placebo disc like target. A moiré pattern is produced by enlarging the photograph and overlaying it with a concentric rings ruling.

Orthokeratology literature outlines a variety of techniques to achieve similar results. We will compare two orthokeratology fitting methods. One is the May-Grant method using mechanical pressure and another by Roger Tabb using a fluid pressure system.

Methodology:

1. Selection of subjects:
   a. number: six people
   b. male or female
   c. not presently wearing contact lenses
   d. refractive error of 2.50 D myopia or less with less than 1.50 D of corneal cylinder
   e. keratometry readings within 41.00 - 46.00 diopters
   f. no active pathology
   g. normal visual system (OEP 21 Points)

2. Lens schedule:

Four Subjects

O.D.	O.S.
1. MGM lens	Tabb lens
2. MGM lens	Tabb lens
3. Tabb lens	MGM lens
4. Tabb lens	MGM lens

Two Subjects

O.D.	O.S.
1. MGM lens	Tabb lens
2. Tabb lens	MGM lens

After 4 weeks switch to:

1. Tabb lens	MGM lens
2. MGM lens	Tabb lens

3. Investigation schedule:

a. First 3 visits for baseline measurements:
   (1) Complete analytical exam (OEP 21 Points)
   (2) Slitlamp evaluation
   (3) Pachometry (central)
   (4) Photoelectrokeratascope (PEK) photograph
   (5) Moire fringe photograph
   (6) Ultrasonography (corneal thickness)

b. Initial contact lenses dispensed
   (1) Standard MGM lens
   (2) Tabb lens (30% tear reservoir)

c. Regular contact lens check
   (1) 4-5 days after dispensing
   (2) 2-3 days later

d. Begin orthokeratology evaluations when up to 12 hours wearing time

e. Examine once a week for 4 weeks:
   (All patients will be evaluated at the same appointment time each week to minimize diurnal fluctuation variation)

Evaluation:

lens in place

(1) record wearing time and any subjective symptoms
(2) distance visual acuity
(3) objective over-refraction (retinoscopy)
(4) subjective over-refraction
(5) slitlamp evaluation with and without flourescein

remove contact lens

(6) slitlamp evaluation
(7) distance visual acuity
(8) moire fringe
(9) keratometry(central)
(11) pachometry (central)
(12) objective refraction (retinoscopy)
(13) tonometry (A.O. Non-Contact)
(14) distance visual acuity
(15) verify lenses

f. On the fifth week:

Do all measurements listed under "e." and in addition (without contact lenses) do:
(1) PEK
(2) Ultrasonography (corneal thickness)

g. Once a week for the next three visits do all procedures listed under "e.".

h. On the ninth session do all procedures listed under "e." and in addition (without lenses) do:
(1) PEK
(2) Ultrasonography (corneal thickness)

i. On the tenth session do a complete 21 Point exam

j. Termination of data collecting continue care of subjects until transfer them to clinicians doing retainer lens wear research project.

Lens Fitting Methods

The May Grant Method has each lens maintain a constant relationship to the cornea. As the cornea changes the lens is changed usually to a flatter base curve.

We used blended tricurves with an intermediate curve width of .25mm, 1.0 mm flatter than the base curve. The peripheral curve was .4 mm wide and 2.50 mm flatter than the base curve. In some instances modification was needed to achieve a proper fit.

The base curve was equal to the flattest central K. The optical zone diameter was equal to the radius of the base curve in mm.

The overall diameter maintained the relationship of 1.3 mm larger than the radius of the base curve. This resulted in covering between 70 and 80% of the corneal surface.

Thickness was varied with the power of the lens such that a plano lens would be .18 mm thick and .01 mm would be subtracted for each diopter of minus power.

Power was computed from the subjective refraction and lacrimal lens.

When changes in corneal findings occured a new lens was fitted with the base curve equal to the new longest corneal radius and the power calculated from the plus acceptance through the original lens and compensated for the change in base curve.

The Tabb Method of ortho-keratology is to gradually increase the planing function of the lens until the desired change in acuity is achieved. The lens is adjusted to maintain a desired

relationship with the cornea via the tear reservoir. The tear reservoir is equal to 1 - $\frac{\text{Area of O.Z.D.}}{\text{Area of Total Diameter}}$.

Initial lens design calls for a 32.5% tear reservoir. When unaided acuity stabilizes and there are no improvements the tear reservoir is increased incrementally to 35%, 37.5%, 40%, 42.5% and 45% by keeping the total diameter constant and decreasing the optic zone diameter. At 40% to 45% tear reservoir, the lens is usually too unstable for proper fit then the lens is cut down in diameter with no peripheral curve changes and re-edged to again produce a 32.5% tear reservoir. If that does not produce the desired effect, then a new lens is designed based on the new K_f to create the proper performance.

We used a modification of the Tabb Method in the lenses we fit. The initial specifications of the lenses were:

1. Base curve = K_f (The Tabb method calls for BC = K_f + 0.25 for 0 to 1.0 D. of corneal cylinder and BC = K_f + 0.50 for 1.0 to 1.5 D. of corneal cylinder.)
2. Overall diameter = K_f + 1.0 mm.
3. Center thickness was standard thickness plus .02 mm.
4. Power = subjected 7a (compensated for lacrimal power).
5. Peripheral curves are a poly curve with three major curves 1 mm apart in radius starting 1 mm flatter than the base curve unless other factors contra-indicate (such as a drastically flattening peripheral curve.)

   e.g. I_1C = OZR + 1.0 mm, .2 - .3 mm width

   I_2C = OZR + 2.0 mm, .3 - .4 mm width such that $I_2CW \geq I$, CW or PCW

   PC = OZR + 3.0 mm, .2 - .3 mm width

The Tabb Method has these curves applied with diamond tools. We did not have them available so we applied the curves with brass tools and tape (losing some precision in curve widths).

The curves are finished with a water series which consists of holding the lens for 2 - 3 seconds on a series of tools covered with velveteen and using water only. The initial tool selected is equal to the OZR (When velveteen is added it is actually .25 to .4 flatter depending on the material). The second tool is .5 mm flatter and so on in .5 mm flatter increments until the radius of the peripheral curve is reached.

If it is necessary to add more blend, a polish series is done. It is similiar to the water series but polish is added on all tools except the initial one (otherwise the optic zone may be damaged). This produces an aspheric peripheral curve.

Sometimes it is necessary to open the I_Z curve or P curve to allow proper tear circulation. In some cases a .1 - .2 mm with a 12.00 tool was added on the peripheral curve to increase the planing of the lens and stimulate corneal change, thus acuity improvement.

6. Optic Zone Diameter = $2\sqrt{(1-t.r.)\left(\frac{O.D.}{2}\right)^2}$

This is derived from: tear reservoir (t.r.) = $1 - \frac{\text{area OZD}}{\text{area OD}}$

and area = πr^2 so t.r. = $1 - \frac{\pi r^2}{\pi r^2}$

or t.r. = $1 - \frac{\left(\frac{OZD}{2}\right)^2}{\left(\frac{OD}{2}\right)^2}$

7. Color - all lenses were blue # 1 tint because of excellent light transmission and for ease of handling.

An example of an Rx is:

32.5% t.r. desired and K_f = 43.75 (or 7.71 mm)

O.D. = 8.7, OZR = 7.7

$OZD = 2\sqrt{(1 - t.r.)\left(\frac{O.D.}{2}\right)^2}$

$= 2\sqrt{(1 - .325)\left(\frac{8.7}{2}\right)^2}$

= 7.147

OZD = 7.2

$PCW = \frac{8.7 - 7.2}{2} = .75$

So I_1C = .25/8.7, I_2C = .3/9.7, PC = .2/10.7

Classification of Observations

We used the classification system of edema listed in Mandell.

0 No central corneal clouding.
1 Just detectable corneal haze without distinct borders.
2 Borders distinct but visible only against pupil background. Light density.
3 Borders very distinct. Medium density.
4 Area of clouding visible against iris and in dimly lighted room. Heavy density.

For peripheral stain observations we used the following grading system: This type of staining is known by various terms including Juxtaposition, 3 - 9 o'clock, and lid gap.

JP0 No stain.
JP1 Very light and diffuse.
JP2 Light and diffuse but not easily countable. Some stipples.
JP3 Moderate stain with some clumping. Stipples with some punctate stain.
JP4 Dense with clumping, stipples, punctate. Some vascular changes.

For miscellaneous stain observation F.B. is used to indicate a foreign body track or insertion-removal stain. C for central.

1 Very light.
2 Definite borders.

Patient Summary

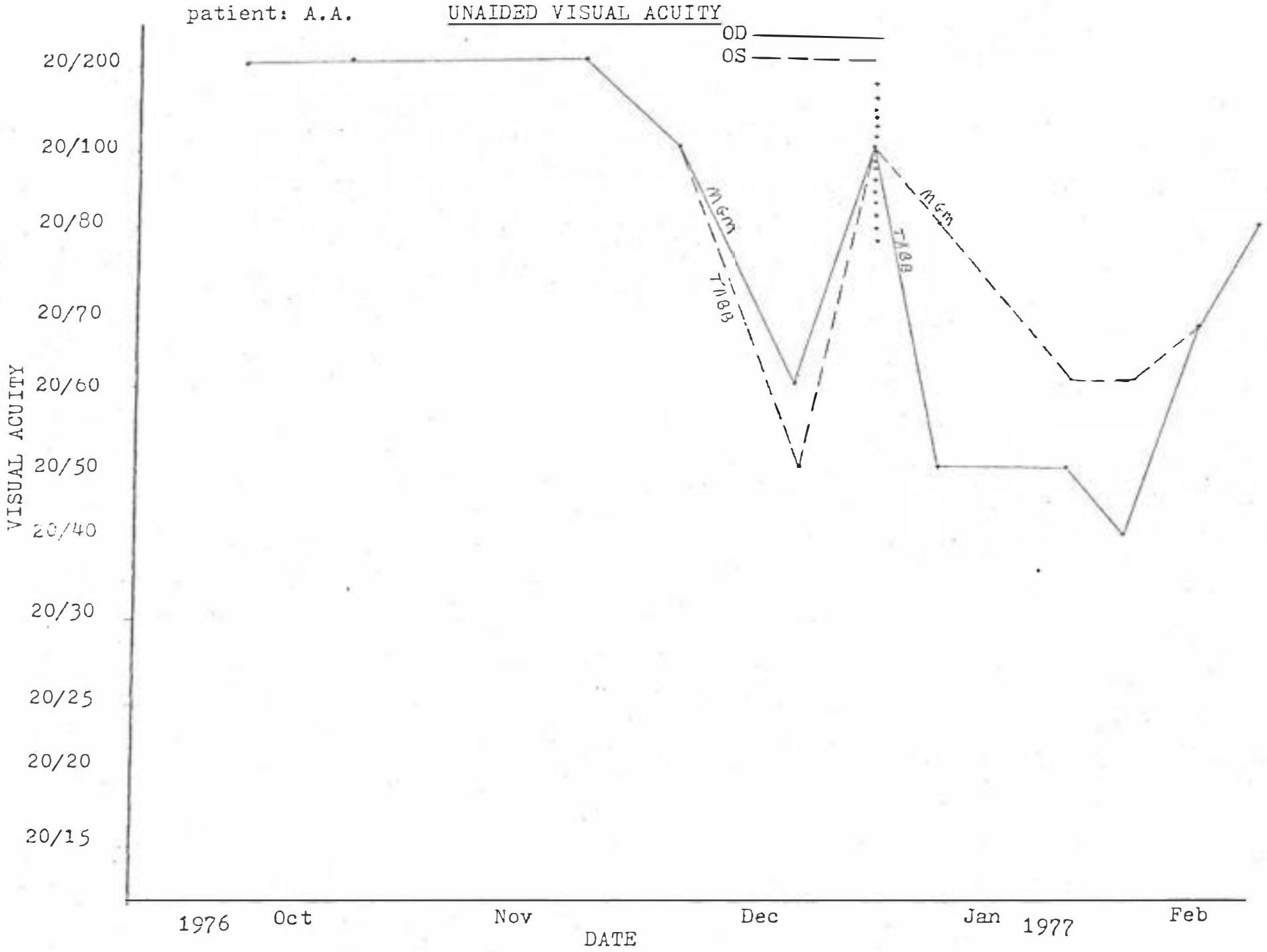
A.A., a 15 year old female. She is a first time contact lens patient. Her fit was right eye MGM method and left eye Tabb method. Original findings were the following: unaided VA 20/200 OD and OS, unaided subjective refraction OD -2.00-0.75x70 and OS -2.50-0.50x90, keratometer readings OD 45.25/44.75@90 and OS 44.62/44.50@90. After one month of contact lens wear her findings improved to the following: unaided VA 20/60 OD and 20/50 OS, unaided subjective refraction OD -1.50-0.75x75 and OS -1.75- 075x90, keratometer readings PD 44.25/44.12@90 and OS 44.25/44.00@180. At this point the fit was changed to OD Tabb method and OS MGM method. After another months wear she stabilized at 20/40 OD and 20/60 OS. She then lost her right contact lens and had to wear her original MGM lens. Unaided VA then decreased to 20/70 OD and OS where it is presently at, with a new lens on order. To this point her unaided refraction is OD -1.75-0.50x65 and OS -2.25 sph, keratometer readings OD 44.50/44.37@90 and OS 44.00/43.75@180.

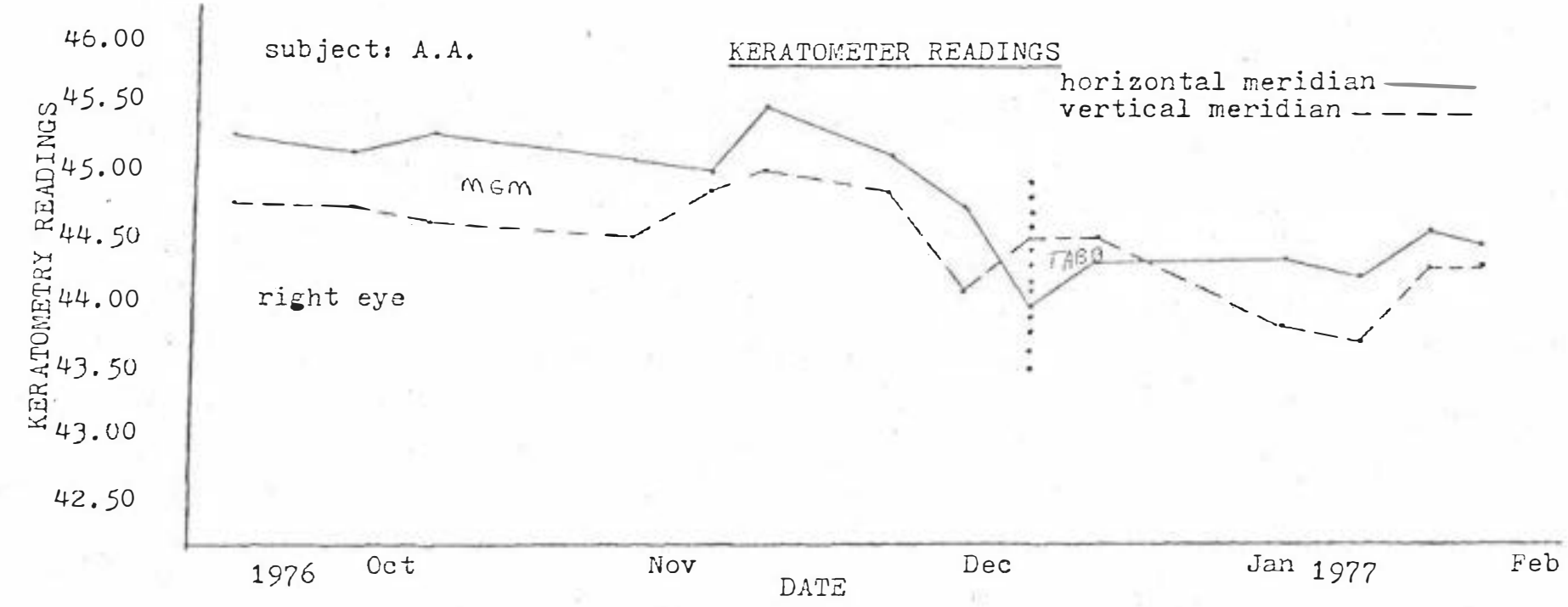
A.A. Female Age 14 Student

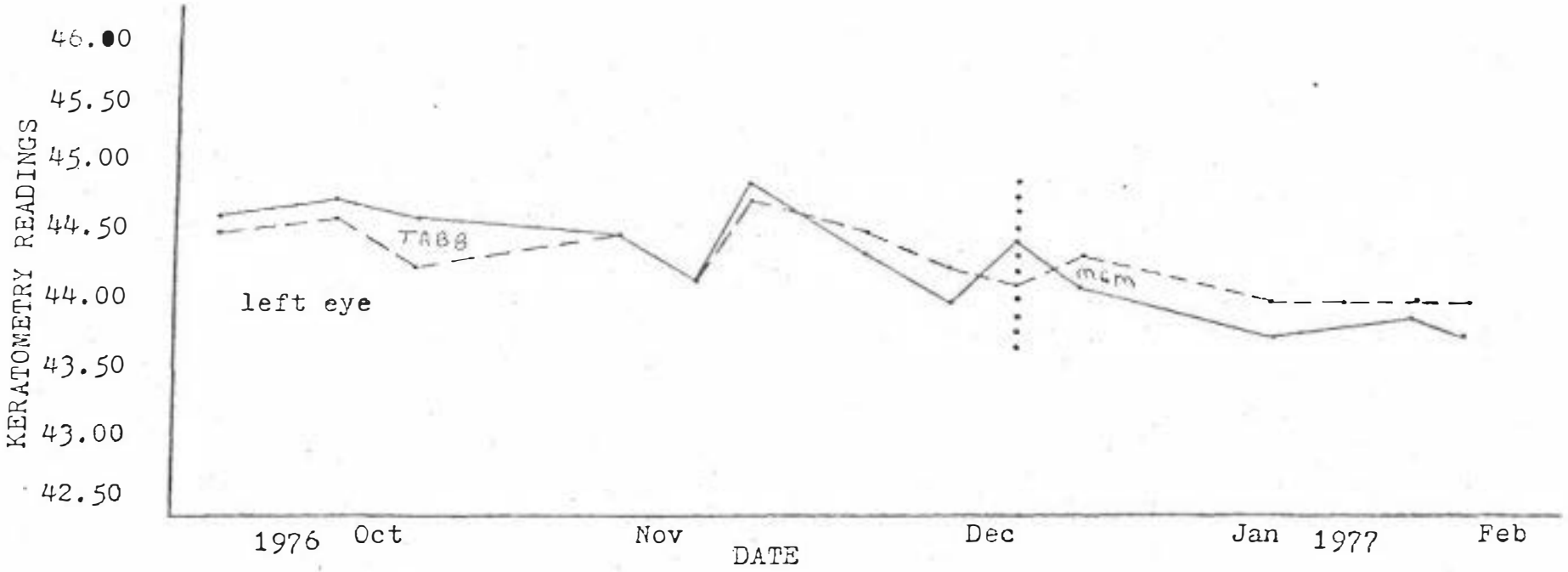
	Date	Corneal Ultra-Sound	Wearing Time	Method	Base Curve	Power	IOP	Edema	Centering and Movement	Staining
R	9/16/76	-	-	-	-	-	17	-	-	-
L		-	-	-	-	-	18	-	-	-
R	9/28/76	0.647	-	-	-	-	18	-	-	-
L		0.639	-	-	-	-	17	-	-	-
R	10/28/76	-	-	-	-	-	-	-	-	-
L		-	-	-	-	-	-	-	-	-
R	11/11/76	-	10	MGM	44.25	-1.75	15.5	1	C3-4T 1mm slow	none
L		-		Tabb	44.37	-2.75	18	1	C3-4T	none
R	11/23/76	-	10	"	"	"	18	0	C3-5T 1.5mm fast	JP#1 C#1
L		-					20	0	C2.5-4 1.5mm slow	JP#1 FB
R	12/2/76	-	14	"	"	"	18	0	C3-5T 1.0mm slow	none
L		-					19	1	C3-5N 1.5mm fast	JP#1
R	12/9/76	0.681	14	"	"	"	20	1	C3-5T 1mm slow	JP#1
L		0.682					20	1	C2.5-5 2mm slow	JP#1
R	12/16/76	-	14	Tabb	43.87	-1.12	18	0	C2-4T 2mm slow	JP#1 FB
L		-		MGM	44.00	-1.62	18	0	C3-4.5 1.5mm slow	JP#1
R	1/5/77	-	14	"	"	"	18	1	C3-5T 1.5mm slow	JP#1
L		-					19	1	C3-5T 1.5 slow	JP#1
R	1/13/77	-	14	"	"	"	-	1	C3-5T 2mm slow	JP#1
L		-					-	1	C3-5T 1.5mm slow	JP#1
R	1/20/77	-	14	"	"	"	16	0	C2-4T 2mm slow	JP#1
L		-					18	0	C2-4T 2mm slow	JP#1
R	1/25/77	0.663	14	MGM	44.25	-1.75	18	0	C2-4T 2mm slow	JP#1
L		0.655		MGM	44.00	-1.62	15	0	C2-4T 2mm slow	JP#1

A.A. Female Age 14 Student

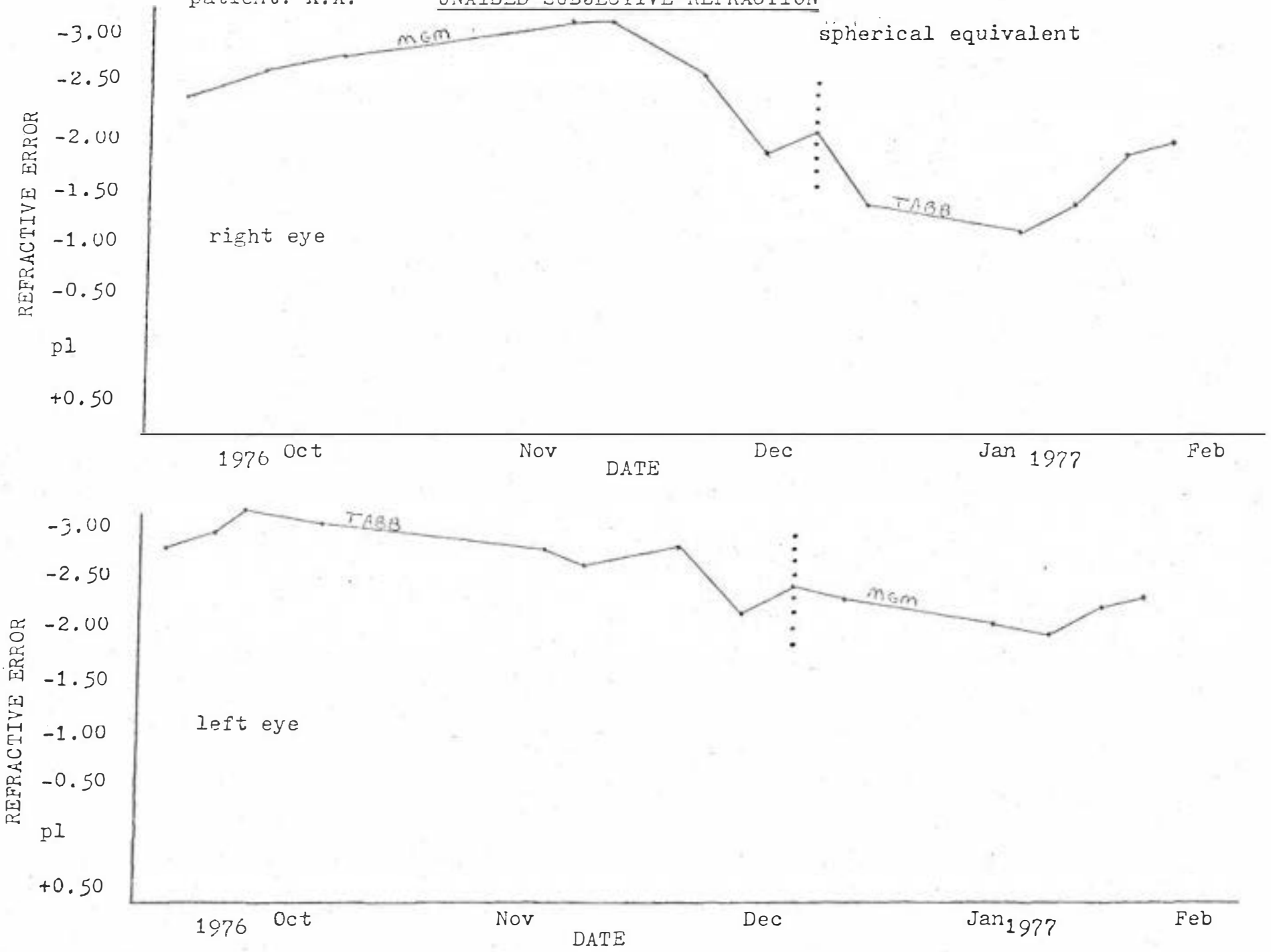
	Date	Unaided VA	Subjective Over-Refraction	Keratometer Readings	Central PEK and Shape Factor	Subjective Refractive Error	Corneal Pachometry
R	9/16/76	20/200	-	45.25 44.75@87	-	-2.00-0.75 x70	-
L		20/200	-	44.62	-	-2.50-0.50 x90	-
R	9/28/76	20/200	-	45.12 44.75@87	-	-2.25-0.75 x70	-
L		20/200	-	44.75 44.12@87	-	-2.75-0.75 x85	-
R	10/28/76	-	-	45.12 44.50@80	45.44 .1 44.86@90.27	-	0.54
L		-	-	44.50 44.50@90	44.84 .11 44.55@60.21	-	0.55
R	11/11/76	20/200	pl-0.25 x90	45.50 45.00@90	-	-2.75-0.75 x60	0.54
L		20/200	-0.25-0.50 x60	44.87 44.75@90	-	-2.75-0.75 x90	0.54
R	11/23/76	20/100	-0.25	45.12 44.87@90	-	-2.25-0.75 x65	0.55
L		20/100	pl	44.37 44.50@90	-	-2.50-0.50 x85	0.58
R	12/2/76	20/60	-0.25-0.25 x70	44.75 44.12@90	-	-1.50-0.75 x75	0.58
L		20/50	pl-0.50 x90	44.00 44.25@90	-	-1.75-0.75 x90	0.58
R	12/9/76	20/100	+0.25-0.50 x90	44.50 44.00@90	44.98 .1 44.52@90.13	-1.75-0.75 x70	0.58
L		20/100	pl-0.25 x90	44.50 44.12@90	44.25 .15 44.32@90.14	-2.00-0.75 x90	0.58
R	12/16/76	20/50	-0.25	44.50 44.37@90	-	-1.25-0.25 x80	0.56
L		20/80	-0.25-0.50 x90	44.12 44.37@90	-	-2.25	0.58
R	1/5/77	20/50	+0.25-0.25 x105	44.37 43.87@90	-	-1.00-0.25 x90	0.56
L		20/60	+0.25-0.75 x105	43.75 44.00@90	-	-2.00	0.58
R	1/13/77	20/40	pl-0.25 x80	44.25 43.75@90	-	-1.25-0.25 x75	-
L		20/60	pl-0.25 x90	44.00 44.00@90	-	-1.75-0.25 x60	-
R	1/20/77	20/40	+0.25-0.50 x70	44.62 44.37@90	-	-1.50-0.75 x60	-
L		20/60	+0.25-0.75 x95	43.87 44.00@90	-	-2.00-0.25 x90	-
R	1/25/77	20/80	+0.25-0.50 x75	44.50 44.37@90	44.79 .24 44.59@90.27	-1.75-0.50 x65	0.60
L		20/80	-0.25-0.75 x85	43.75 44.00@90	43.97 .19 44.17@90.20	-2.25	0.60


patient: A.A.
UNAIDED VISUAL ACUITY
OD
OS
20/200
20/100
20/80
20/70
20/60
20/50
20/40
20/30
20/25
20/20
20/15
VISUAL ACUITY
1976
Oct
Nov
Dec
Jan
1977
Feb
DATE


subject: A.A.
KERATOMETER READINGS
horizontal meridian
vertical meridian
right eye
KERATOMETRY READINGS
46.00
45.50
45.00
44.50
44.00
43.50
43.00
42.50
1976
Oct
Nov
Dec
Jan
1977
Feb
DATE


left eye
KERATOMETRY READINGS
46.00
45.50
45.00
44.50
44.00
43.50
43.00
42.50
1976
Oct
Nov
Dec
Jan
1977
Feb
DATE

patient: A.A. UNAIDED SUBJECTIVE REFRACTION



P.E.K. READOUT

Patient: A.A. Date: 10/28/76

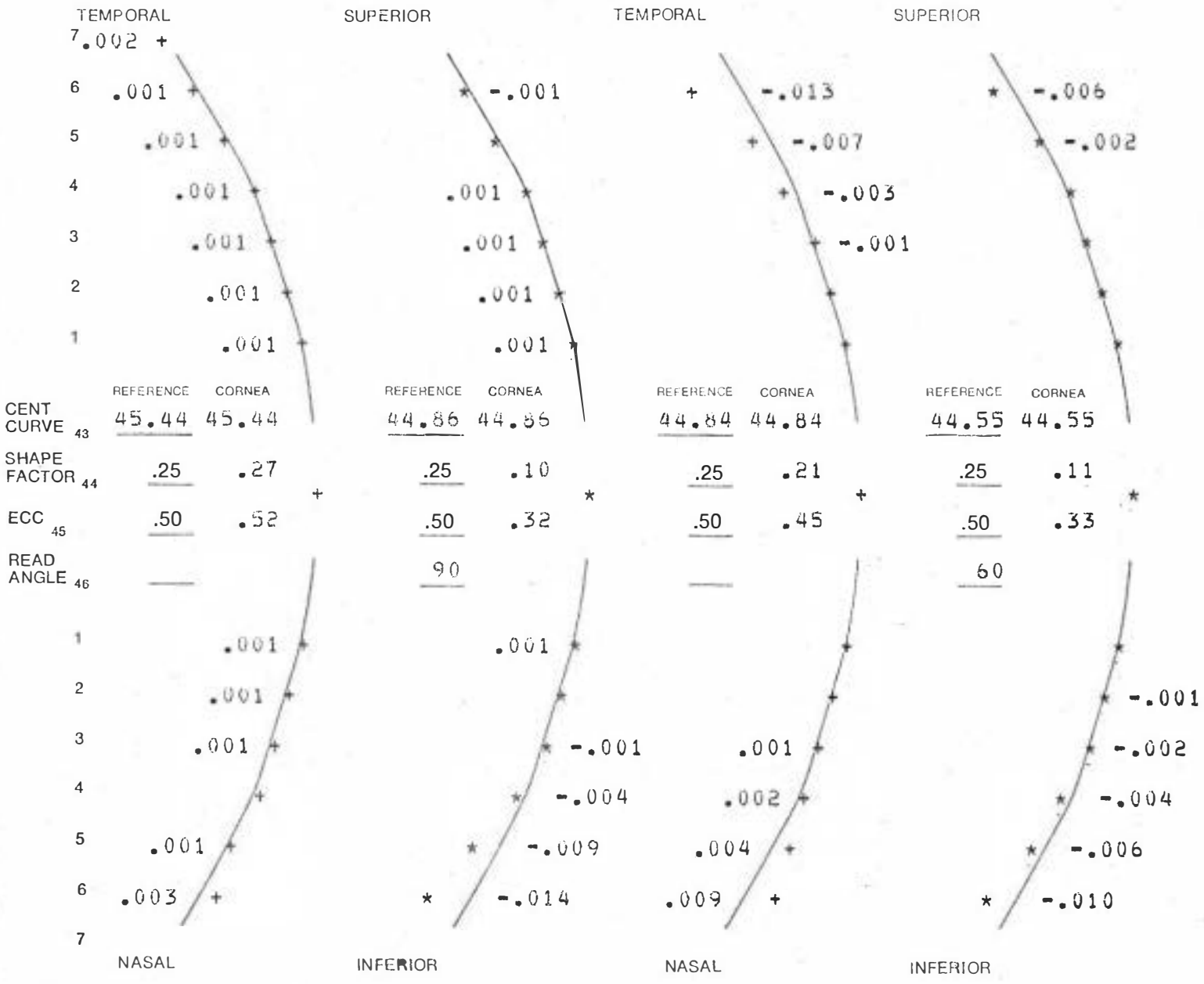
NOTES

Unaided V.A.: OD 20/200, OS 20/200

41

APEX 42 OD 1. mm at 265 OS 1. mm at 345

AA (1)



P.E.K. READOUT

Patient: A.A. Date: 12/9/76

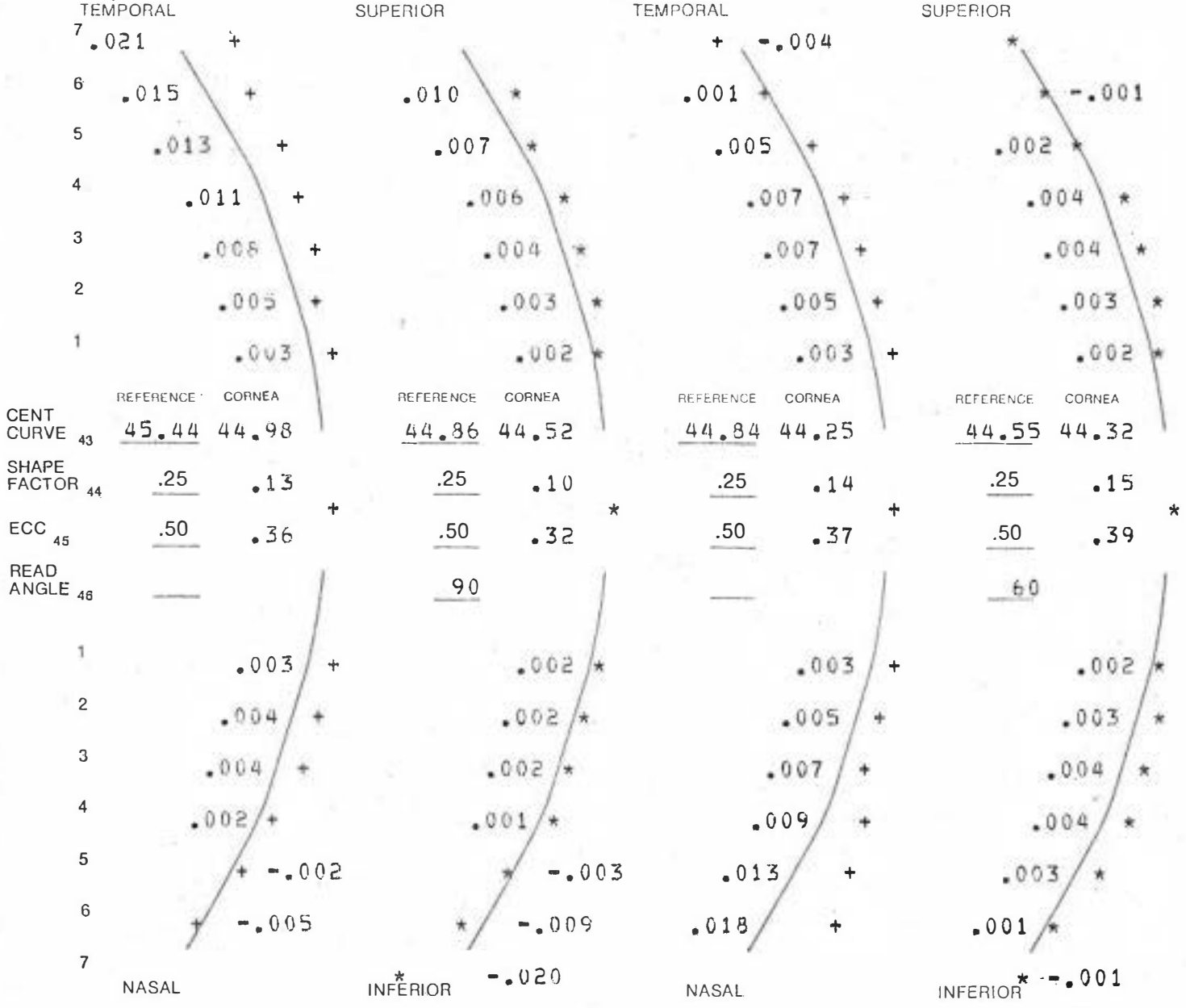
NOTES

Unaided V.A.: OD 20/100, OS 20/100

41

APEX 42 OD 2. mm at 305 OS 1. mm at 360

AA (2)



P.E.K. READOUT

Patient: A.A. Date: 1/25/77

NOTES

Unaided V.A.: OD 20/80, OS 20/80

41

APEX 42 OD 1. mm at 345 AA(3) OS 1. mm at 325

	OD TEMPORAL	OD SUPERIOR	OS TEMPORAL	OS SUPERIOR
7	.030 +		.006 +	.021 *
6	.021 +	.019 *	.009 +	.011 *
5	.016 +	.010 *	.011 +	.008 *
4	.012 +	.006 *	.010 +	.007 *
3	.009 +	.004 *	.009 +	.007 *
2	.006 +	.002 *	.007 +	.006 *
1	.004 +	.001 *	.005 +	.004 *
	REFERENCE CORNEA	REFERENCE CORNEA	REFERENCE CORNEA	REFERENCE CORNEA
CENT CURVE 43	45.44 44.77	44.86 44.59	44.64 43.97	44.55 44.17
SHAPE FACTOR 44	.25 .24	.25 .27	.25 .19	.25 .20
	+ .49	* .52	+ .43	* .44
READ ANGLE 46	—	90	—	60
1	.004 +	.001 *	.005 +	.004 *
2	.007 +	.002 *	.008 +	.007 *
3	.008 +	.003 *	.011 +	.009 *
4	.009 +	.003 *	.015 +	.008 *
5	.011 +	.001 *	.022 +	.007 *
6	.017 +		.034 +	.005 *
7				
	NASAL	INFERIOR	NASAL	INFERIOR

Patient Summary

A.B., a 23 year old female in her first year of optometry school. She is bothered daily with a persistent sinus problem taking decongestants for relief. She is a first time contact lens patient. Her fit was right eye Tabb method and OS MGM method. Her original findings were as follows: unaided VA 20/80 OD and 20/70 OS, unaided subjective refraction OD -2.00 sphere and OS -1.50 sphere, keratometer readings OD 41.25/41.75 @90 and OS 41.25/42.50@90. After approximately one month her unaided VA improved to 20/50 OD and OS, refraction OD -1.50-0.50 x130 and OS -1.00-0.75x45 and k's 41.25/41.50@90 and OS 41.75/42.50@90. At this point we decided to take her lenses away due to a persistent #2 edema due to her sinus problems. Further action with contact lenses will be continued when her sinus problems are lessened or gone.

A.B. Female Age 22 Optometry Student

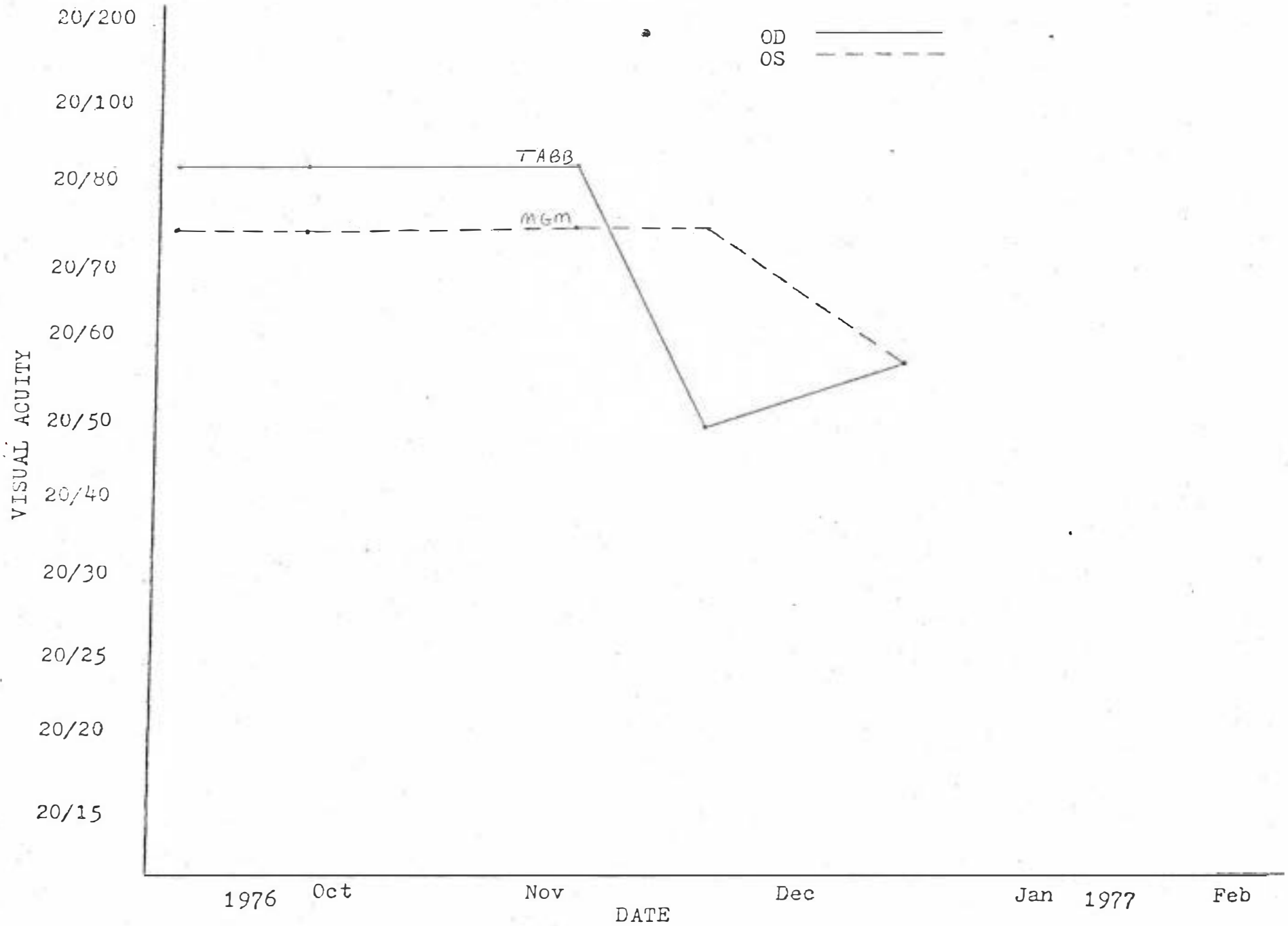
Date		Corneal Ultra-Sound	Wearing Time	Method	Base Curve	Power	IOP	Edema	Centering and Movement	Staining
9/16/76	R	-	0	-	-	-	15	-	-	-
	L	-		-	-	-	15	-	-	-
9/22/76	R	-	0	-	-	-	-	-	-	-
	L	-		-	-	-	-	-	-	-
9/30/76	R	-	0	-	-	-	15	-	-	-
	L	-		-	-	-	16	-	-	-
10/28/76	R	0.574	0	-	-	-	-	-	-	-
	L	0.550		-	-	-	-	-	-	-
11/11/76	R	-	6	Tabb	41.00	-2.12	13.5	1	C3-4 0.5mm slow	none
	L	-		MCM	41.25	-1.25	13.5	1	C3-4 0.5mm slow	none
11/23/76	R	-	6	"	"	"	-	1	C3-4 0.5mm slow	none
	L	-					-	1	C3-4 0.5mm slow	none
12/2/76	R	-	10	"	"	"	13.5	1	C3-4T 0.5mm slow	JP#1
	L	-					13	2	C2-4T 1.5mm slow	C#1
12/9/76	R	-	10	"	"	"	-	2	C3-4T 0.5mm slow	FB
	L	-					-	2	C2-4T 1.5mm slow	C#1

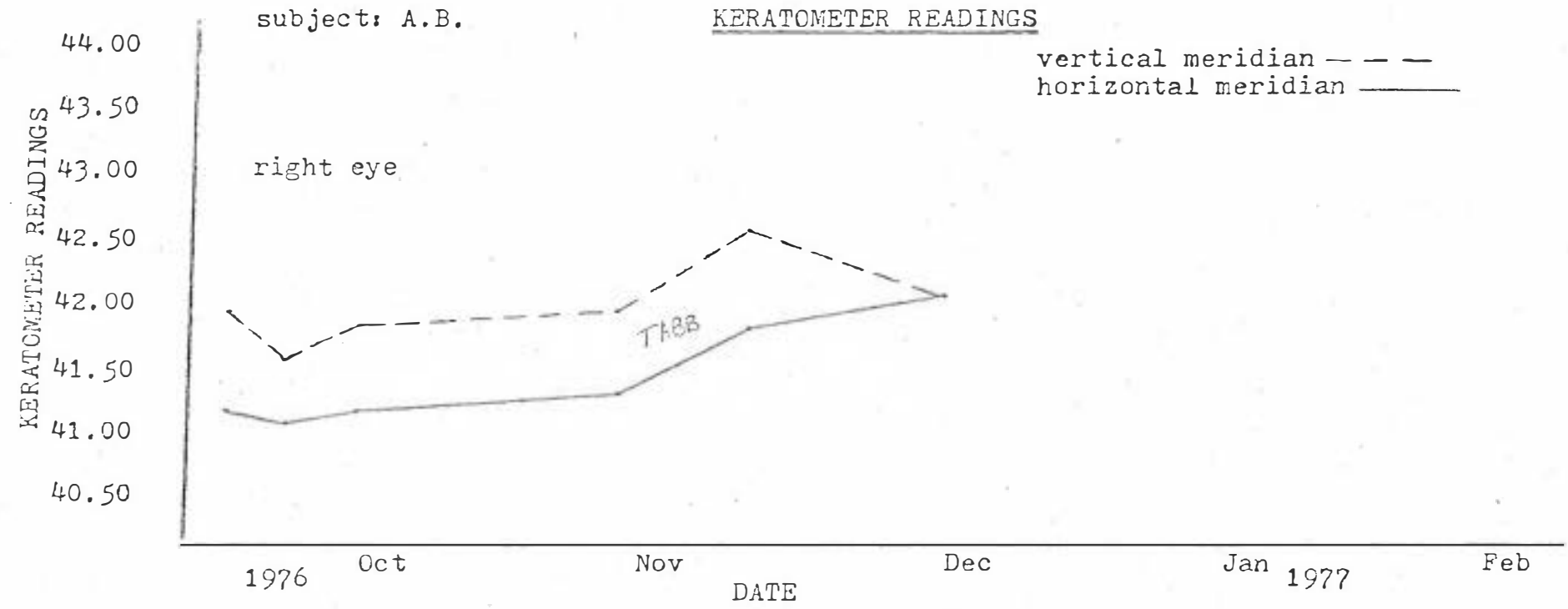
A.B. Female Age 22 Optometry Student

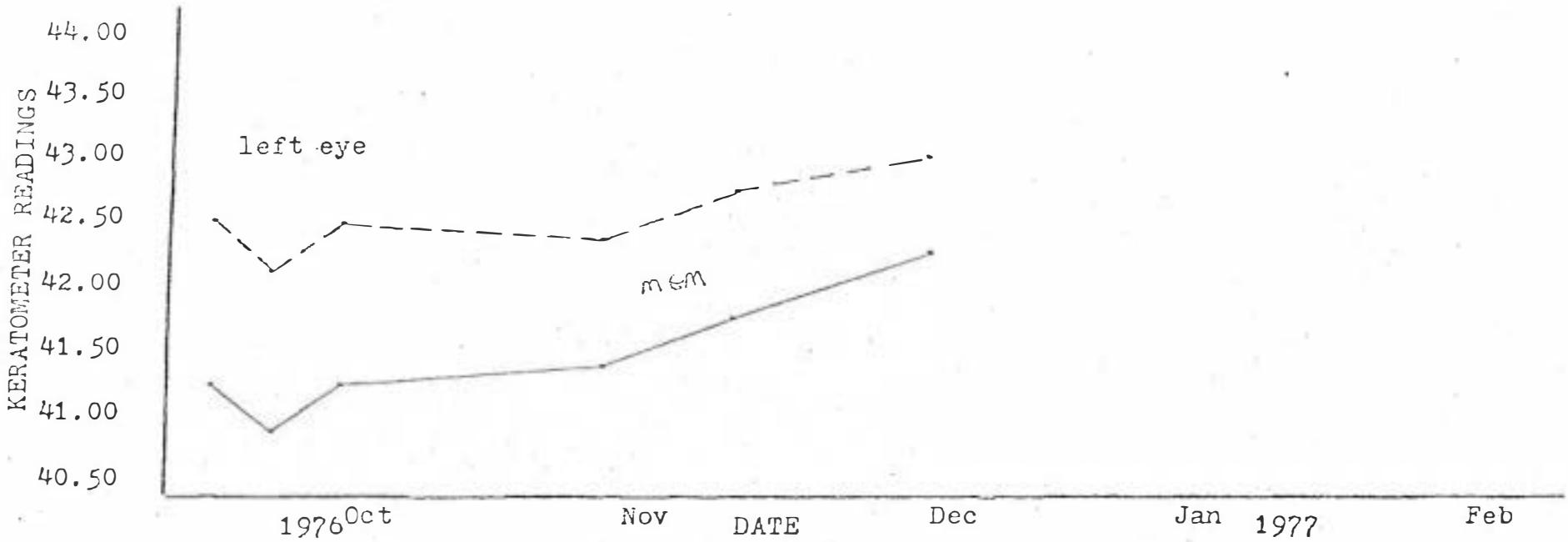
Date		Unaided VA	Subjective Over-Refraction	Keratometer Readings	Central PEK and Shape Factor	Subjective Refractive Error	Corneal Pachometry
9/16/76	R	20/80	-	41.12 41.87@90	-	-	-
	L	20/70	-	41.25 42.50@90	-	-	-
9/22/76	R	-	-	41.00 44.50@80	-	-	-
	L	-	-	40.87 42.12@80	-	-	-
9/30/76	R	20/80	-	41.12 41.75@90	-	-	-
	L	20/70	-	41.25 42.50@95	-	-	-
10/28/76	R	-	-	41.25 41.87@90	41.19 .27 41.69@90.23	-	0.49
	L	-	-	41.37 42.35@95	41.47 .29 42.36@105.23	-	0.48
11/11/76	R	20/40	pl-0.25 x89	41.75 42.50@90	-	-2.25-0.25 x15	0.49
	L	20/70	+0.25-0.25 x80	41.75 42.75@90	-	-2.25-0.50 x25	0.48
11/23/76	R	-	-	-	-	-	-
	L	-	-	-	-	-	-
12/2/76	R	20/50	+0.50-0.25 x108	42.00 42.00@90	-	-1.75-1.25 x150	0.56
	L	20/50	+0.50-0.50 x63	42.25 43.00@90	-	-2.00-1.25 x15	0.56
12/9/76	R	20/50	-	41.25 41.50@90	41.26 .44 41.86@90.35	-1.50-0.50 x130	0.54
	L	20/60	-	41.75 42.50@90	41.97 .33 42.59@105.44	-1.00-0.75 x45	0.52

suject: A.B.

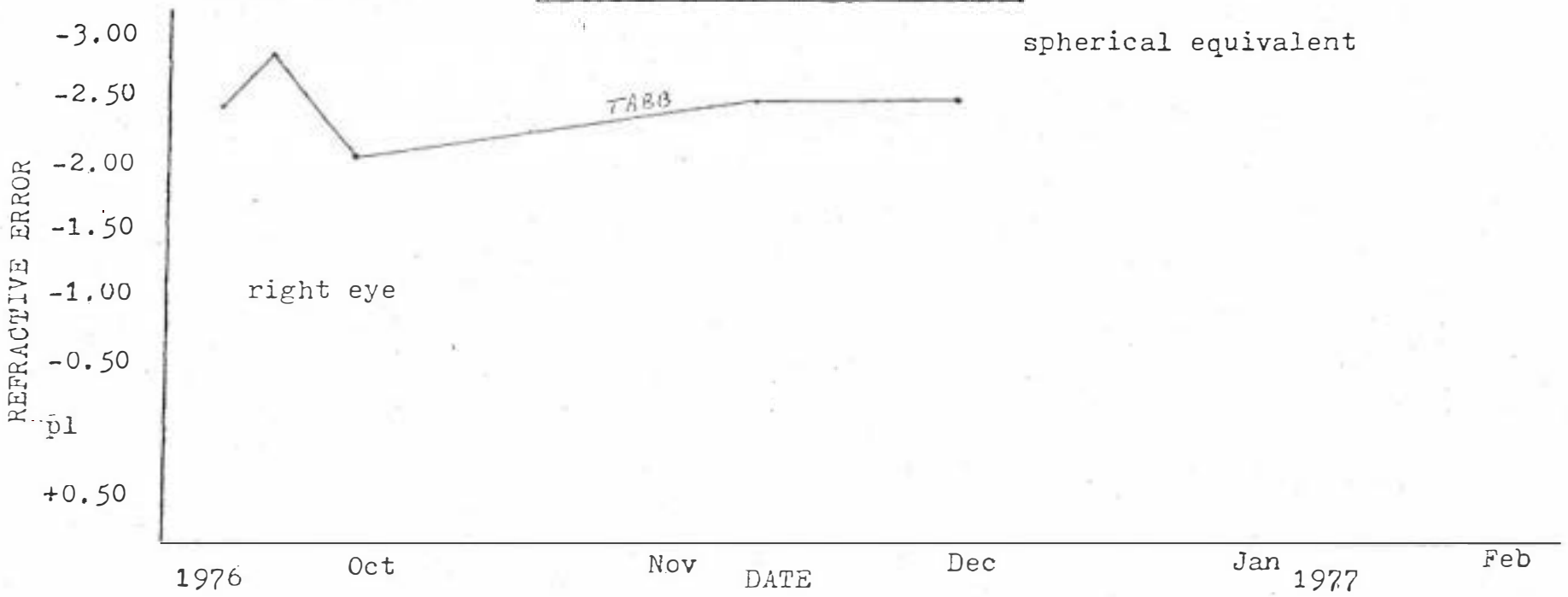
UNAIDED VISUAL ACUITY

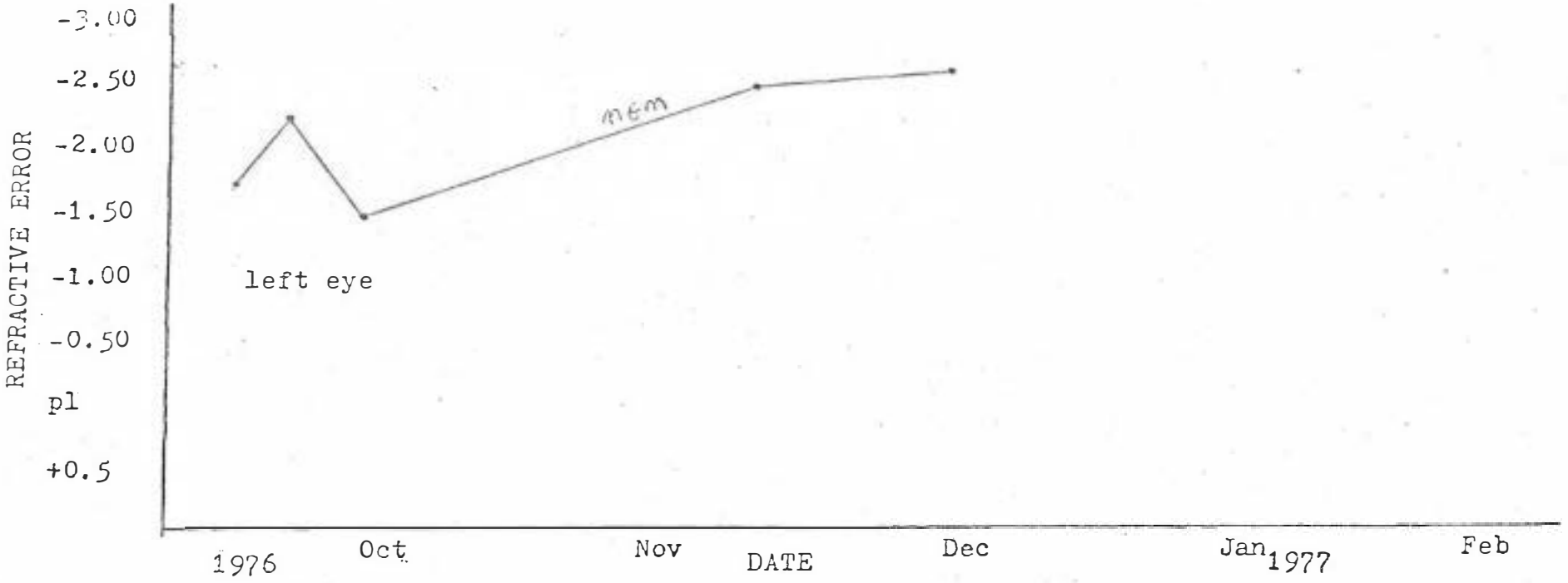



subject: A.B.
KERATOMETER READINGS
vertical meridian
horizontal meridian
right eye
KERATOMETER READINGS
44.00
43.50
43.00
42.50
42.00
41.50
41.00
40.50
TABB
1976
Oct
Nov
Dec
Jan
1977
Feb
DATE


left eye
KERATOMETER READINGS
44.00
43.50
43.00
42.50
42.00
41.50
41.00
40.50
MGM
1976
Oct
Nov
Dec
Jan
1977
Feb
DATE

patient: A.B. UNAIDED SUBJECTIVE REFRACTION





Patient Summary

D.B., a 21 year old female secretary was a first time contact lens wearer. She had three weeks of visual training in April of 1975 at Pacific's clinic for myopia control. Conclusions at the end of the sessions were that no significant change in her unaided VA or refractive error could be substantiated. We fit her with an MGM lens on the right eye and a Tabb lens on her left. Her original findings are as follows: unaided VA 20/60 OD and OS, unaided subjective refraction OD -1.25 sphere and OS -1.25 sphere, keratometer readings OD 46.50/45.50@90 and OS 46.50/45.12@90. After 1 month of wear her VA improved to 20/15 OD and OS. She was then given new lenses with 0.75 D less (-). After one month her VA gradually decreased to 20/30 OD and OS. At this point we gave back her original lenses. Within three weeks her VA improved to 20/20 OD and OS where she presently stands. Her unaided subjective refraction is OD -0.87 sphere and OS -0.62 sphere, keratometer readings OD 45.37/44.87@90 and OS 45.50/45.00@90.

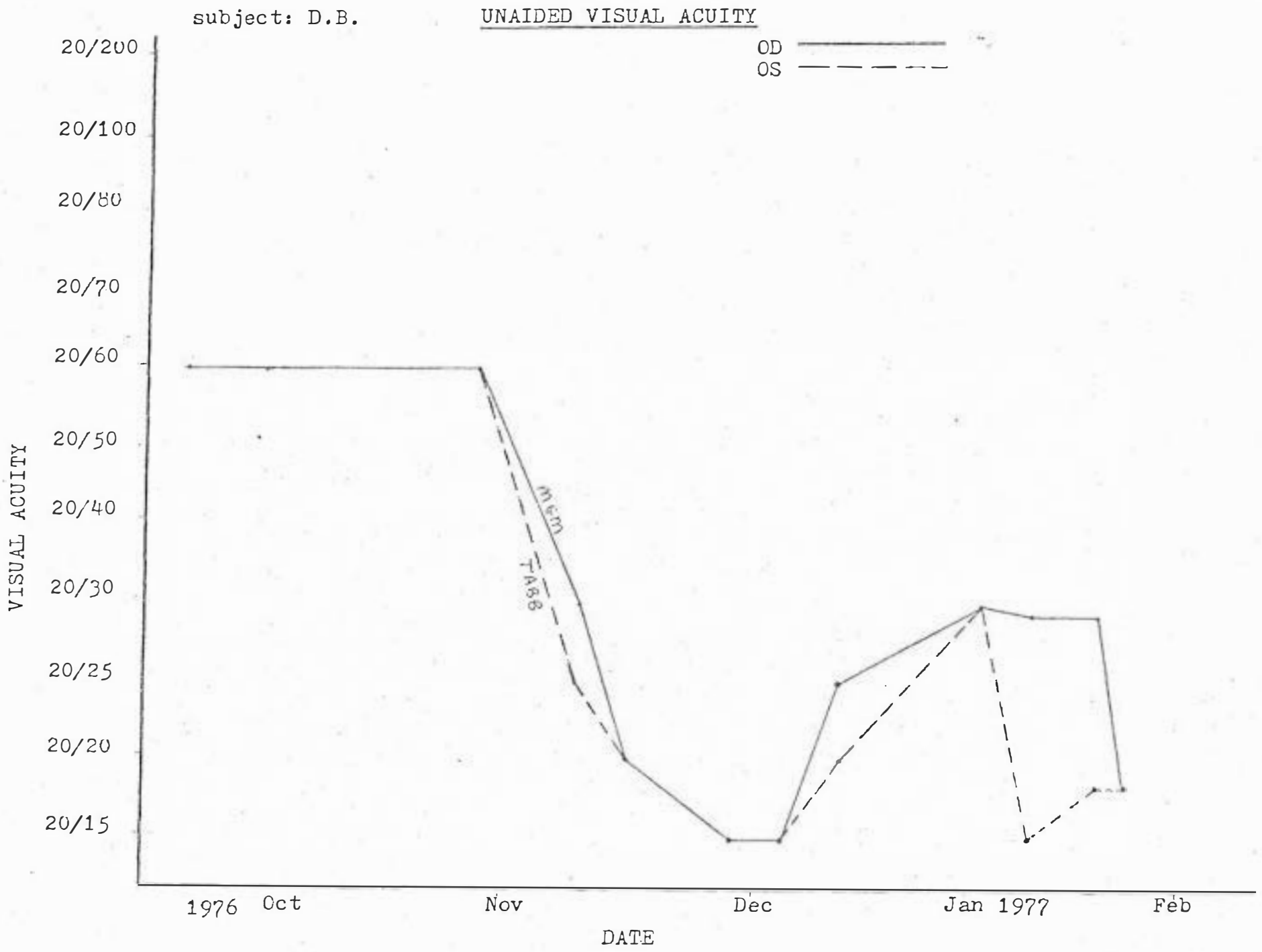
D.B. Female Age 21 Secretary

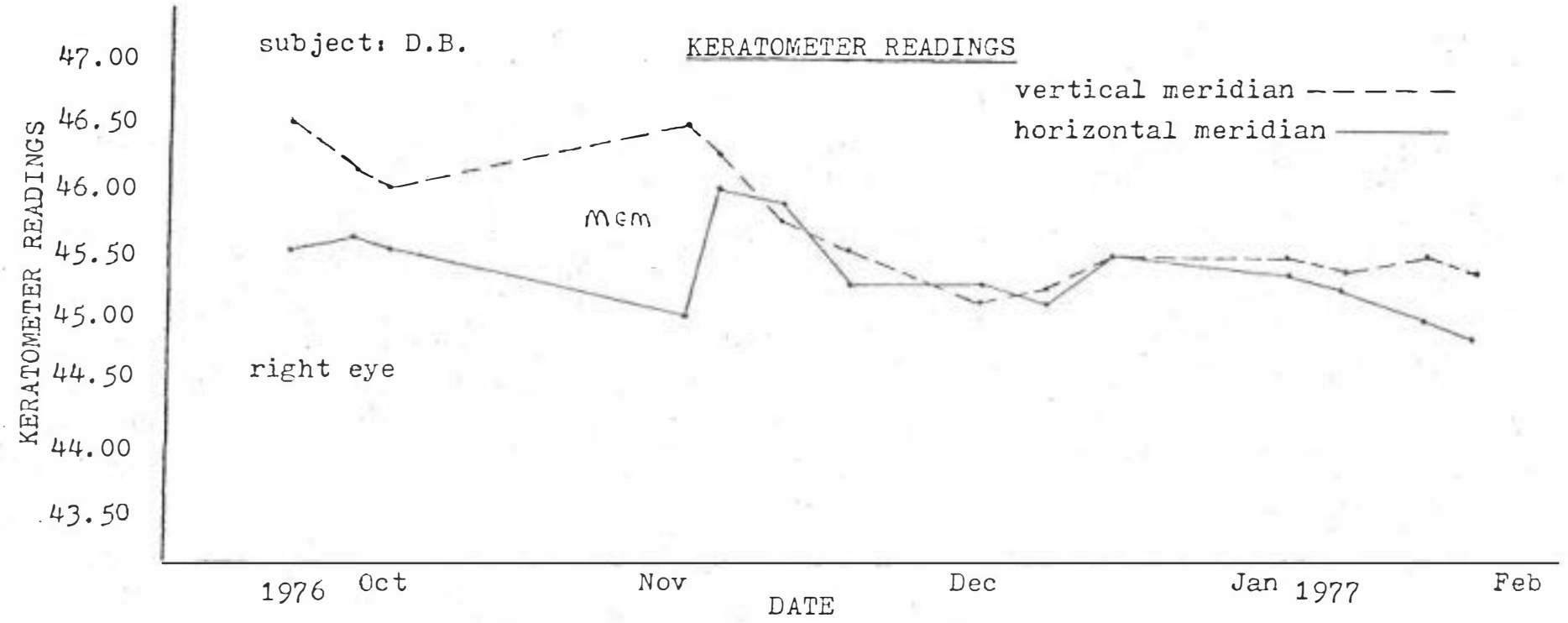
Date		Corneal Ultra-Sound	Wearing Time	Method	Base Curve	Power	IOP	Edema	Centering and Movement	Staining
9/21/76	R	-	0	-	-	-	14	-	-	-
	L	-		-	-	-	14	-	-	-
9/28/76	R	-	0	-	-	-	13	-	-	-
	L	-		-	-	-	13	-	-	-
9/30/76	R	-	0	-	-	-	13	-	-	-
	L	-		-	-	-	14	-	-	-
11/11/76	R	-	14	MGM	45.25	-1.25	14.5	2	C3-4T 1mm slow	JP#1 FB
	L	-		Tabb	45.00	-1.25	13.5	1	C3-4T 1.5mm slow	FB
11/18/76	R	-	14	"	"	"	13	1	C2-4T 1mm slow	JP#1 C#1
	L	-					13	0	C3-4T 1.5mm fast	C#1 FB
12/2/76	R	-	14	MGM	45.25	-0.50	12	1	C2-3N 0.5mm slow	C#2
	L	-		Tabb	45.25	-0.50	14	1	C2-3T 1mm slow	C#2
12/9/76	R	0.635	14	"	"	"	12	0	C3 1mm slow	none
	L	0.624					14	0	C3T 1.5mm slow	none
12/16/76	R	-	14	"	"	"	16	0	C3-4T 0.5mm slow	JP#1
	L	-					14	1	C3-4T 1mm slow	JP#1
1/5/77	R	-	14	MGM	45.25	-1.25	13	1	C2-4T 1mm slow	JP#1
	L	-		Tabb	45.00	-1.25	14	1	C2-4T 1mm slow	JP#1
1/12/77	R	-	14	"	"	"	-	1	C3-4 1mm slow	JP#1
	L	-					-	1	C3-4T 1mm slow	JP#1
1/20/77	R	-	14	"	"	"	-	0	C1-5N 3mm fast	none
	L	-					-	0	C1-4 2mm fast	JP#1
1/25/77	R	0.617	14	"	"	"	13	0	C1-4N 2mm fast	none
	L	0.604					13	0	C1-4N 2mm fast	none

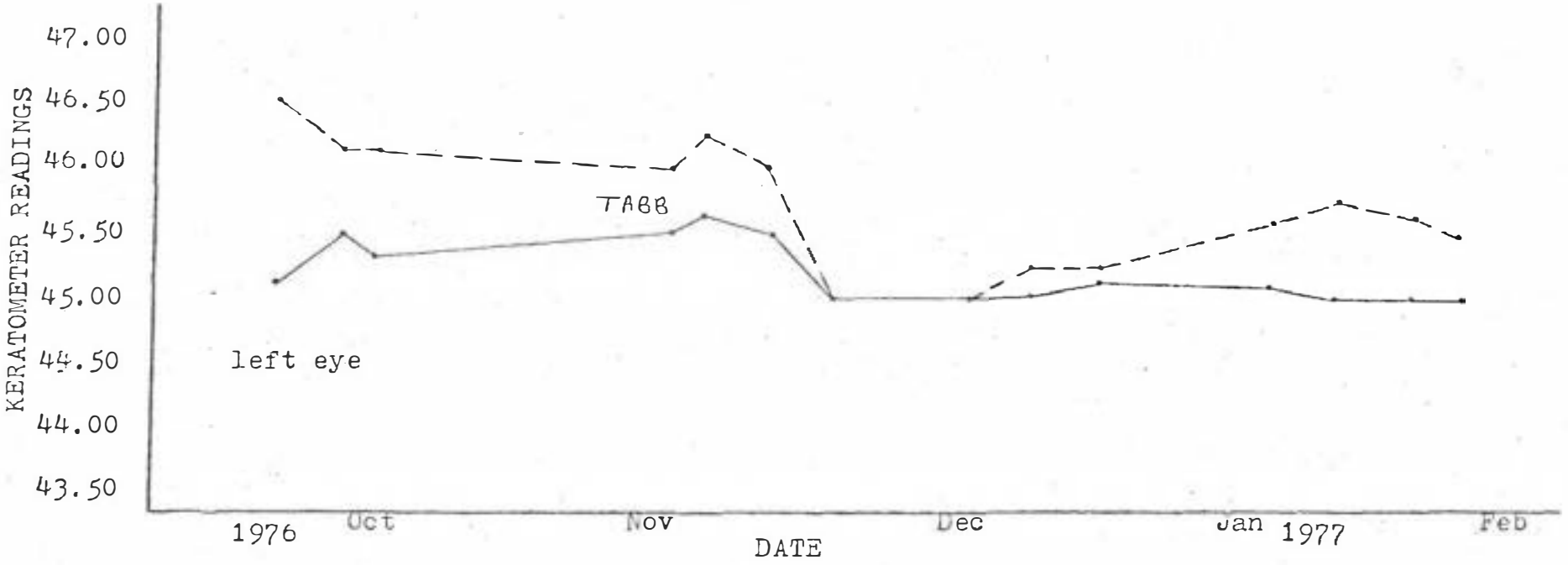
D.B. Female Age 21 Secretary

	Date	Unaided VA	Subjective Over-Refraction	Keratometer Readings	Central PEK and Shape Factor	Subjective Refractive Error	Corneal Pachometry
R	9/21/76	20/60	-	45.50 46.50@90	-	-1.25	-
L		20/60	-	45.12 46.50@90	-	-1.25	-
R	9/28/76	20/60	-	45.62 46.12@90	-	-1.25	-
L		20/60	-	45.50 46.12@90	-	-1.25	-
R	9/30/76	20/60	-	45.50 46.00@90	45.91 .18 46.51@115.11	-1.25	0.56
L		20/60	-	45.37 46.12@90	45.79 .41 46.78@100.10	-1.25	0.56
R	11/11/76	20/30	pl-0.50 x90	45.87 45.75@90	-	-1.00-0.75 x85	0.60
L		20/25	pl	45.50 46.00@90	-	-1.25-0.25 x105	0.60
R	11/18/76	20/20	+0.50-0.50 x85	45.25 45.50@90	-	-0.25-0.50 x85	0.60
L		20/20	+0.75-0.75 x100	45.00 45.00@90	-	-0.25-0.50 x105	0.58
R	12/2/76	20/15	+0.75-0.75 x68	45.25 45.12@90	-	pl-0.25 x70	0.54
L		20/15	+1.00-1.00 x110	45.00 45.00@90	-	+0.50-1.00 x115	0.60
R	12/9/76	20/15	-0.25-0.50 x95	45.12 45.25@90	45.40 -.10 45.97@95.04	-0.25	0.56
L		20/15	pl-0.25 x80	45.00 45.25@90	45.36 -.07 46.13@100-.03	-0.50	0.56
R	12/16/76	20/25	pl-0.50 x90	45.50 45.50@90	-	-1.25	0.56
L		20/20	-0.25	45.12 45.25@90	-	-0.75	0.56
R	1/5/77	20/30	-0.50-0.50 x90	45.37 45.50@90	-	-0.75-0.25 x85	0.54
L		20/30	-0.25	45.12 45.62@90	-	-1.00	0.54
R	1/12/77	20/30	+0.75-0.25 x75	45.25 45.37@90	-	-0.50	-
L		20/15	+1.00-0.50 x105	45.00 45.75@90	-	pl	-
R	1/20/77	20/30	+0.50-0.50 x90	45.00 45.50@90	-	-0.75-0.25 x90	-
L		20/20	+0.75-0.37 x90	45.00 45.62@90	-	-0.25	-
R	1/25/77	20/20	-	44.87 45.37@90	45.50 .14 46.02@90.13	-0.75-0.50 x95	0.60
L		20/20	-	45.00 45.50@90	45.63 .31 46.61@90.50	-0.50-0.75 x60	0.52

subject: D.B.


UNAIDED VISUAL ACUITY
OD
OS
20/200
20/100
20/80
20/70
20/60
20/50
20/40
20/30
20/25
20/20
20/15
VISUAL ACUITY
MGM
TABB
1976 Oct
Nov
Dec
Jan 1977
Feb
DATE

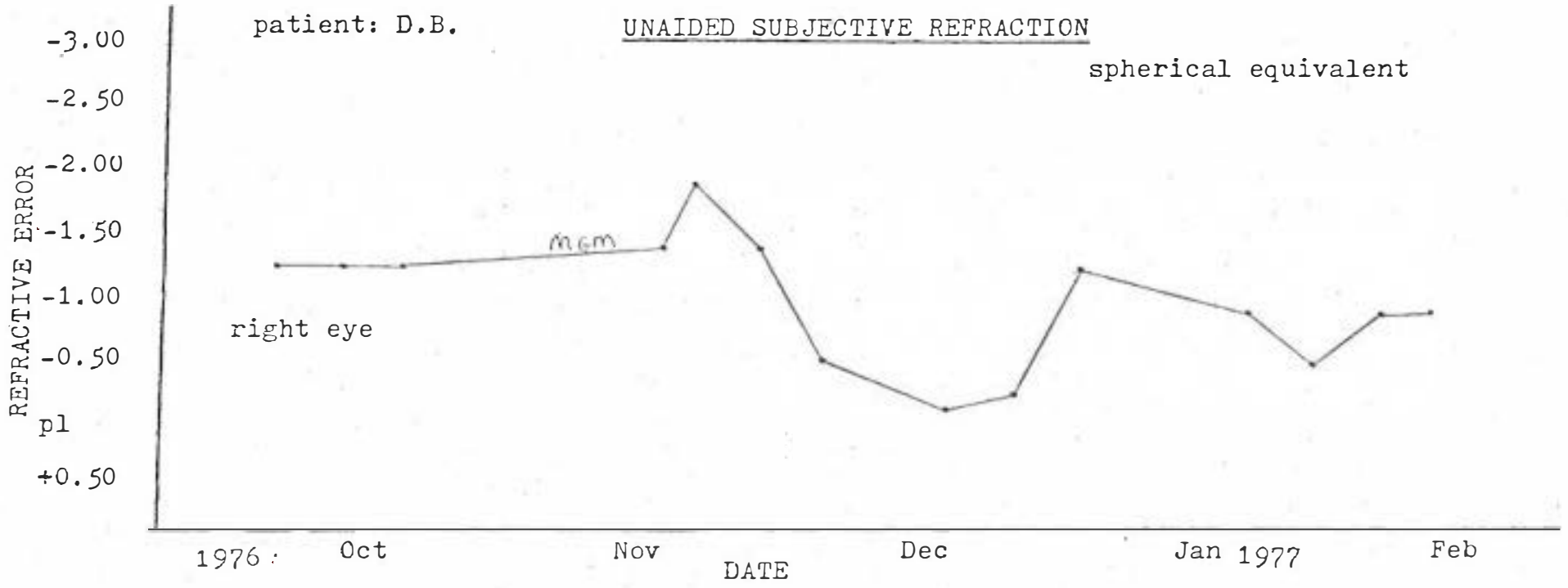

subject: D.B.
KERATOMETER READINGS
vertical meridian
horizontal meridian
MEM
right eye
KERATOMETER READINGS
47.00
46.50
46.00
45.50
45.00
44.50
44.00
43.50
1976
Oct
Nov
Dec
Jan
1977
Feb
DATE

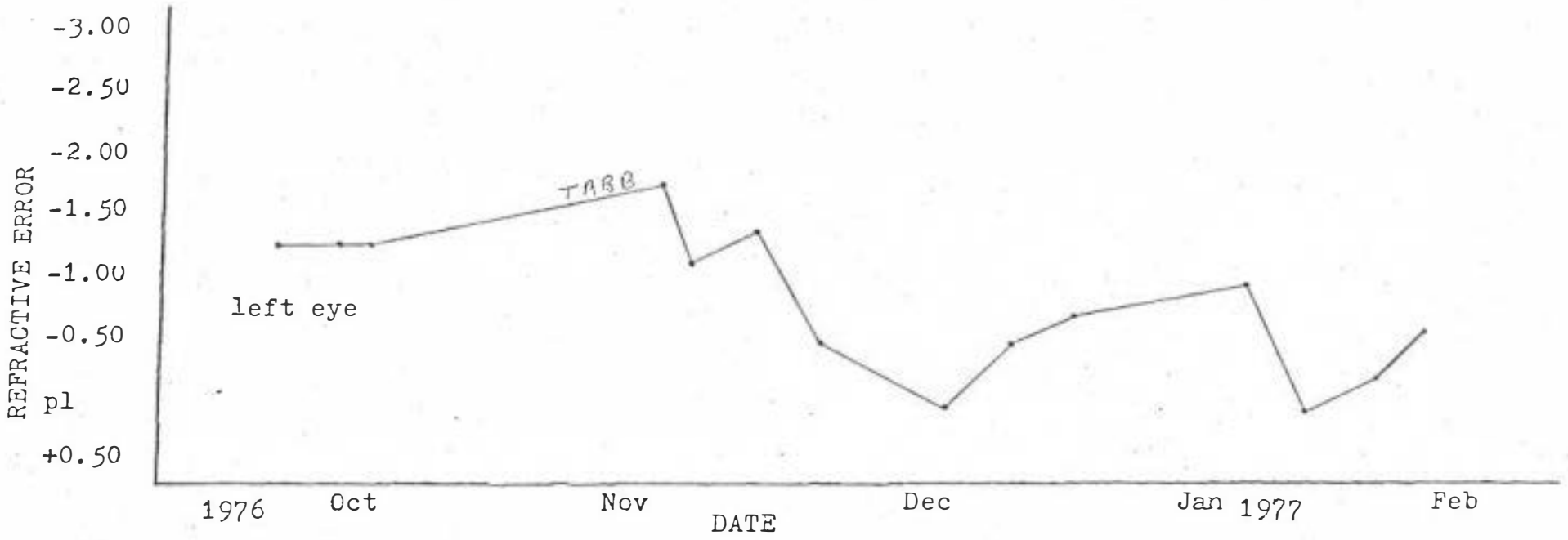

TABB
left eye
KERATOMETER READINGS
47.00
46.50
46.00
45.50
45.00
44.50
44.00
43.50
1976
Oct
Nov
Dec
Jan
1977
Feb
DATE

patient: D.B.

UNAIDED SUBJECTIVE REFRACTION

spherical equivalent





P.E.K. READOUT

Patient: D.B. Date: 9/30/76

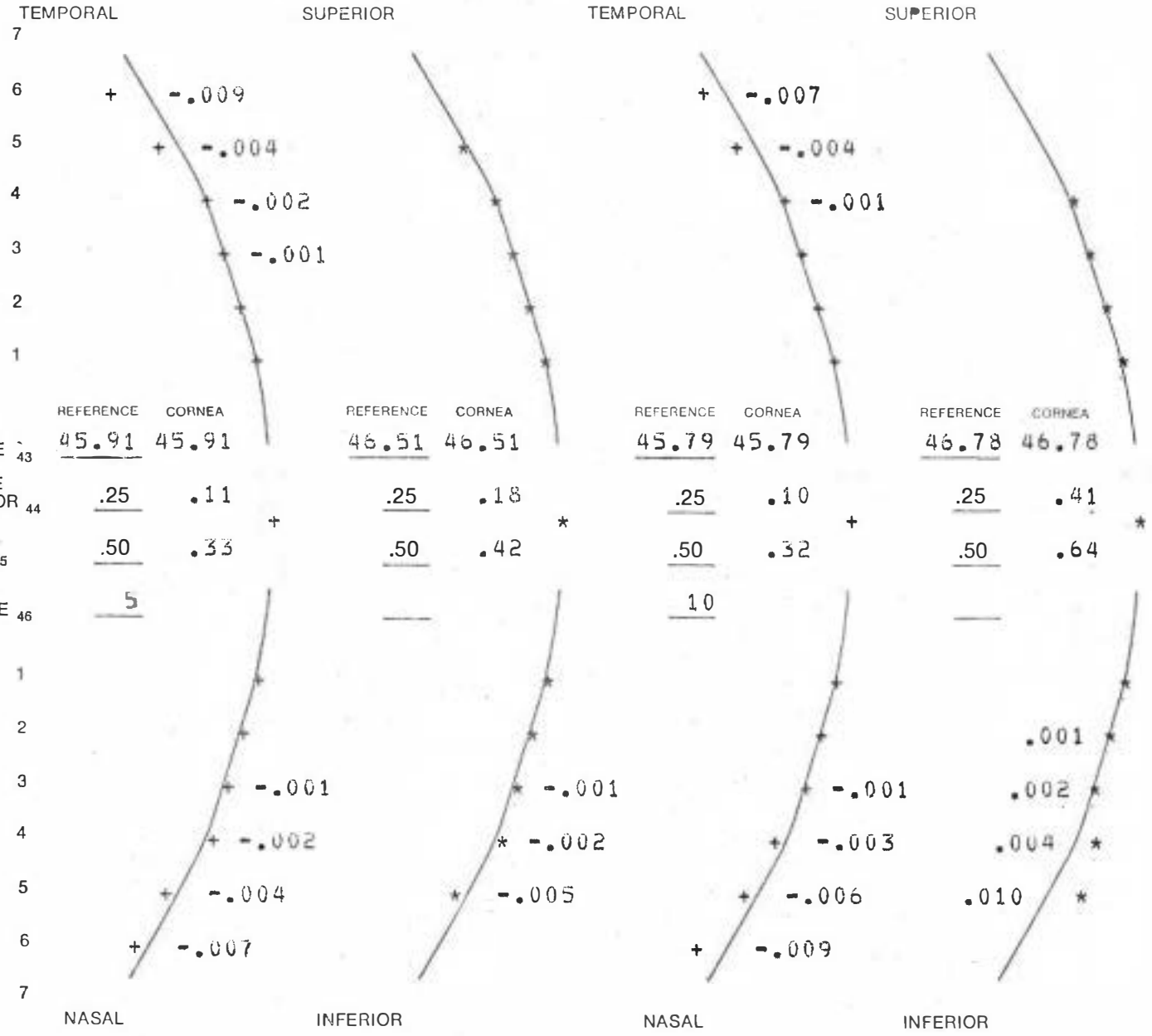
NOTES

Unaided V.A.: OD 20/60, OS 20/60

41

APEX 42 OD 0. mm at 255 OS 0. mm at 100

08(1)



P.E.K. READOUT

Patient: D.B. Date: 12/9/76

NOTES

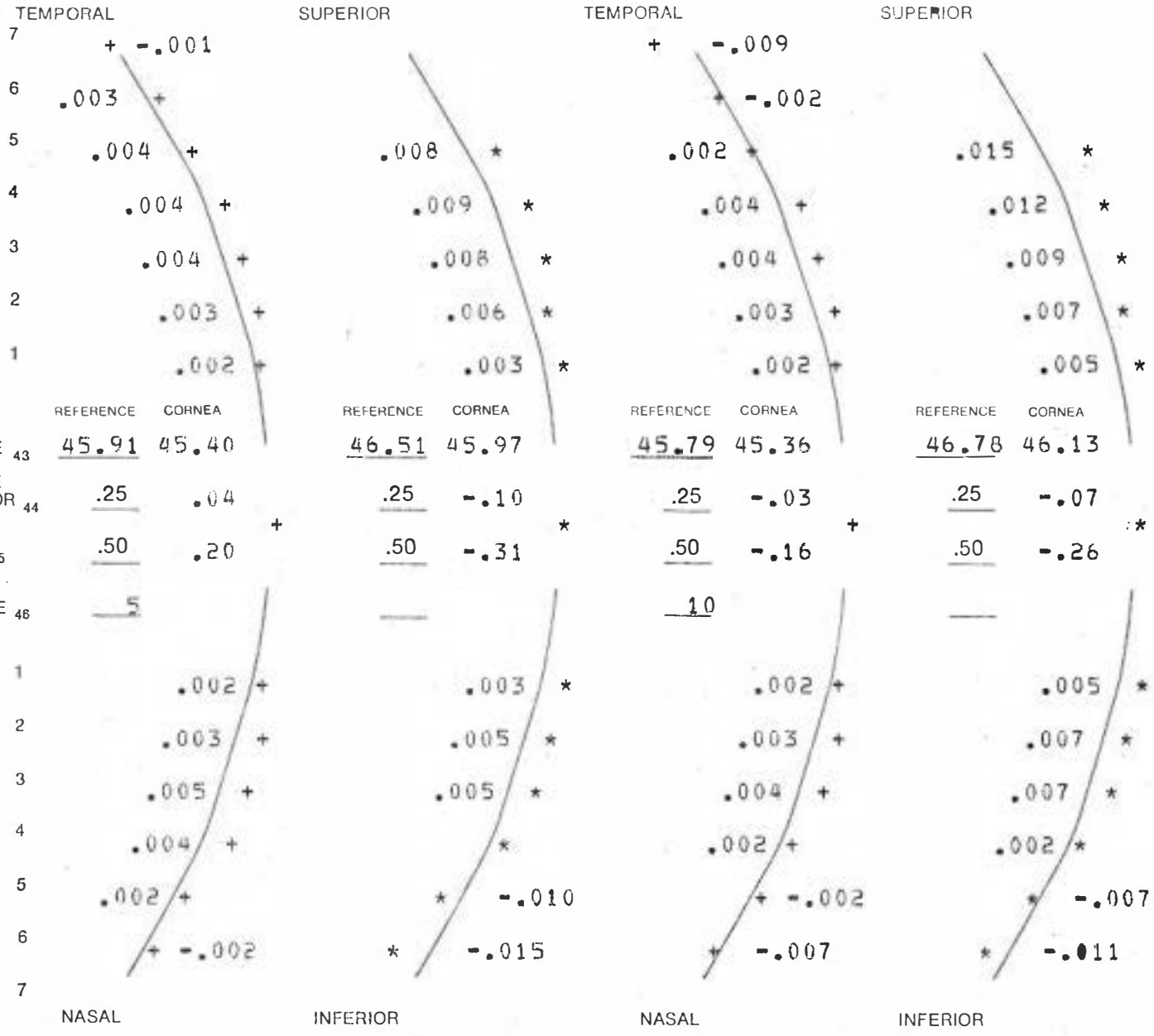
SHAPE FACTOR LOW OOH OOV OSH OSV CENTERING MAY BE DIFFICULT

Unaided V.A.: OD 20/15, OS 20/15

41

APEX 42 OD 0. mm at 0 OS 0. mm at 0

OD (2)



P.E.K. READOUT

Patient: D.B. Date: 1/25/77

NOTES

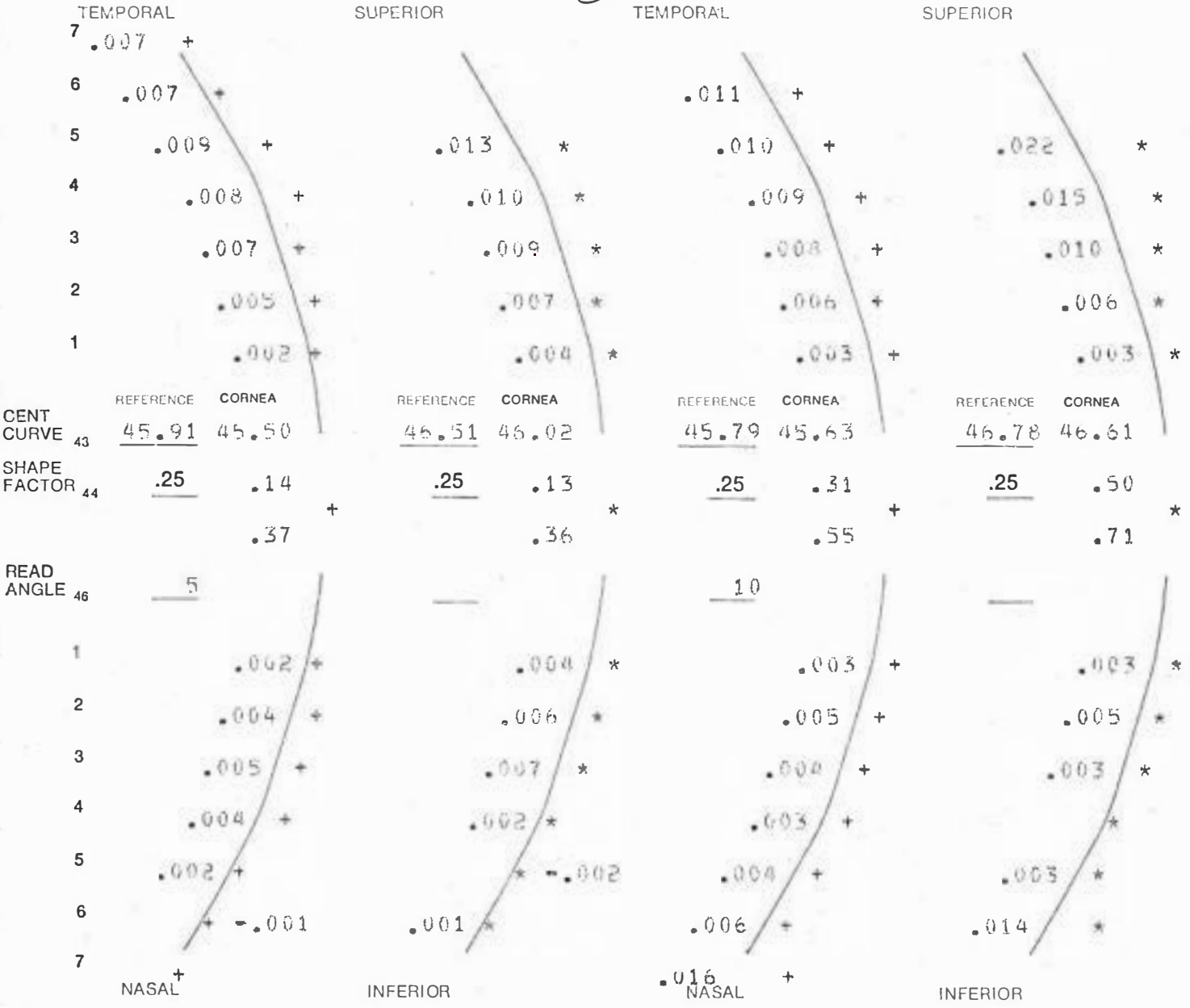
IRREGULAR CORNEA - READINGS DIFFICULT

Unaided V.A.: OD 20/20, OS 20/20

41

APEX 42 OD 1. mm at 280 OS 0. mm at 290

DR 3



Patient Summary

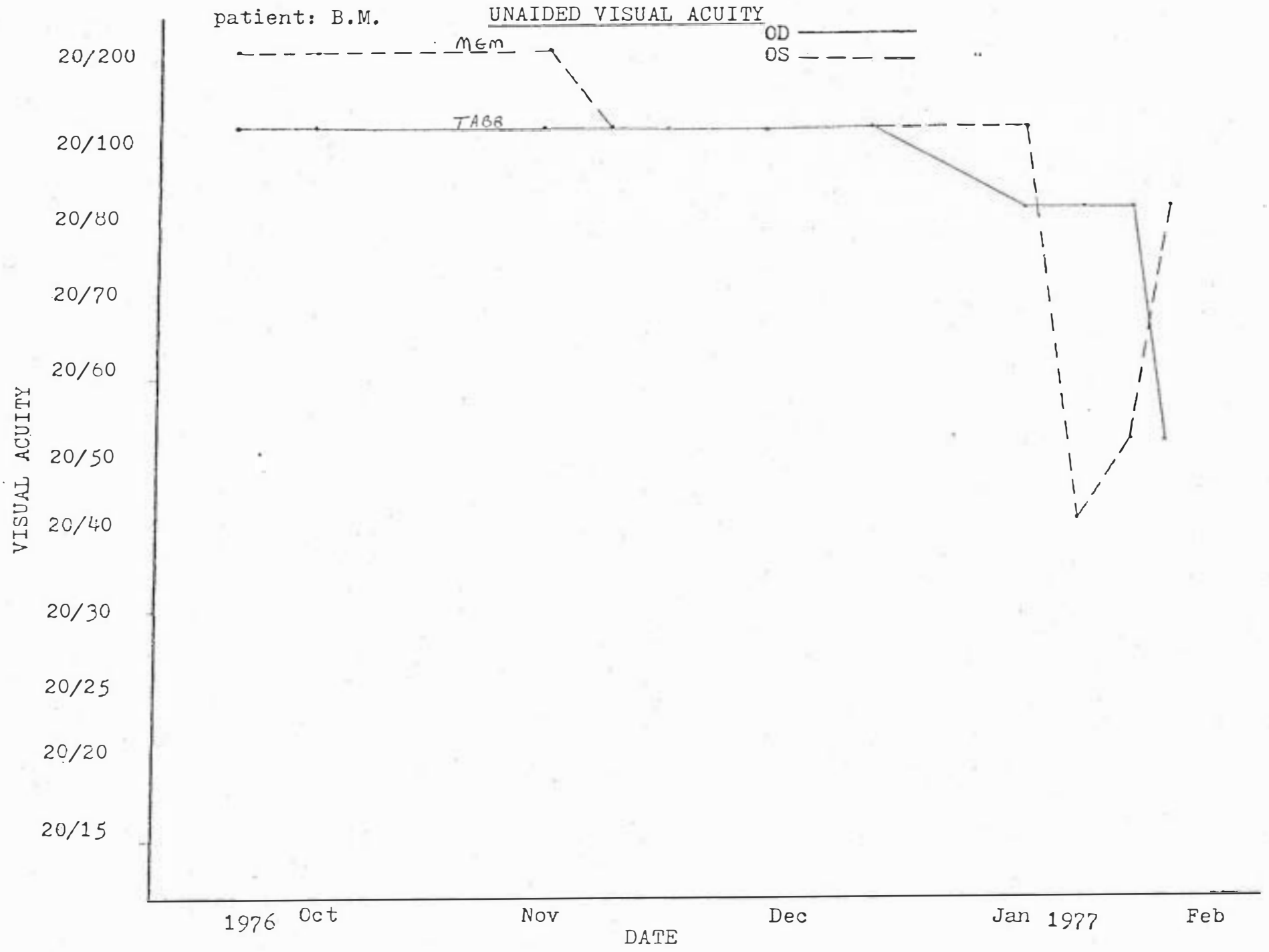
B.M., a 25 year old male carpenter, had been an unsuccessful hard contact lens wearer approximately four years before entering our study. He was fit with OD Tabb method and OS MGM method. His original findings are as follows: unaided VA 20/100 OD and 20/200 OS, unaided subjective refraction OD -2.00 sphere and OS -2.75 sphere, keratometer readings PD 43.62/44.25@90 and OS 44.37/44.37@90. After one week of contact lens wear his left eye VA improved to 20/100 and his right eye remained at 20/100. Here he remained fairly stable for two months, all the time we were making modifications on his lenses to flatten his corneas. At this point the lenses were modified with tape on a 12mm diameter tool .3 mm wide periphereal curve. His unaided VA two weeks later improved to 20/50 OD and OS. His unaided subjective refraction is now OD -1.62 sphere and OS -1.12 sphere, keratometer readings OD 44.00/43.75@90 and OS 44.12/44.12@90.

B.M. Male Age 25 Carpenter

	Date	Corneal Ultra-Sound	Wearing Time	Method	Base Curve	Power	IOP	Edema	Centering and Movement	Staining
R	9/21/76	-	-	-	-	-	13	-	-	-
L		-	-	-	-	-	13	-	-	-
R	9/30/76	-	-	-	-	-	16	-	-	-
L		-	-	-	-	-	15	-	-	-
R	11/11/76	-	11	Tabb	43.87	-1.62	14	0	C3-4 1mm slow	none
L		-		MGM	44.25	-2.25	13.5	0	C3-4 1mm fast	none
R	11/18/76	-	14	"	"	"	15	0	C3-4 1mm slow	none
L		-					14	1	C3-4	none
R	12/2/76	-	14	"	"	"	14	0	C2.5-3.5 1mm slow	JP#1 FBC
L		-					15	1	C2.5-4N 1.5mm slow	FBC
R	12/16/76	-	14	"	"	"	13	0	C3-4.5 1.5mm slow	FBC
L		-					13	0	C2.5-3.5 1.5mm slow	FBC
R	1/5/77	0.580	14	"	"	"	11	0	C2.5-4.0 1.5mm slow	JP#1
L		0.553					15	0	C3-4 1mm slow	JP#1
R	1/13/77	-	14	"	"	"	-	1	C3-4 1mm slow	none
L		-					-	1	C3-4 1mm slow	JP#1
R	1/20/77	-	14	"	"	"	11	1	C2.5-3.5 1mm slow	JP#1
L		-					11	1	C2.5-3.5 1mm slow	JP#1
R	1/25/77	0.556	14	"	"	"	14	1	C2.5-3.5 1mm slow	none
L		0.548					14	1	C2.5-3.5 1mm slow	none

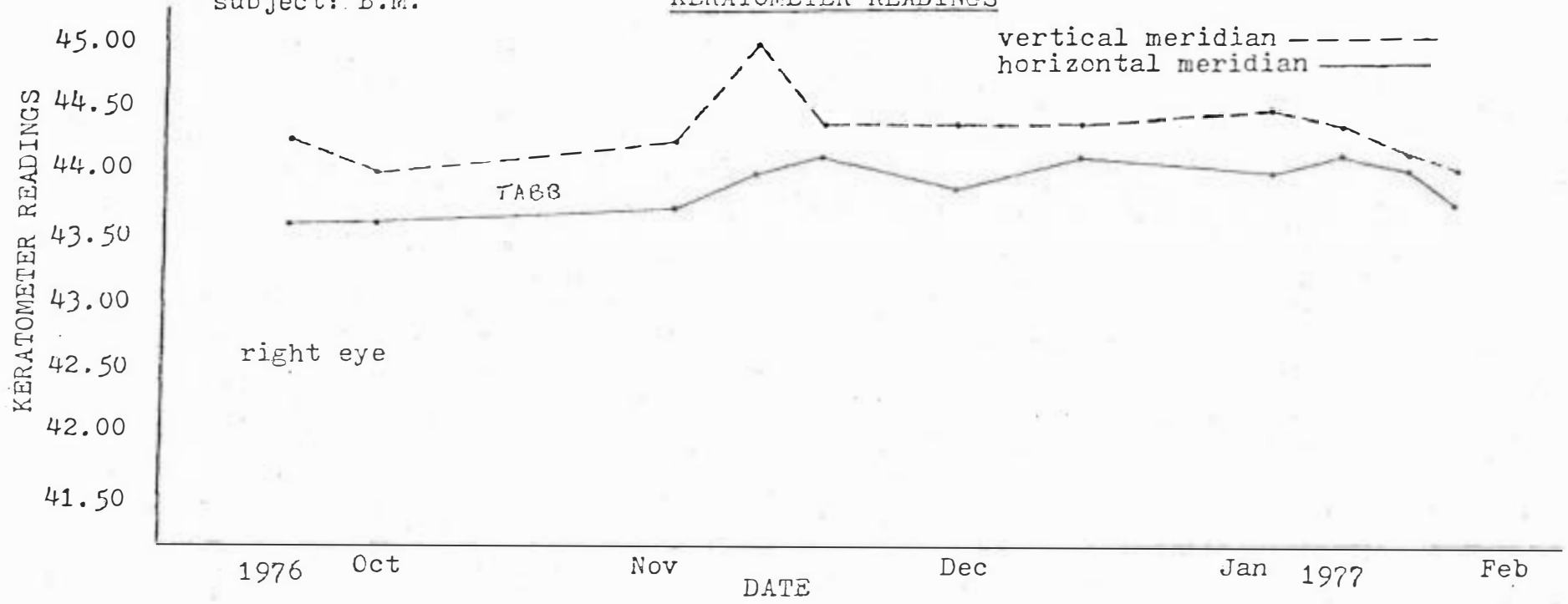
B.M. Male Age 25 Carpenter

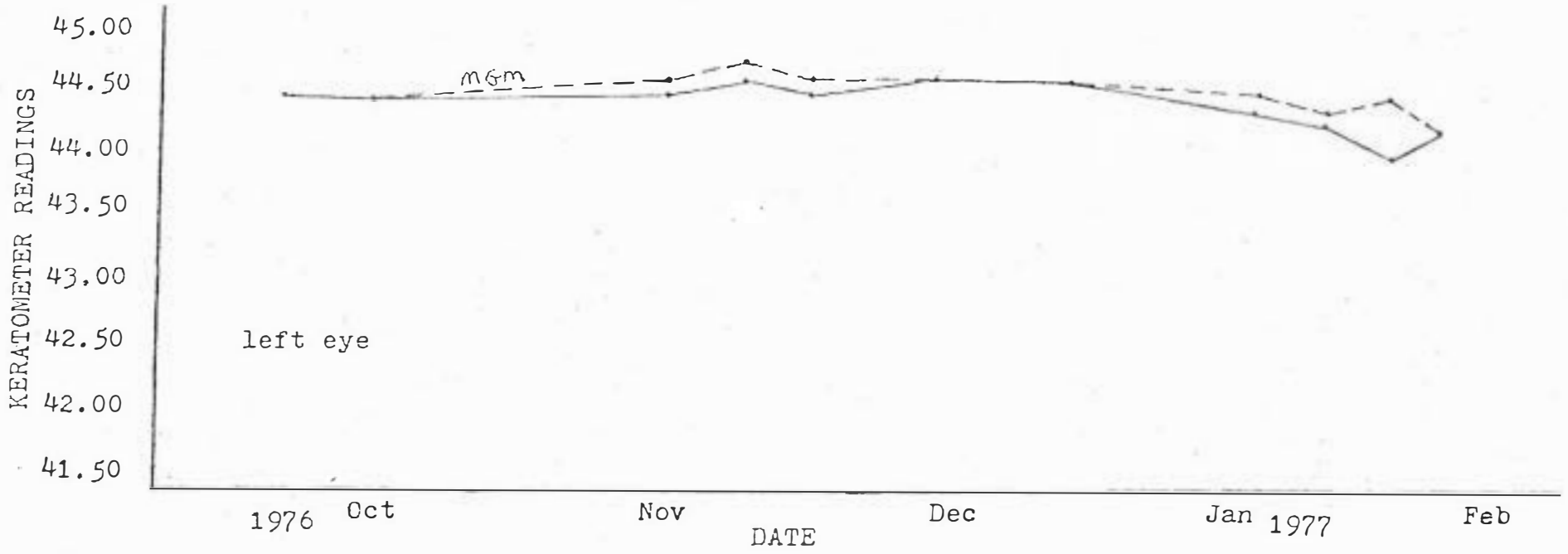
Date	Unaided VA	Subjective Over-Refraction	Keratometer Readings	Central PEK and Shape Factor	Subjective Refractive Error	Corneal Pachometry
R 9/21/76	20/100	-	43.62 44.25@90	-	-2.00-0.25 x180	-
L	20/200	-	44.37 44.37@90	-	-2.75	-
R 9/30/76	20/100	-	43.62 44.00@90	44.16 .1 44.85@5.31	-1.75-0.25 x180	-
L	20/200	-	44.37 44.37@90	44.80 .08 45.13@170.24	-2.50	-
R 11/11/76	20/100	+0.25	44.00 45.00@90	-	-2.25-0.75 x180	0.52
L	20/100	+0.25	44.50 44.62@90	-	-2.50-0.50 x155	0.48
R 11/18/76	20/100	+0.37	44.12 44.37@90	-	-2.00	0.50
L	20/100	+0.25	44.37 44.50@90	-	-2.00-0.25 x90	0.48
R 12/2/76	20/100	+0.25-0.25 x75	43.87 44.37@90	-	-1.50-0.25 x98	0.54
L	20/100	+0.25	44.50 44.50@90	-	-2.00-0.25 x105	0.58
R 12/16/76	20/100	+0.50-0.50 x90	44.12 44.37@90	44.10 -.09 44.62@95.07	-1.75-0.50 x30	0.48
L	20/100	+0.50-0.50 x55	44.50 44.50@90	44.80 .06 45.13@80.22	-2.50-0.50 x5	0.52
R 1/5/77	20/80	+0.50	44.00 44.50@90	-	-1.75	0.52
L	20/100	pl	44.25 44.37@90	-	-2.25	0.52
R 1/13/77	20/80	+0.25-0.25 x90	44.12 44.37@90	-	-1.75	0.52
L	20/80	+0.25	44.12 44.25@90	-	-1.00-0.25 x60	0.52
R 1/20/77	20/80	+0.50-0.25 x90	44.00 44.12@90	-	-1.50-0.25 x75	0.54
L	20/50	+0.50	43.87 44.37@90	-	-1.75-0.25 x60	0.54
R 1/25/77	20/50	+0.25-0.50 x90	43.75 44.00@90	43.81 .27 44.46@90.13	-1.25-1.00 x60	0.56
L	20/80	+0.25-0.25 x75	44.12 44.12@90	44.37 .22 44.40@90.05	-1.25-1.25 x60	0.52


patient: B.M.
UNAIDED VISUAL ACUITY
OD
OS
M&m
TABB
20/200
20/100
20/80
20/70
20/60
20/50
20/40
20/30
20/25
20/20
20/15
VISUAL ACUITY
1976
Oct
Nov
Dec
Jan
1977
Feb
DATE

subject: B.M.

KERATOMETER READINGS

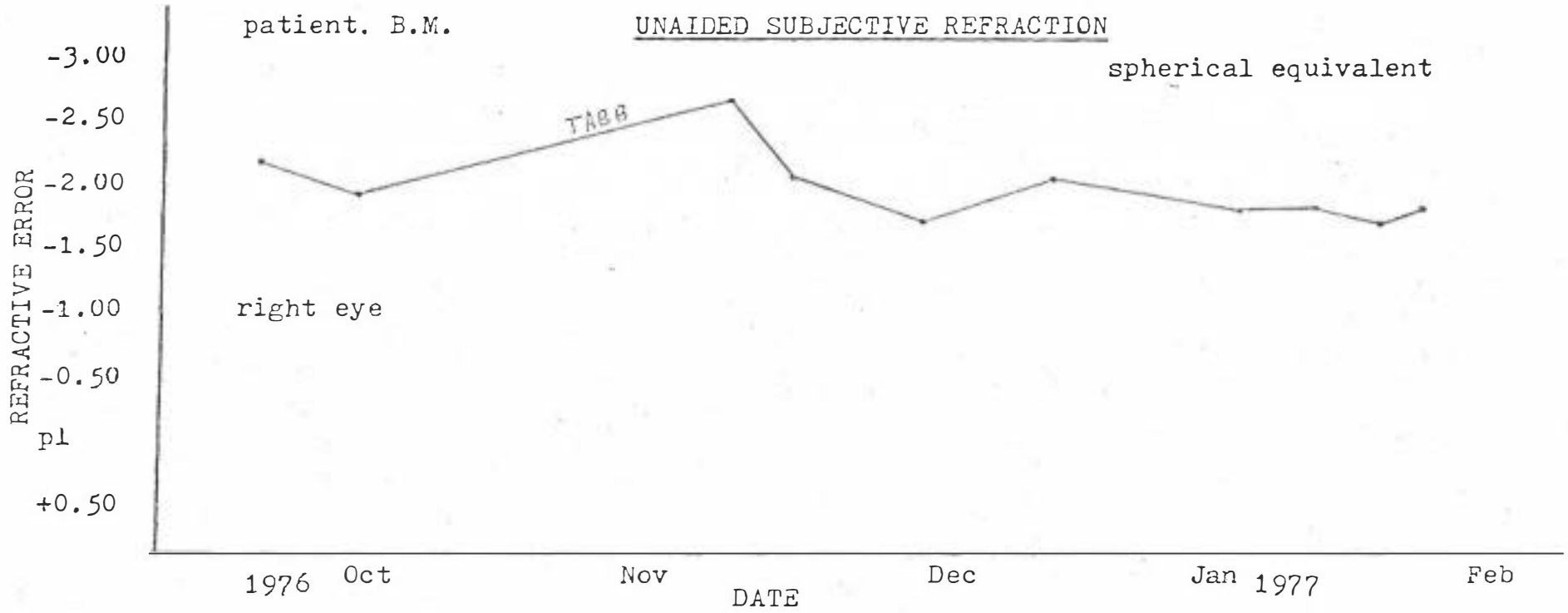


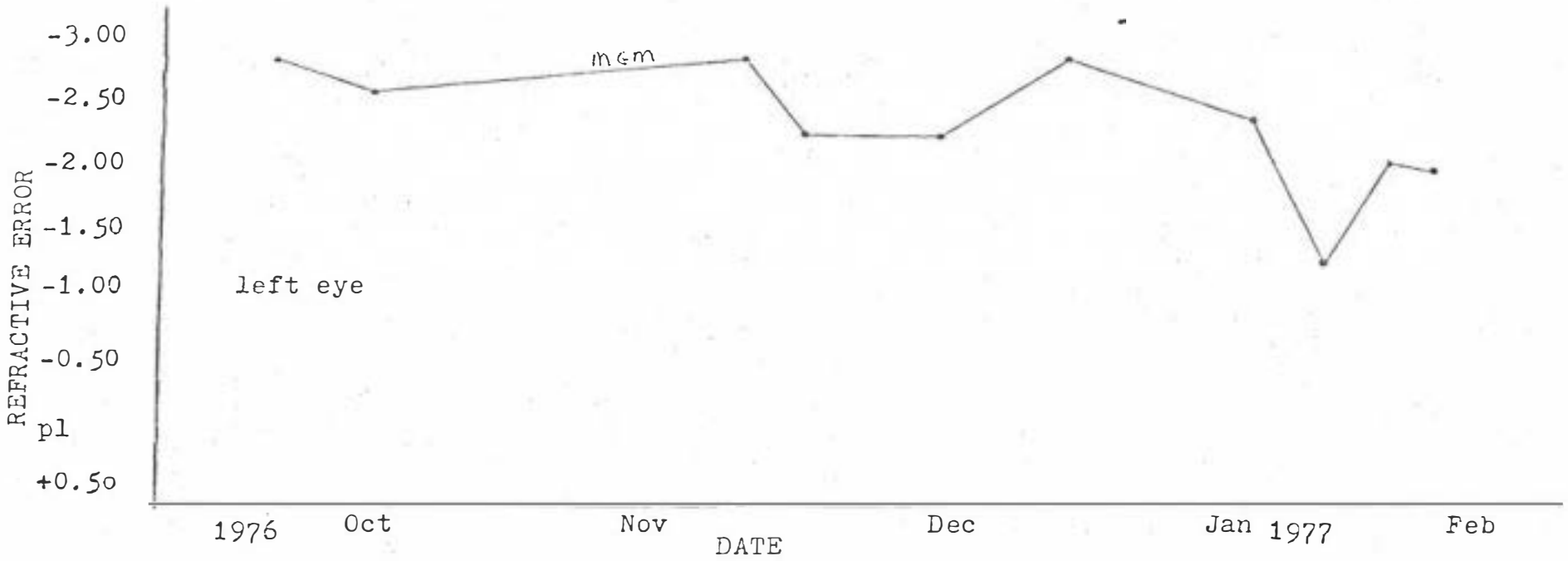


patient. B.M.

UNAIDED SUBJECTIVE REFRACTION

spherical equivalent





P.E.K. READOUT

Patient: B.M. Date: 9/30/76

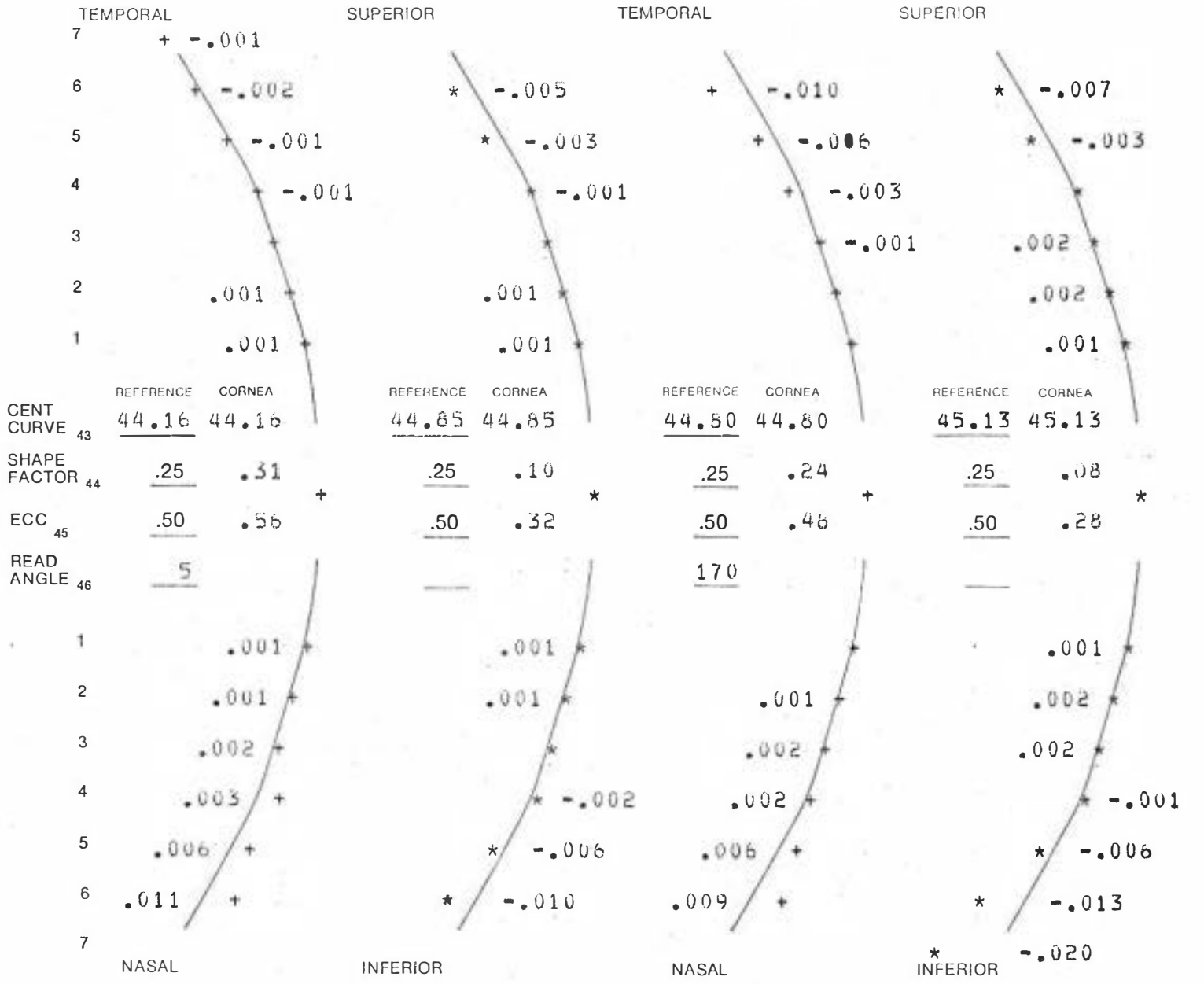
NOTES IRREGULAR CORNEA - READINGS DIFFICULT

Unaided V.A.: OD20/100, OS 20/200

41

APEX 42 OD 0. mm at 235 OS 1. mm at 335

BM (1)



P.E.K. READOUT

Patient: B.M. Date: 12/ 16/76

NOTES

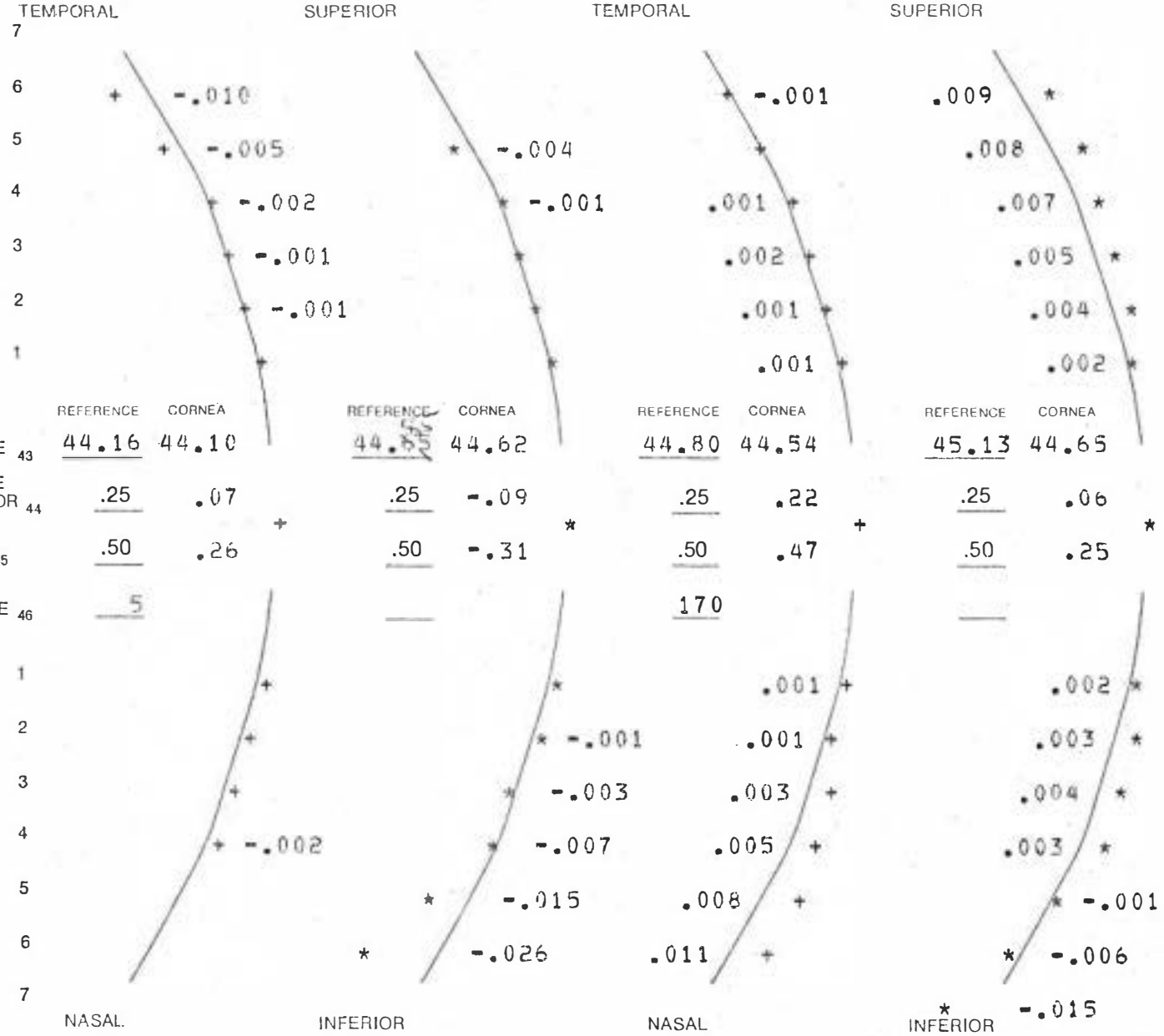
SHAPE FACTOR LOW ODV CENTERING MAY BE DIFFICULT

Unaided V.A.: OD20/100, OS 20/100

41

APEX 42 OD 0. mm at 180 OS 2. mm at 285

BM (2)



	REFERENCE	CORNEA	REFERENCE	CORNEA	REFERENCE	CORNEA	REFERENCE	CORNEA
CENT CURVE 43	44.16	44.10	44.24	44.62	44.80	44.54	45.13	44.65
SHAPE FACTOR 44	.25	.07	.25	-.09	.25	.22	.25	.06
ECC 45	.50	.26	.50	-.31	.50	.47	.50	.25
READ ANGLE 46	5				170			

P.E.K. READOUT

Patient: B.M. Date: 1/25/77

NOTES

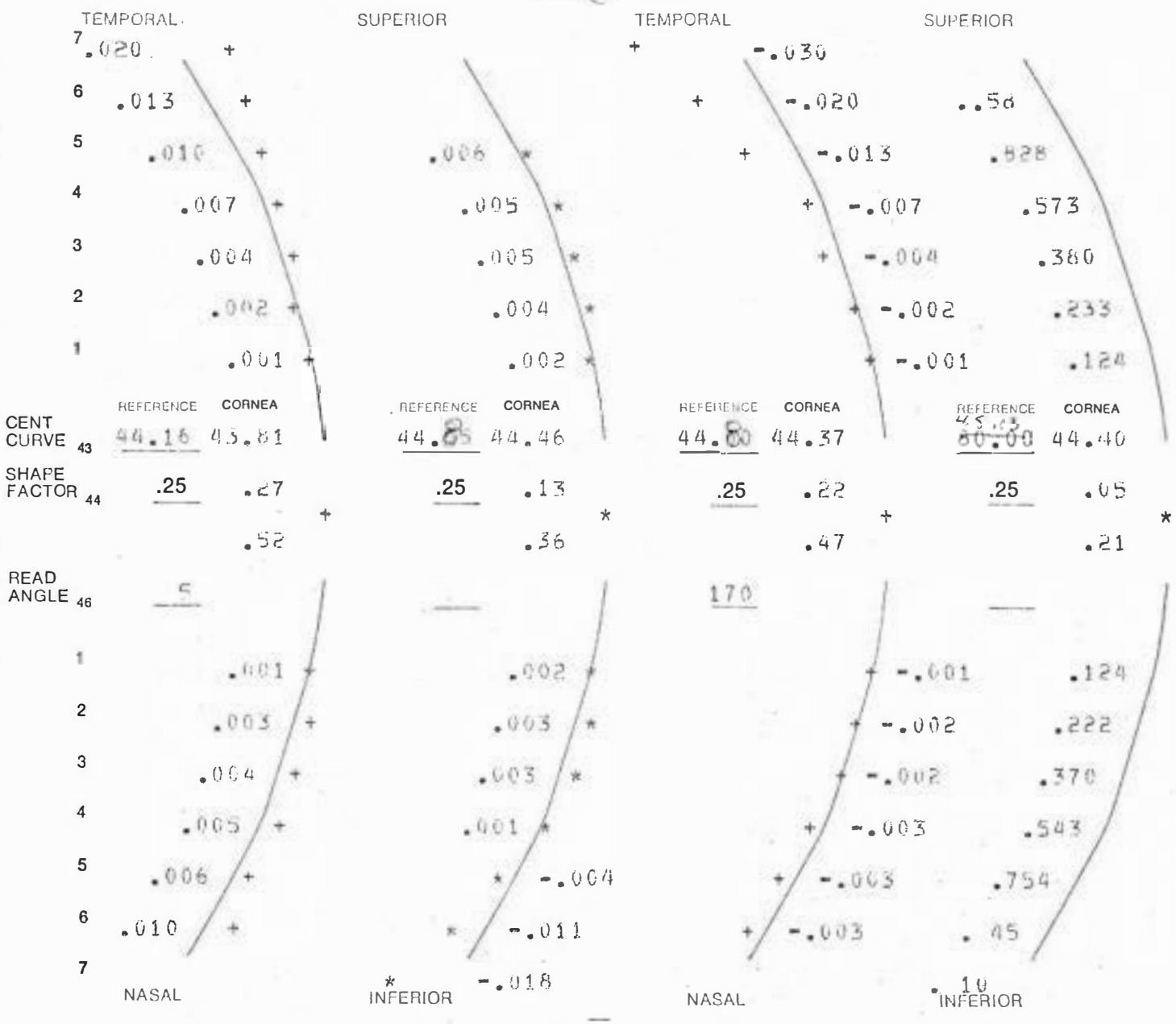
IRREGULAR CORNEA - READINGS DIFFICULT
SHAPE FACTOR LOW - OSV CENTERING MAY BE DIFFICULT

Unaided V.A.: OD 20/50, OS 20/80

41

APEX 42 OD 1. mm at 175 OS 4. mm at 150

BM (3)



Patient Summary

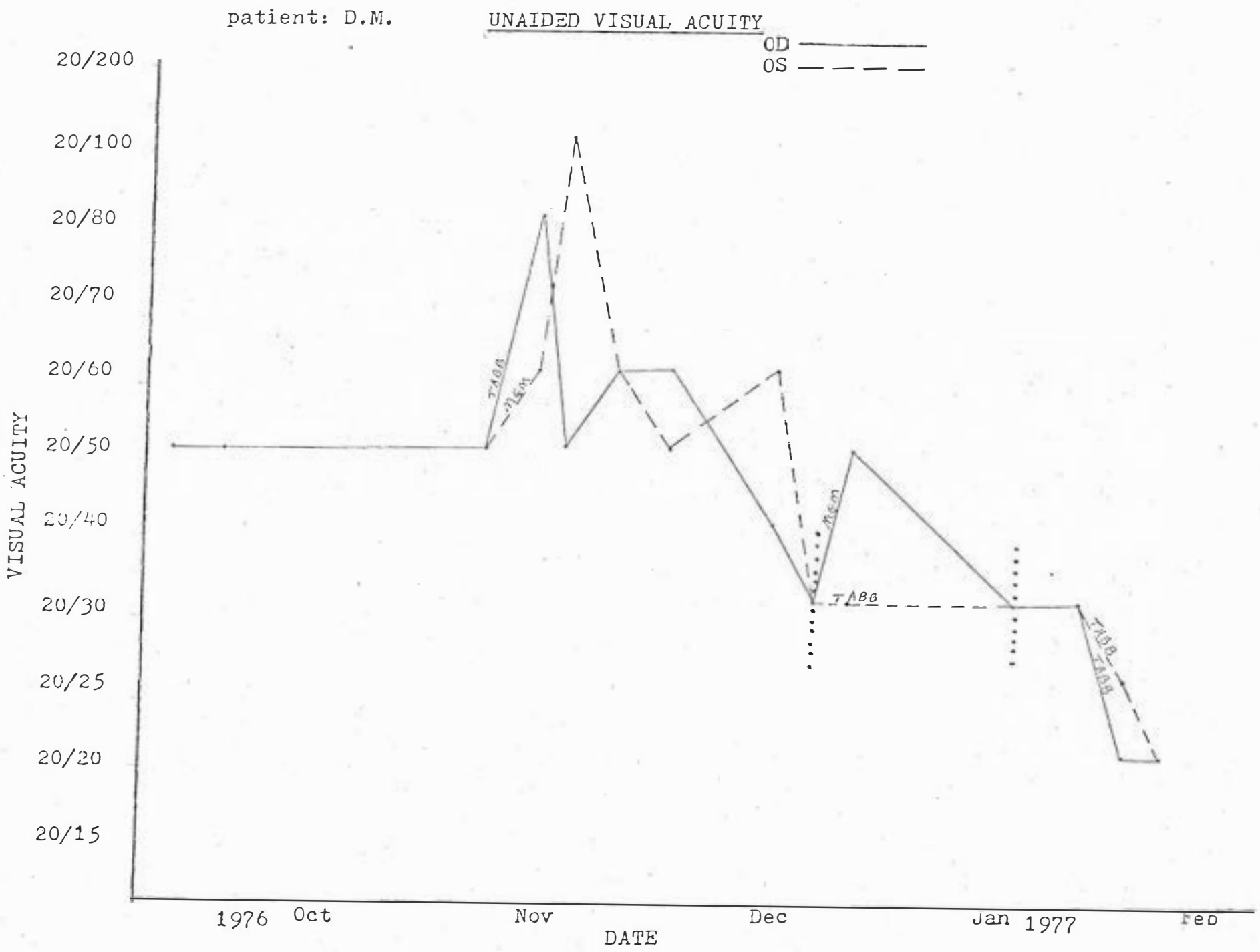
D.M., a 23 year old male in his first year of optometry school was a first time contact lens wearer. He was fit with right eye Tabb method and left eye MGM method. His original findings are as follows: unaided VA 20/50 OD and OS, unaided subjective refraction OD -1.25-0.50x165 and OS -1.25-0.50x165, keratometer readings OD 43.62/44.62@90 and OS 44.00/44.50@90. He showed an initial decrease in VA to 20/100 OS and 20/80 OD two days after his lenses were dispensed. Approximately one week later his VA returned to 20/50 OD and OS. After 4 weeks his acuity improved to 20/30 OD and OS, then after 8 weeks improved further to 20/20 OD and OS. At this point his unaided subjective refraction is PD and OS -0.62 sphere and keratometer readings OD 43.50/44.00@90 and OS 43.75/44.00@90.

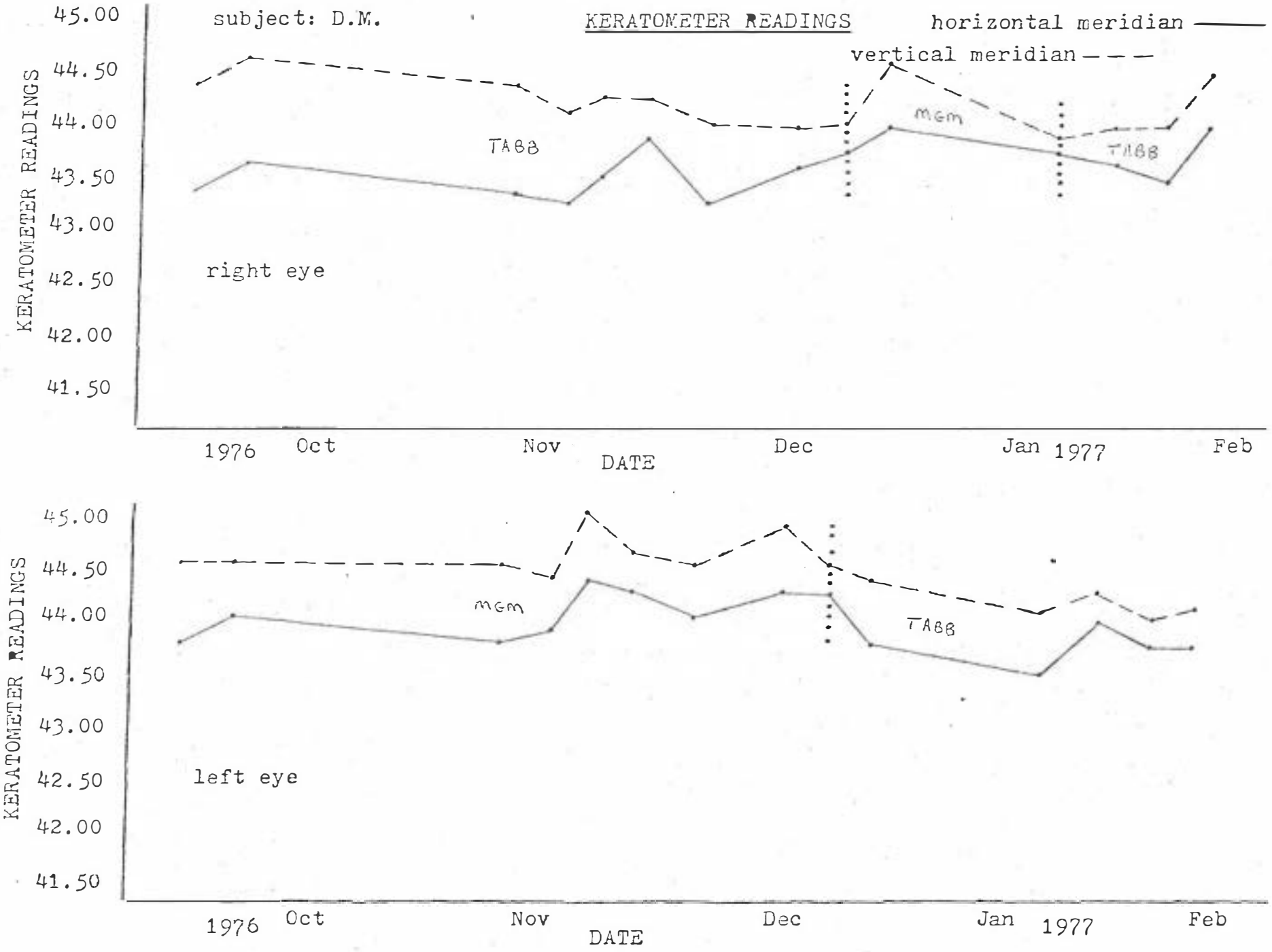
D.M. Male Age 23 Optometry Student

	Date	Corneal Ultra-Sound	Wearing Time	Method	Base Curve	Power	IOP	Edema	Centering and Movement	Staining
R	9/16/76	-	-	-	-	-	14	-	-	-
L		-	-	-	-	-	14	-	-	-
R	9/23/76	-	-	-	-	-	13	-	-	-
L		-	-	-	-	-	14	-	-	-
R	10/28/76	0.559	-	-	-	-	-	-	-	-
L		0.550	-	-	-	-	-	-	-	-
R	11/11/76	-	10	Tabb	42.87	-0.87	12	0	C3-3.5 0.5mm slow	none
L		-		MGM	43.37	-0.75	13	1	C3-3.5 0.5mm fast	none
R	11/18/76	-	14	"	"	"	11.5	1	C3-4 1mm slow	JP#1
L		-					12	1	C3-4T 1mm slow	JP#1
R	12/2/76	-	14	"	"	"	13	0	C3-4T 1.5mm slow	none
L		-					12	1	C3-4T 1.5mm slow	JP#1 C#1
R	12/9/76	0.574	14	MGM	42.87	-0.75	13	0	C3-4	none
L		0.570		Tabb	43.50	-0.75	12	1	C3-4T 1.5mm slow	JP#1
R	12/14/76	-	14	"	"	"	12	1	C3-4 1mm slow	JP#1
L		-					13	1	C2-3 1mm slow	JP#1
R	1/5/77	-	14	Tabb	42.87	-0.87	10	1	C3-4T 1 mm slow	JP#1
L		-		Tabb	43.50	-0.75	11	1	C3-2 1mm slow	JP#1
R	1/13/77	-	14	"	"	"	-	1	-	none
L		-					-	1	-	none
R	1/20/77	-	14	"	"	"	12	1	C3-4T	none
L		-					13	1	C3-4T 1mm slow	none
R	1/25/77	0.593	14	"	"	"	10	1	C3-4T	none
L		0.565					11	1	C3-4T	none

D.M. Male Age 23 Optometry Student

Date	Unaided VA	Subjective Over Refraction	Keratometer Readings	Central PEK and Shape Factor	Subjective Refractive Error	Corneal Pachometry
R 9/16/76	20/50	-	43.37 / 44.37@90	-	-1.00-0.75 x170	-
L	20/50	-	43.75 / 44.50@90	-	-1.00-0.75 x165	-
R 9/23/76	20/50	-	43.62 / 44.62@90	-	-1.25-0.50 x165	-
L	20/50	-	44.00 / 44.50@90	-	-1.25-0.50 x165	-
R 10/28/76	20/50	-	43.37 / 44.37@73	43.40 .37 / 44.31@95.39	-	.47
L	20/50	-	43.75 / 44.50@86	44.00 .2 / 44.18@95.32	-	.46
R 11/11/76	20/60	+0.25	43.87 / 44.25@90	-	-1.25-0.50 x165	.62
L	20/60	pl	44.25 / 44.62@90	-	-1.50-0.25 x175	.62
R 11/18/76	20/60	pl	43.25 / 44.00@90	-	-1.25	.53
L	20/50	pl-0.25 x90	44.00 / 44.50@90	-	-1.75	.58
R 12/2/76	20/40	+0.25	43.62 / 44.00@90	-	-1.25-0.25 x15	.52
L	20/60	pl-0.37 x110	44.25 / 44.87@90	-	-1.25-0.50 x135	.52
R 12/9/76	20/30	pl	43.75 / 44.00@90	43.51 .31 / 44.71@95.32	-1.25	.52
L	20/30	pl	44.25 / 44.50@90	44.49 .27 / 44.97@90.31	-1.50	.52
R 12/14/76	20/50	pl	44.00 / 44.62@90	-	-1.50-0.50 x180	.55
L	20/30	-0.25	43.75 / 44.37@90	-	-1.75	.55
R 1/5/77	20/30	pl	43.25 / 43.87@90	-	-0.25-0.50 x180	.54
L	20/30	-0.25	43.50 / 44.12@90	-	-1.00	.52
R 1/13/77	20/30	+0.25	43.62 / 44.00@90	-	-1.50	.52
L	20/30	-0.50	44.00 / 44.25@90	-	-1.75	.52
R 1/20/77	20/20	+0.25	43.50 / 44.00@90	-	-0.50	.52
L	20/25	+0.25	43.75 / 44.00@90	-	-0.25-0.25 x90	.52
R 1/25/77	20/20	+0.75-0.25 x70	44.00 / 44.50@90	43.78 .81 / 44.24@90.48	-0.50-0.25 x45	.52
L	20/20	+0.25	43.75 / 44.12@90	43.90 .35 / 44.09@90.20	-0.75	.52

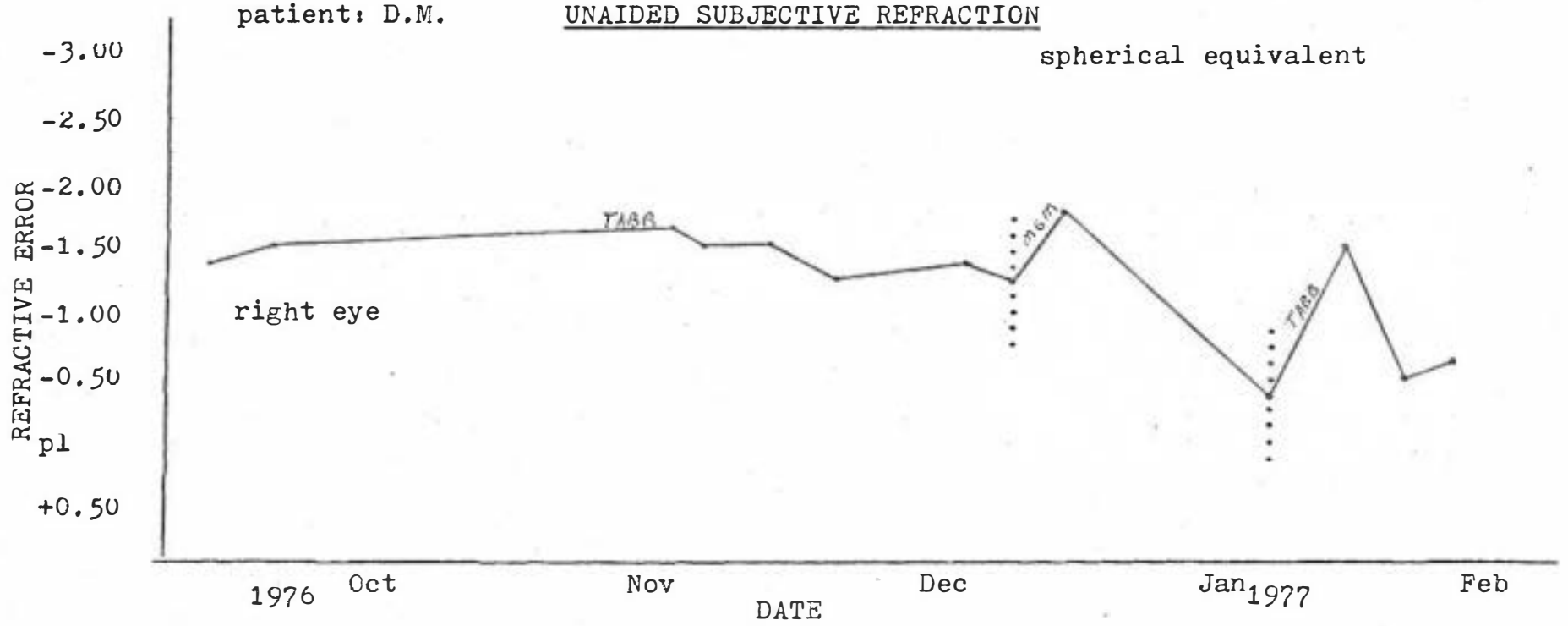

patient: D.M.
UNAIDED VISUAL ACUITY
OD
OS
20/200
20/100
20/80
20/70
20/60
20/50
20/40
20/30
20/25
20/20
20/15
VISUAL ACUITY
TABB
TABB
TABB
1976 Oct
Nov
Dec
Jan 1977
Feb
DATE

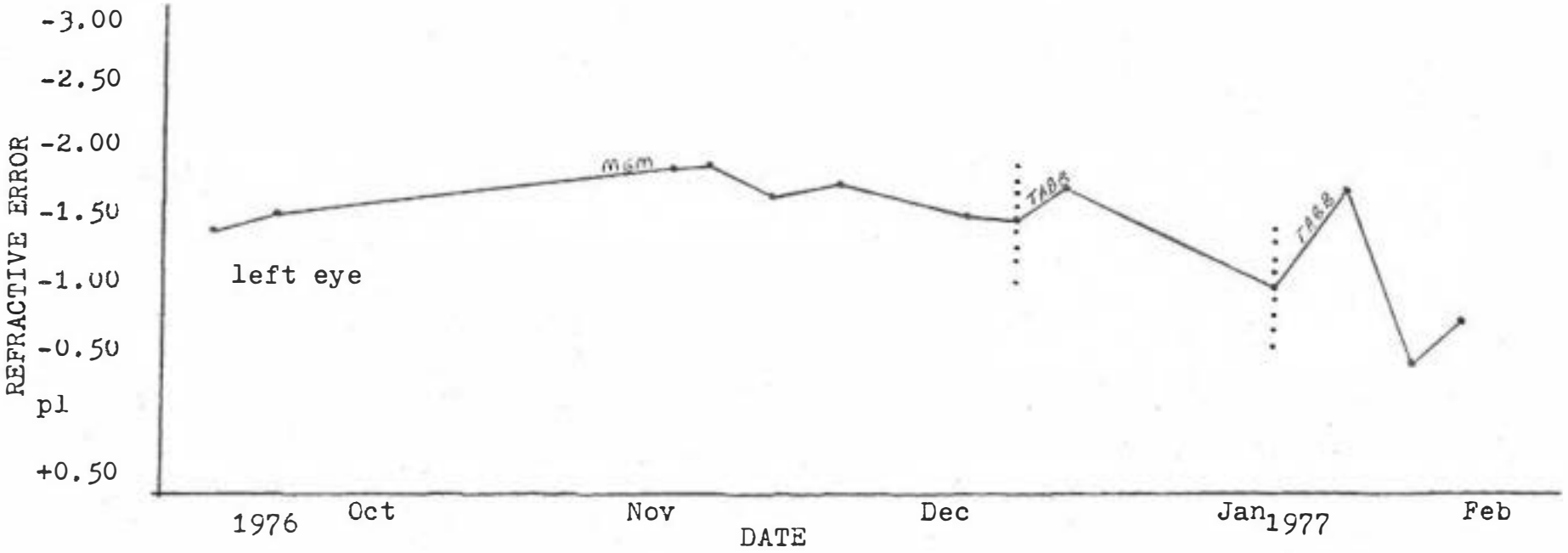

subject: D.M.
KERATOMETER READINGS
horizontal meridian
vertical meridian
KERATOMETER READINGS
45.00
44.50
44.00
43.50
43.00
42.50
42.00
41.50
TABB
MGM
TABB
right eye
1976
Oct
Nov
Dec
Jan
1977
Feb
DATE
KERATOMETER READINGS
45.00
44.50
44.00
43.50
43.00
42.50
42.00
41.50
MGM
TABB
left eye
1976
Oct
Nov
Dec
Jan
1977
Feb
DATE

patient: D.M.

UNAIDED SUBJECTIVE REFRACTION

spherical equivalent





P.E.K. READOUT

Patient: D.M. Date: 10/28/76

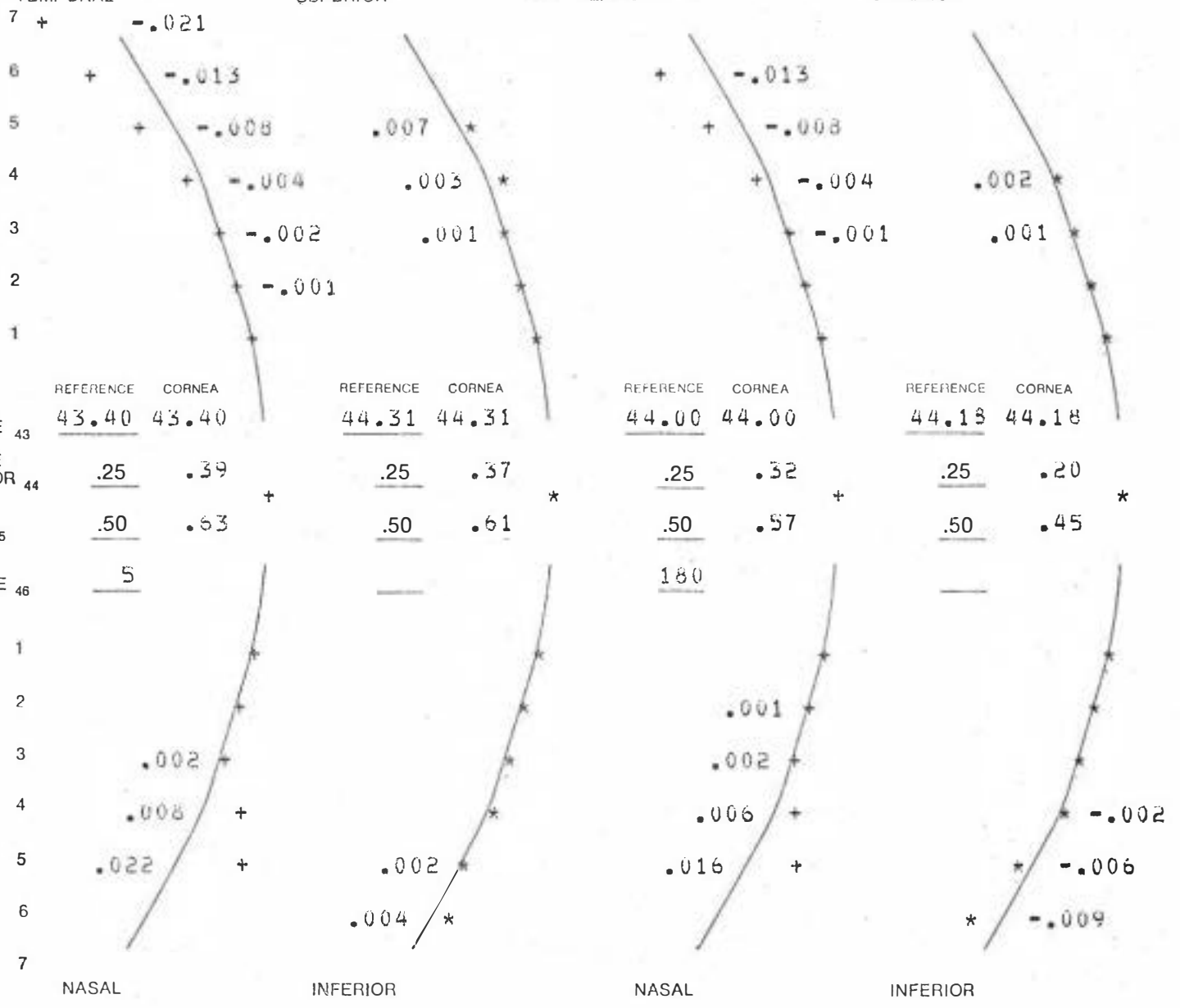
NOTES IRREGULAR CORNEA - READINGS DIFFICULT

Unaided V.A.: OD 20/50, OS 20/50

41

APEX 42 OD 1. mm at 190 OS 1. mm at 330

OM (1)



P.E.K. READOUT

Patient: D.M. Date: 12/9/76

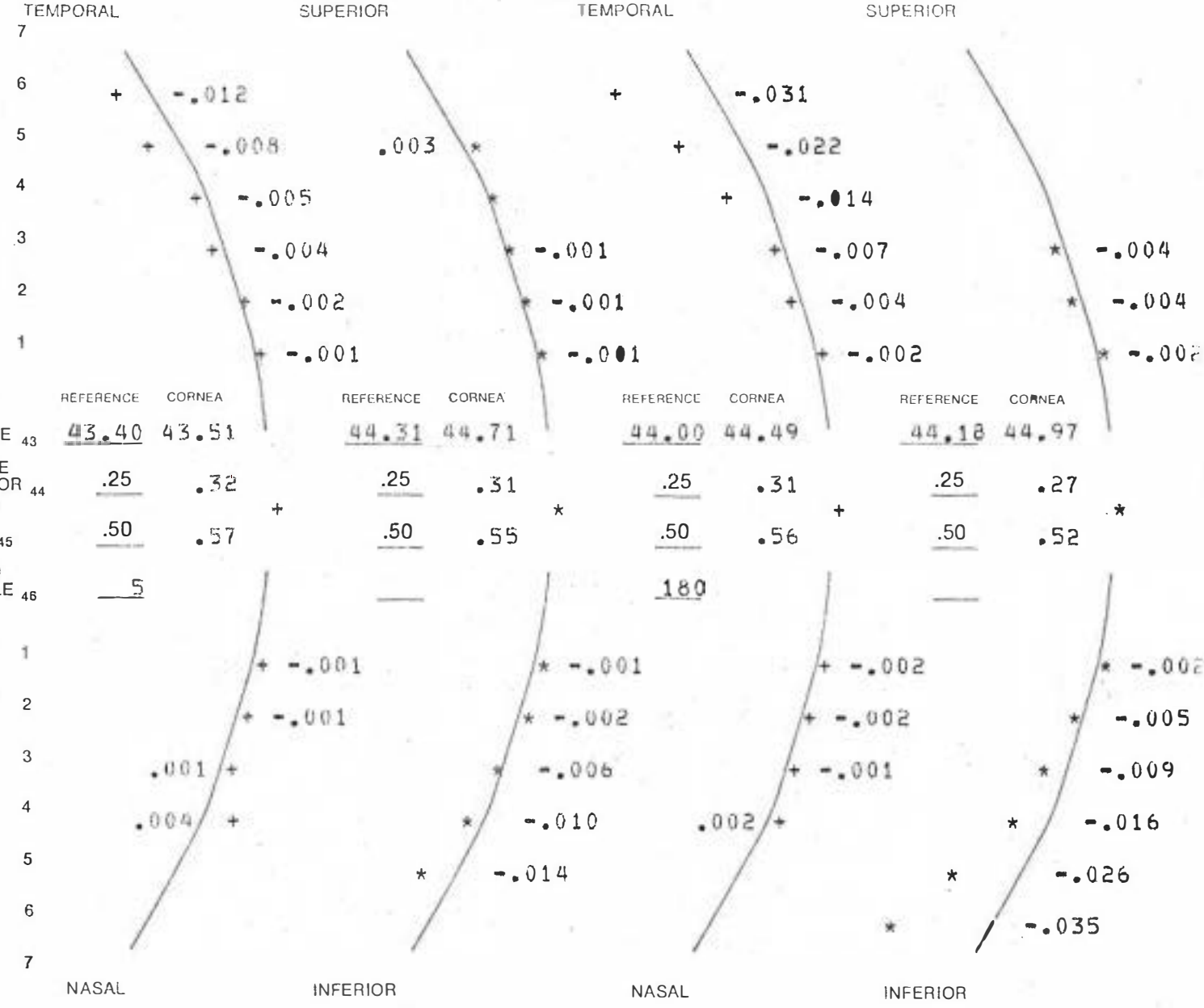
NOTES

Unaided V.A.: OD 20/30, OS 20/30

41

APEX 42 OD 1. mm at 225 OS 2. mm at 320

Dm (2)



	REFERENCE	CORNEA	REFERENCE	CORNEA	REFERENCE	CORNEA	REFERENCE	CORNEA
CENT CURVE 43	43.40	43.51	44.31	44.71	44.00	44.49	44.18	44.97
SHAPE FACTOR 44	.25	.32	.25	.31	.25	.31	.25	.27
ECC 45	.50	.57	.50	.55	.50	.56	.50	.52
READ ANGLE 46	5				180			

P.E.K. READOUT

Patient: D.M. Date: 1/25/77

NOTES

IRREGULAR CORNEA - READINGS DIFFICULT
SHAPE FACTOR OVER .65 HAS KERATOCONUS BEEN CONSIDERED

5 Unaided V.A.: OD 20/20, OS 20/20

41

APEX 42 OD 1. mm at 220 OS 1. mm at 300

DM (3)

	OD TEMPORAL	OD SUPERIOR	OS TEMPORAL	OS SUPERIOR
7				
6	+ -.005		+ -.004	
5	+ -.004		+ -.001	
4	+ -.002	.013 *	.001 +	.006 *
3	+ -.002	.006 *	.001 +	.002 *
2	+ -.001	.003 *	.001 +	.001 *
1	+ -.001	.002 *	.001 +	.001 *
REFERENCE	43.40	44.31	44.00	44.18
CORNEA	43.78	44.24	45.90	44.09
CENT CURVE 43	43.40	44.31	44.00	44.18
SHAPE FACTOR 44	.25	.25	.25	.25
	.81	.48	.35	.20
	+ .90	* .69	+ .59	* .45
READ ANGLE 46	5	—	180	—
1	+ -.001	.002 *	.001 +	.001 *
2	+	.002 *	.001 +	.001 *
3	.002 +	*	.002 +	* -.001
4	.011 +	* -.001	.005 +	* -.003
5	.038 +	* -.002	.016 +	* -.007
6	.080 /	.001 *	/	* -.013
7				
	NASAL	INFERIOR	NASAL	INFERIOR

—

Patient Summary

K.R., a 17 year old female was a first time contact lens patient. She was fit with right eye MGM method and left eye Tabb method. Her original findings are as follows: unaided VA 20/50 OD and 20/40 OS, unaided subjective refraction OD and OS -1.00 sphere, keratometer readings OD 43.87/44.75@90 and OS 44.12/44.62@90. After an initial decrease in acuity she improved to 20/25 OD and OS in approximately 2 weeks. After another 3 weeks we gave her new lenses with approximately 0.75 D less (-). After 3 weeks her unaided acuity decreased to 20/40 OD and 20/60 OS. At this point we gave back her original lenses. Within a week she came back to 20/20 OD and 20/15 OS where she now stands. Her unaided subjective refraction is OD -0.25 and OS +0.25, keratometer readings are OD 43.87/43.75@90 and OS 44.00/43.50@90.

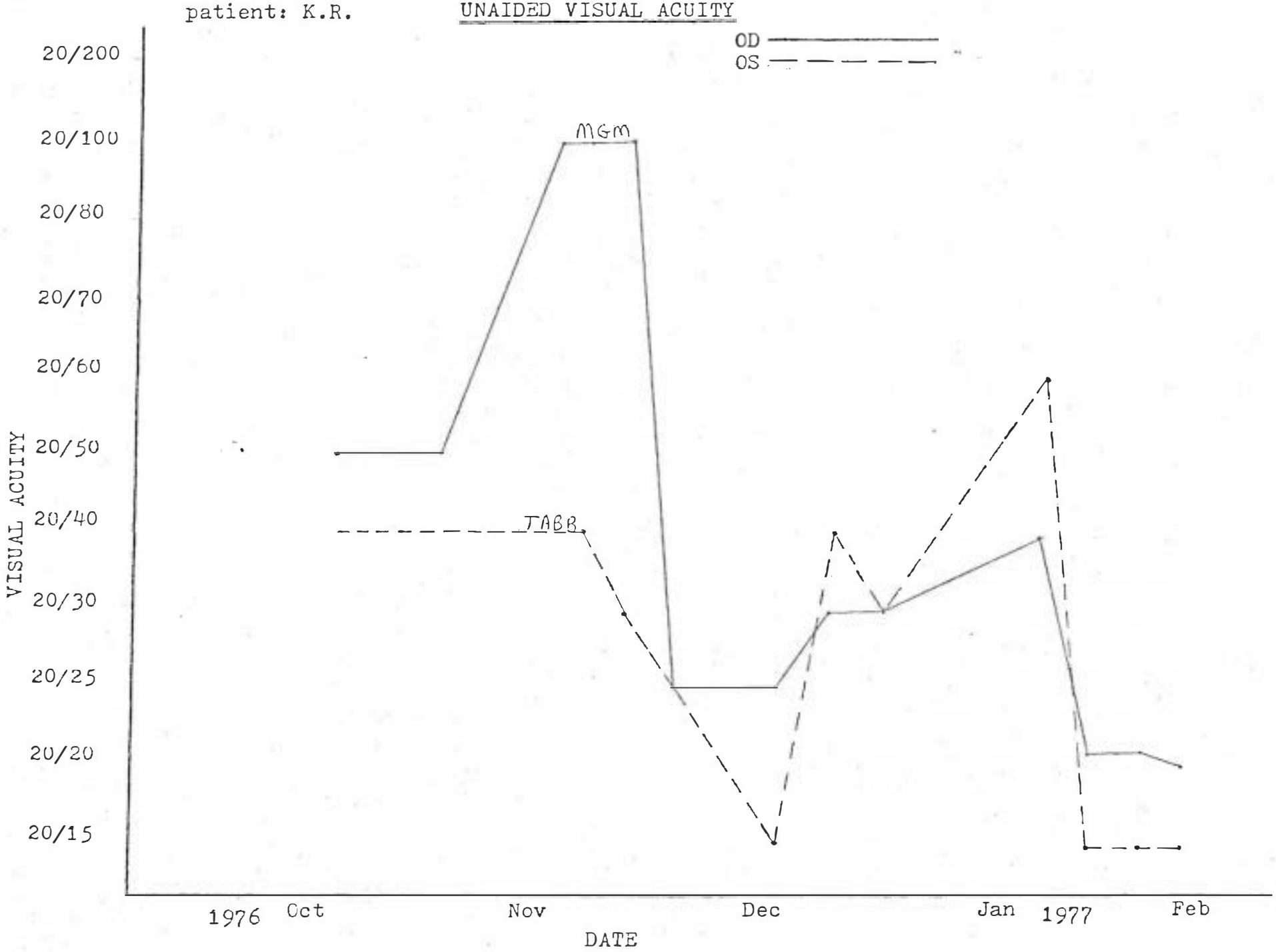
K.R. Female Age 17 Student

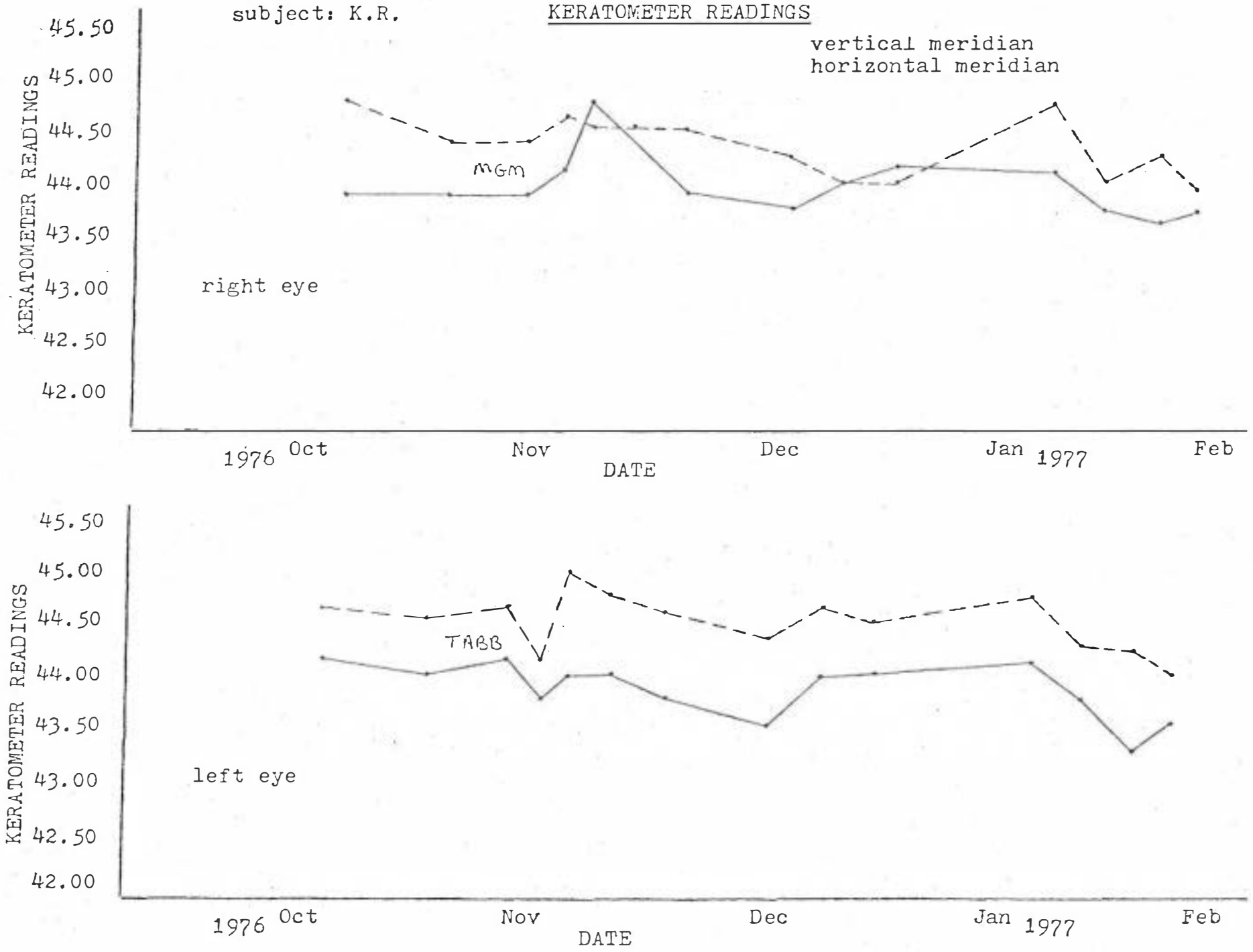
	Date	Corneal Ultra-Sound	Wearing Time	Method	Base Curve	Power	IOP	Edema	Centering and Movement	Staining
R	10/4/76	-	0	-	-	-	-	-	-	-
L		-		-	-	-	-	-	-	-
R	10/18/76	-	0	-	-	-	18	-	-	-
L		-		-	-	-	16	-	-	-
R	10/28/76	0.583	0	-	-	-	-	-	-	-
L		0.584		-	-	-	-	-	-	-
R	11/11/76	-	14	MGM	43.62	-1.00	22	1	C3-4 0.5 slow	C#1
L		-		Tabb	43.75	-1.25	19	1	C3-4 0.5 slow	C#1
R	11/18/76	-	14	"	"	"	22	2	C3-4 1.0mm fast	JP#1
L		-					19	1	C2-3T 0.5mm slow	JP#1
R	12/2/76	-	14	MGM	43.62	-0.50	19	0	C2-5 1.0mm slow	C#1 JP#1
L		-		Tabb	44.00	-0.75	18	1	C1.5-4 2.0mm slow	C#1 JP#1
R	12/9/76	0.618	14	"	"	"	18	1	C3-5 1.5mm slow	none
L		0.579					17	1	C3-5 1.5mm slow	none
R	12/16/76	-	14	"	"	"	19	1	C2-5 1.5mm slow	JP#1
L		-					19	1	C2-4 1.5mm slow	JP#1
R	1/7/77	-	14	MGM	43.62	-1.00	20	1	C3-4 1.0mm slow	none
L		-		Tabb	43.75	-1.25	20	1	C3-4 1.0mm slow	none
R	1/13/77	-	14	"	"	"	-	1	C3-4 1mm slow	JP#1
L		-					-	1	C3-4.5 1.5mm slow	JP#1
R	1/20/77	-	14	"	"	"	18	0	C2-4N 1.5mm slow	JP#1
L		-					18	0	C2-3T 1.0mm slow	JP#1
R	1/25/77	0.586	14	"	"	"	19	-	C3-4 1.0mm slow	none
L		0.580					17	-	C3-4 1.0mm slow	none

K.R. Female Age 17 Student

	Date	Unaided VA	Subjective Over-Refraction	Keratometer Readings	Central PEK and Shape Factor	Subjective Refractive Error	Corneal Pachometry
R	10/4/76	20/50	-	43.87 44.75@84	-	-1.00-0.25 x125	-
L		20/40	-	44.12 44.62@90	-	-1.25	-
R	10/18/76	20/50	-	43.87 44.37@90	-	-1.00	-
L		20/40	-	44.00 44.50@90	-	-1.00	-
R	10/28/76	20/50	-	43.87 44.37@90	44.14 .21 44.84@90.25	-	0.54
L		20/40	-	44.12 44.62@89	44.27 .12 44.97@90.27	-	0.54
R	11/11/76	20/100	+0.50-0.37 x83	44.50 44.50@90	-	-1.00-0.50 x90	0.58
L		20/30	+0.50	44.00 44.75@90	-	-0.50	0.58
R	11/18/76	20/25	+0.50-0.50 x85	43.87 44.50@90	-	-0.25-0.75 x85	0.52
L		20/25	+0.25	43.75 44.62@90	-	-0.50-0.50 x20	0.56
R	12/2/76	20/25	+0.50-0.50 x90	43.75 44.25@90	-	-0.75-0.25 x90	0.52
L		20/15	+0.25	43.50 44.37@90	-	pl-0.50 x10	0.54
R	12/9/76	20/30	-0.50-0.50 x85	44.00 44.00@90	43.82 -.08 44.42@90-.06	pl-1.00 x80	0.54
L		20/40	-0.25	44.00 44.62@90	43.69 .06 44.72@90.07	-0.25-0.25 x125	0.54
R	12/16/76	20/30	+0.25-0.25 x120	44.12 44.00@90	-	-1.25	0.54
L		20/30	pl-0.25 x90	44.00 44.50@90	-	-0.75	0.54
R	1/7/77	20/40	+0.75-0.50 x90	44.12 44.75@90	-	-1.00-0.50 x75	0.54
L		20/60	pl-0.25 x90	44.12 44.75@90	-	-0.75-0.75 x165	0.54
R	1/13/77	20/20	+0.75-0.50 x90	43.75 44.00@90	-	-0.25-0.50 x90	0.54
L		20/15	+0.75-0.25 x90	43.75 44.25@90	-	pl	0.55
R	1/20/77	20/20	+0.50-0.25 x75	43.62 44.25@90	-	-0.25-0.50 x90	-
L		20/15	+0.50-0.25 x80	43.25 44.25@90	-	pl	-
R	1/25/77	20/20	+0.75-0.75 x90	43.75 43.87@90	44.14 .25 44.84@90.21	pl-0.50 x90	0.54
L		20/15	+0.75	43.50 44.50@90	44.27 .27 44.97 .12	+0.25	0.56

patient: K.R.

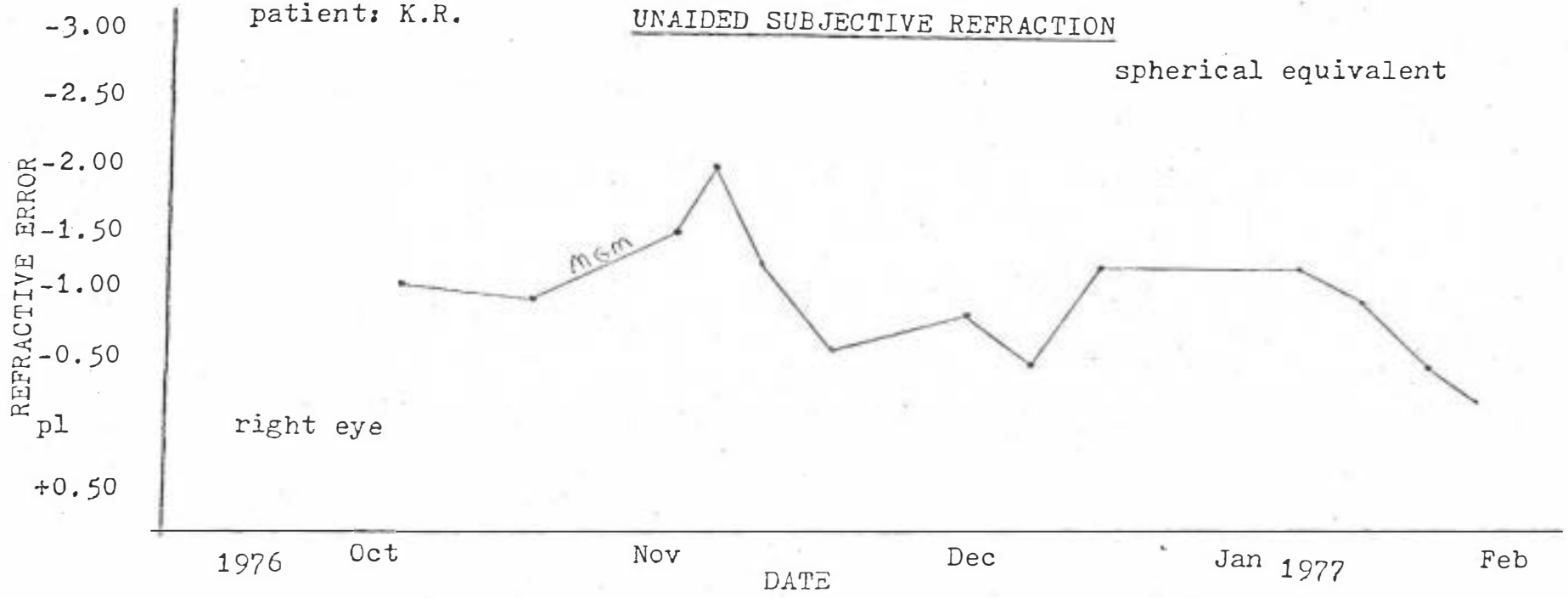

UNAIDED VISUAL ACUITY
OD
OS
MGM
TABB
20/200
20/100
20/80
20/70
20/60
20/50
20/40
20/30
20/25
20/20
20/15
VISUAL ACUITY
1976
Oct
Nov
Dec
Jan
1977
Feb
DATE

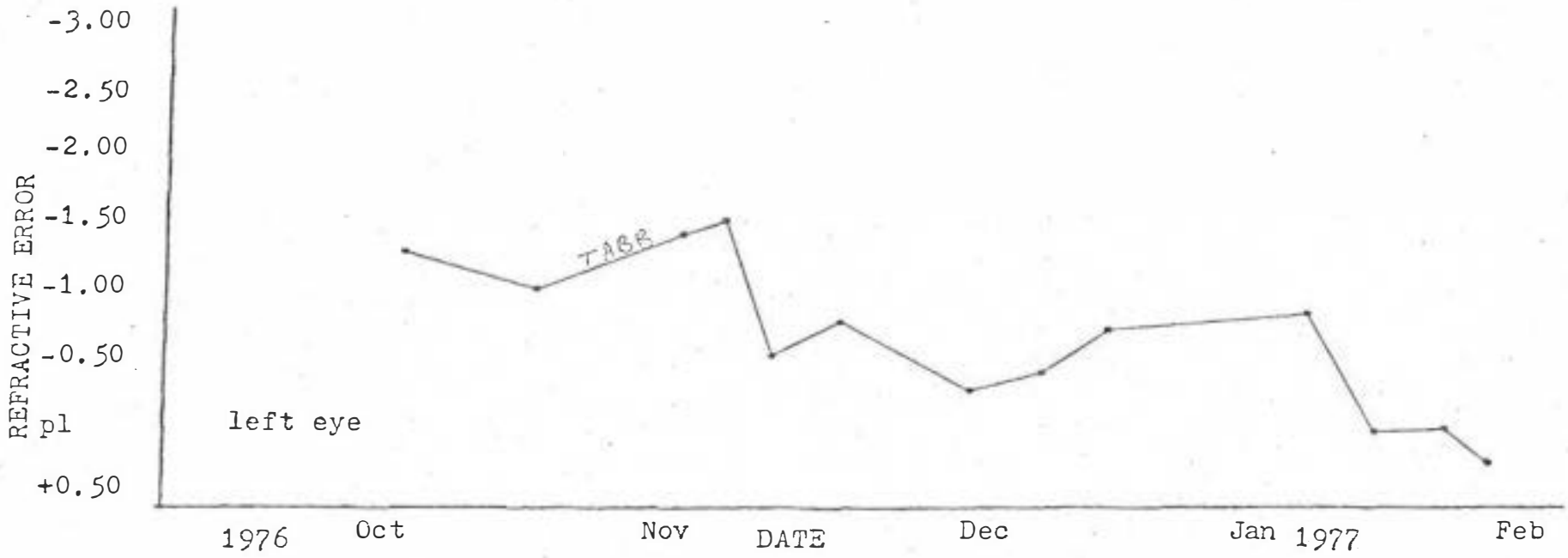

subject: K.R.
KERATOMETER READINGS
vertical meridian
horizontal meridian
MGM
right eye
KERATOMETER READINGS
45.50
45.00
44.50
44.00
43.50
43.00
42.50
42.00
1976 Oct
Nov
Dec
Jan 1977
Feb
DATE
TABB
left eye
KERATOMETER READINGS
45.50
45.00
44.50
44.00
43.50
43.00
42.50
42.00
1976 Oct
Nov
Dec
Jan 1977
Feb
DATE

patient: K.R.

UNAIDED SUBJECTIVE REFRACTION

spherical equivalent





P.E.K. READOUT

Patient: K.R. Date: 10/28/76

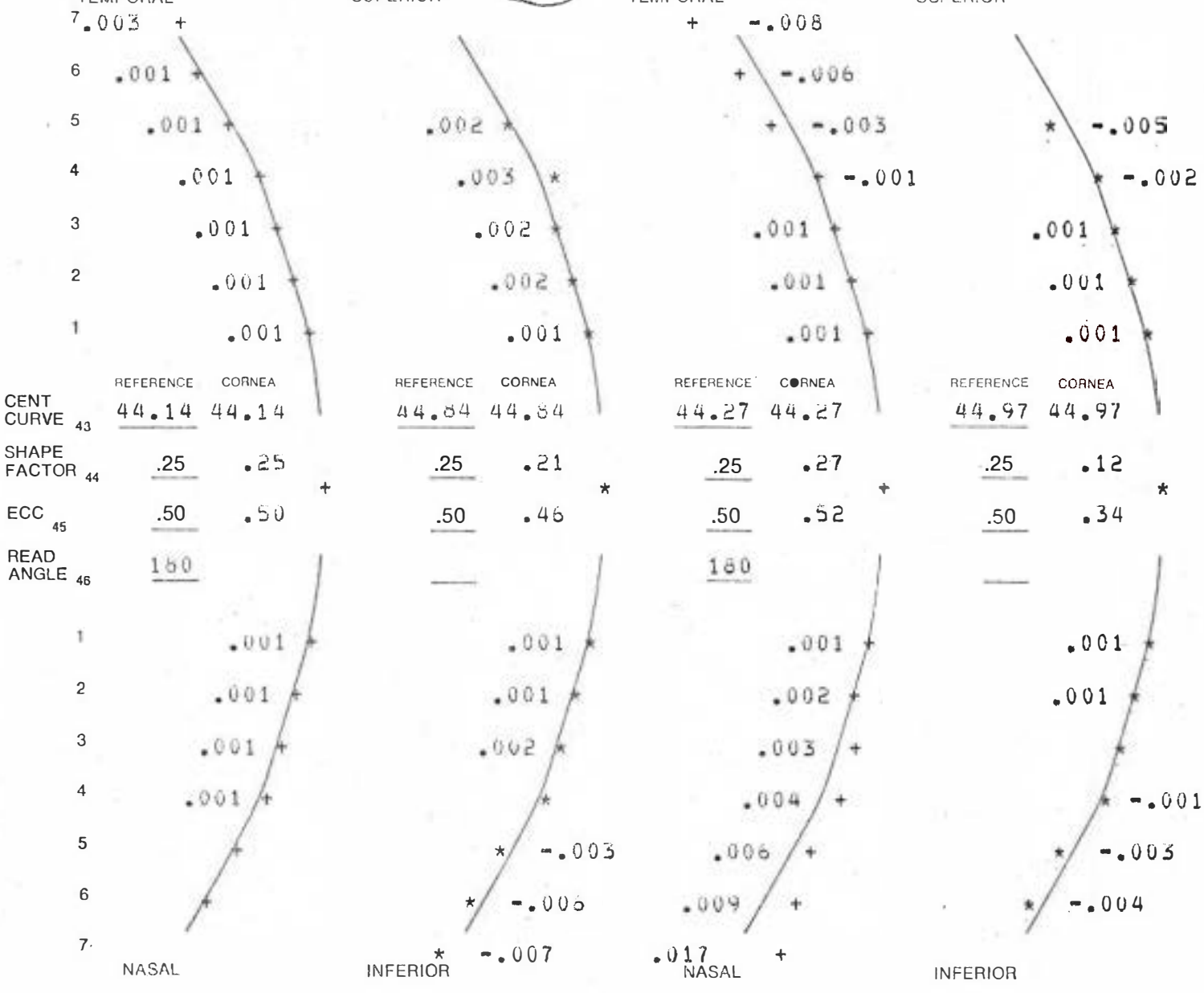
NOTES

Unaided V.A.: OD 20/50, OS 20/40

41

APEX 42 OD 0. mm at 295 OS 1. mm at 45

KR 1



P.E.K. READOUT

Patient: K.R. Date: 12/9/76

NOTES

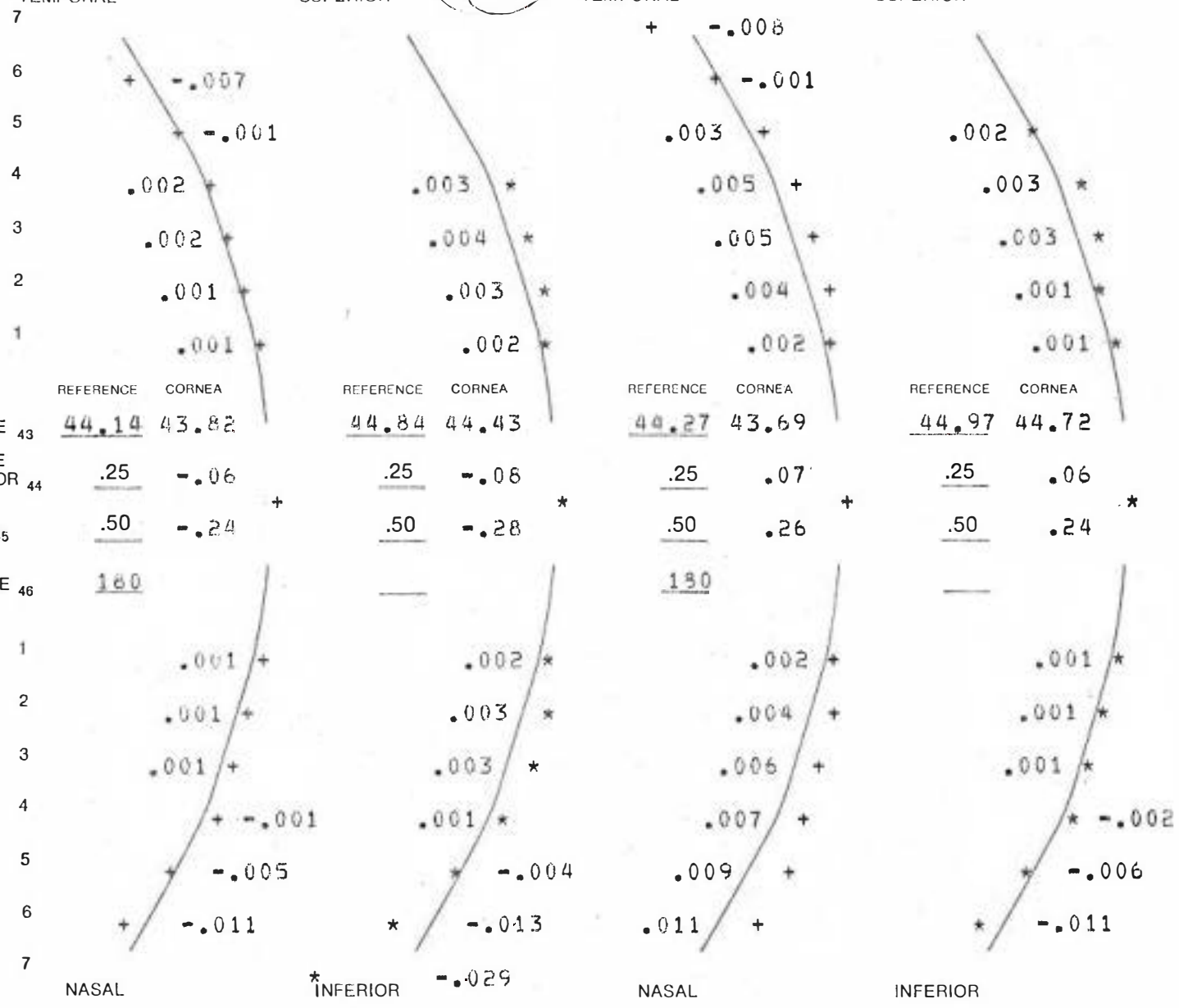
SHAPE FACTOR LOW ODH ODV CENTERING MAY BE DIFFICULT

Unaided V.A.: OD 20/30, OS 20/40

41

APEX 42 OD 0. mm at 0 OS 2. mm at 310

KR (2)



P.E.K. READOUT

Patient: K.R. Date: 1/25/77

NOTES

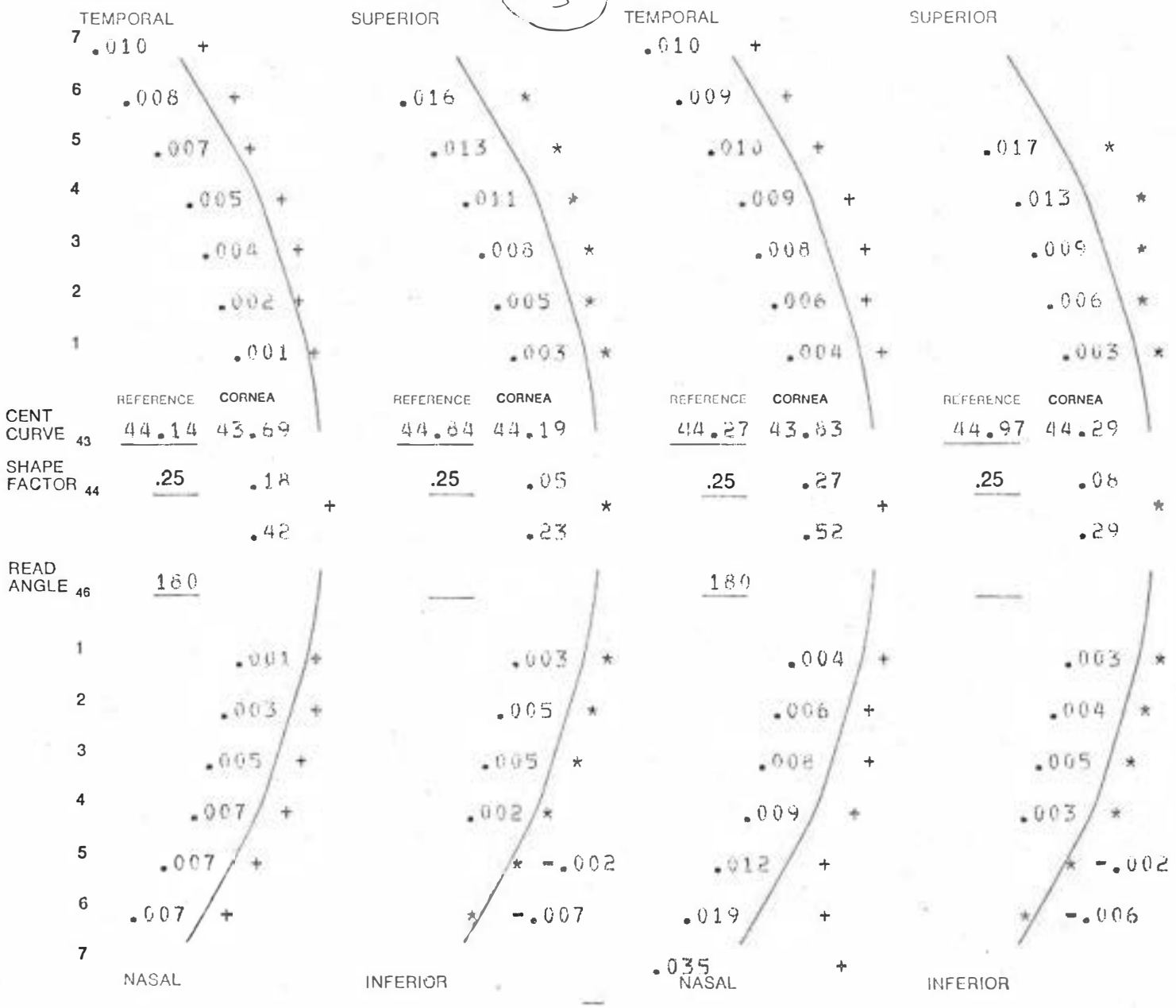
IRREGULAR CORNEA - READINGS DIFFICULT

Unaided V.A.: OD 20/20, OS 20/15

41

APEX 42 OD 6. mm at 270 OS 3. mm at 260

KR 3



Discussion and Observations

Moiré fringe.

Unfortunately much of the moiré fringe photographs were unusable due to a variety of technical difficulties so that data was lost. We still feel changes in the central cornea area should be investigated.

MGM versus modified Tabb method.

The following pages are tables and graphs showing a comparison of the MGM and modified Tabb fitting methods.

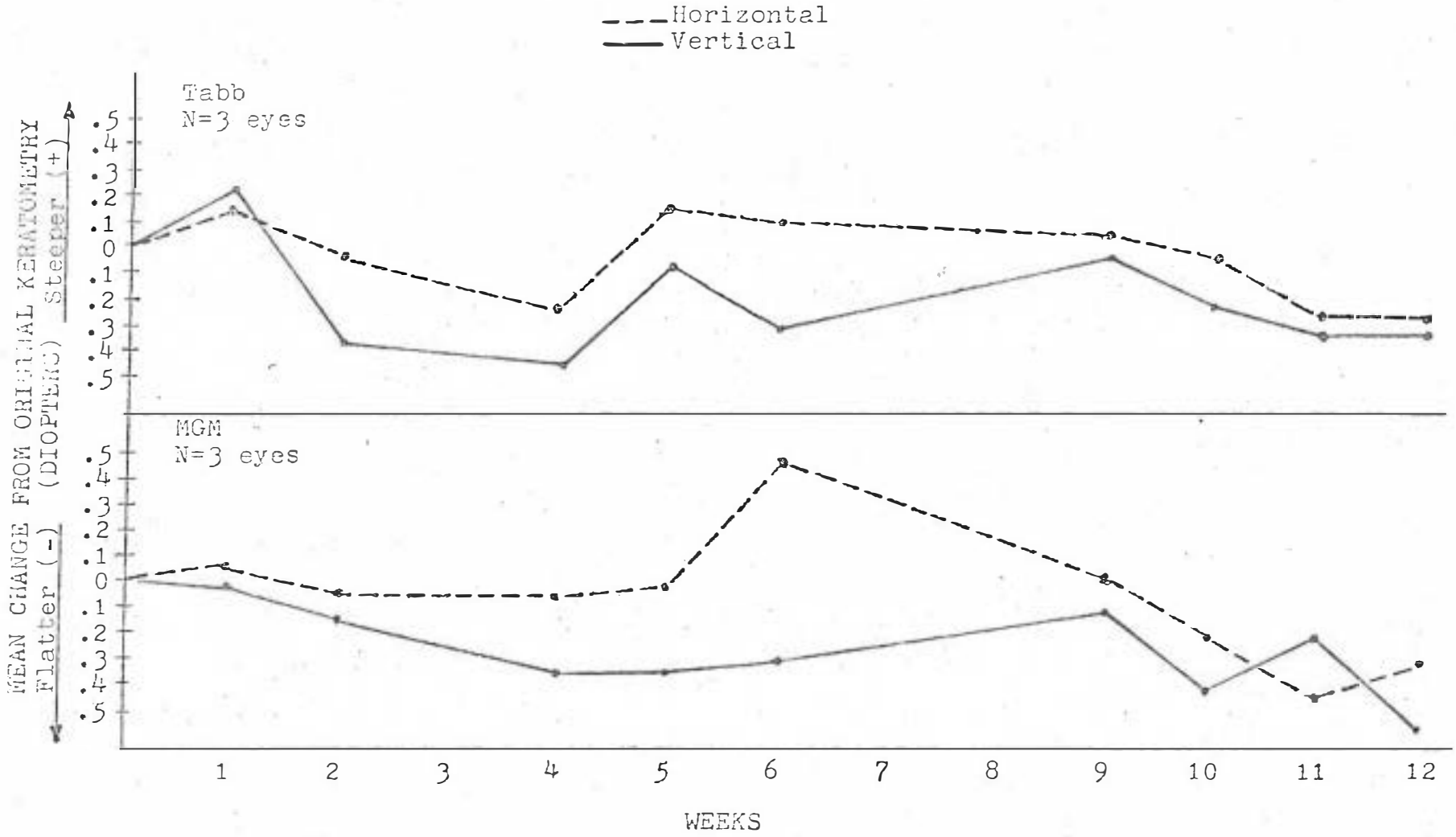
Initially we observed greater edema with the MGM lens but minor modifications corrected this. Generally the MGM lens centered better (as would be expected with a larger lens) than the modified Tabb lens on those individuals which showed a tendency for the lenses to move temporal.

Both methods we used appear to be equally effective in producing acuity changes. This may be because they are so similiar in base curve with the major difference being size. We also became so accustomed to and preferred the water series for blending the peripheral curves that we used it on the MGM lens thus inadvertantly negating any differences in peripheral curve blends.

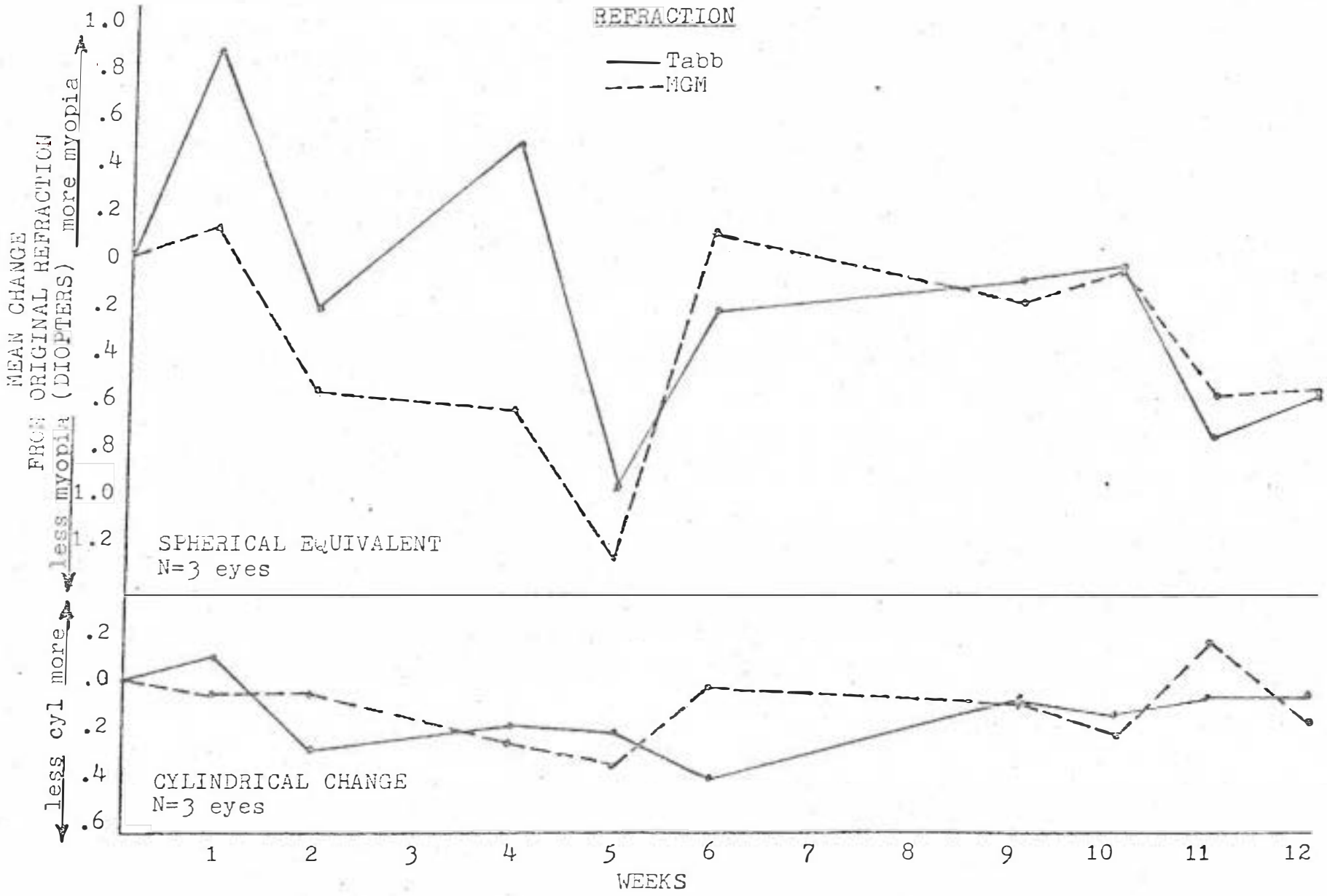
One advantage of the Tabb method is that fewer lens changes are needed as modifications can be done to the existing lens to achieve the desired effect. This gives the practioner skilled in modifications better control over the lens parameters. Also, a large inventory of lenses is not needed as is required with the MGM fitting technique.

SUBJECTS WITH THE SAME FITTING METHOD
FOR THE DURATION OF THIS STUDY

KERATOMETRY



SUBJECTS WITH THE SAME FITTING METHOD
FOR THE DURATION OF THIS STUDY



SUBJECTS WITH THE SAME FITTING METHOD
FOR THE DURATION OF THIS STUDY
(N=3 EYES)

DATE	MEAN SUBJ. REFRACTION (SPH. EQUIV)	CHANGE FROM ORIGINAL R.E.	MEAN AMOUNT OF CYLINDER	CHANGE FROM ORIGINAL CYL.	UNAIDED V.A. (20/X)
TABB 9/30/76	-1.42		.67		66.7
MGM	-1.67		.42		103.3
TABB 11/11/76	-2.25	-.83	.75	+.08	51.7
MGM	-1.79	-.12	.34	-.08	76.7
TABB 11/18/76	-1.17	+.25	.36	-.31	48.3
MGM	-1.08	+.59	.33	-.09	48.3
TABB 12/2/76	-1.87	-.45	.46	-.21	43.3
MGM	-1.04	+.63	.12	-.30	46.7
TABB 12/9/76	-.44	+.98	.44	-.23	51.7
MGM	-.37	+1.30	.06	-.36	48.3
TABB 12/16/76	-1.17	+.25	.25	-.42	50
MGM	-1.75	-.08	.37	-.05	51.6
TABB 1/5/77	-1.29	+.13	.55	-.12	56.7
MGM	-1.46	+.21	.29	-.13	56.7
TABB 1/13/77	-.58	+.84	.50	-.17	36.7
MGM	-.71	+.96	.17	-.25	30
TABB 1/20/77	-.62	+.80	.58	-.09	38.3
MGM	-1.08	+.59	.55	+.13	33.3
TABB 1/25/77	-.75	+.67	.59	-.08	28.3
MGM	-1.04	+.63	.21	-.21	40

MEAN CHANGE

TABB	+0.293	-0.172
MGM	+0.523	-0.149

SUBJECTS WITH THE SAME FITTING METHOD
FOR THE DURATION OF THIS STUDY
(N=3 EYES)

DATE		MEAN HORIZONTAL K-READINGS	CHANGE FROM ORIGINAL K's	MEAN VERTICAL K-READINGS	CHANGE FROM ORIGINAL K's	MEAN HORIZONTAL PEK	CHANGE FROM ORIGINAL K's
9/30/76	TABB	44.37		45.04			
	MGM	44.58		45.00			
11/11/76	TABB	44.50	+.13	45.25	+.21	44.74	
	MGM	44.62	+.04	44.96	-.04	44.95	
11/18/76	TABB	44.30	-.07	44.66	-.38		
	MGM	44.50	-.08	44.83	-.17		
12/2/76	TABB	44.12	-.25	44.58	-.46		
	MGM	44.50	-.08	44.62	-.38		
12/9/76	TABB	44.50	+.13	44.94	-.10	44.38	-.36
	MGM	44.56	-.02	44.62	-.38	44.59	-.36
12/16/76	TABB	44.46	+.09	44.71	-.33		
	MGM	45.04	+.46	44.67	-.33		
1/5/77	TABB	44.41	+.04	44.96	-.08		
	MGM	44.58	0.0	44.87	-.13		
1/13/77	TABB	44.29	-.08	44.79	-.25		
	MGM	44.37	-.21	44.54	-.46		
1/20/77	TABB	44.08	-.29	44.66	-.38		
	MGM	44.16	-.42	44.71	-.29		
1/25/77	TABB	44.08	-.29	44.67	-.37	44.57	-.17
	MGM	44.24	-.34	44.45	-.55	44.67	-.28

MEAN CHANGE

TABB	-0.066	-0.238
MGM	-0.072	-0.303

SUBJECTS WITH THE SAME FITTING METHOD
FOR THE DURATION OF THIS STUDY
(N=3 EYES)

DATE	MEAN VERTICAL PEK	CHANGE FROM ORIGINAL K's	MEAN CORNEAL THICKNESS (PACHOMETRY)	MEAN CORNEAL THICKNESS (ULTRASOUND)
TABB 9/30/76			.530	.570
MGM			.530	.565
TABB 11/11/76	45.53		.567	
MGM	45.49		.553	
TABB 11/18/76			.547	
MGM			.533	
TABB 12/2/76			.573	
MGM			.533	
TABB 12/9/76	45.16	-0.38	.550	.594
MGM	44.70	-0.81	.550	.602
TABB 12/16/76			.527	
MGM			.540	
TABB 1/5/77			.533	
MGM			.533	
TABB 1/13/77			.535	
MGM			.530	
TABB 1/20/77			.540	
MGM			.540	
TABB 1/25/77	45.35	-0.18	.527	
MGM	45.04	-0.45	.553	
TABB 3/9/77				.584
MGM				.580

The Mean Findings of Subjects with the Same Fitting Method for the Duration of this Study

	Average Horizontal K-Readings		Average Vertical K-Readings		Average Amount of Cylinder		Average Refractive Error (Sphere Equivalent)		Average Central Corneal Curvature (PEK)		Average Corneal Thickness (Pachometry)		Average Corneal Thickness (Ultrasound)	
DATE	MGM	TABB	MGM	TABB	MGM	TABB	MGM	TABB	MGM	TABB	MGM	TABB	MGM	TABB
9/30/76	44.58	44.37	45.00	45.04	.42	.67	-1.67	-1.42	44.95 45.49@90	49.74 45.53@90	.530	.530	.565	.570
	After one week of contact lens wear:													
11/11/76	44.62	44.50	44.96	45.25	.34	.75	-1.79	-2.25	-	-	.553	.567	-	-
11/18/76	44.50	44.30	44.83	44.66	.33	.36	-1.08	-1.17	-	-	.533	.547	-	-
12/2/76	44.50	44.12	44.62	44.58	.12	.46	-1.04	-1.87	-	-	.533	.573	-	-
12/9/76	44.56	44.50	44.62	44.94	.06	.44	- .37	- .44	44.67 45.17@90	44.38 45.16@90	.550	.550	.602	.594
12/16/76	45.04	44.46	44.67	44.71	.37	.25	-1.75	-1.17	-	-	.540	.527	-	-
1/5/77	44.58	44.41	44.87	44.96	.29	.55	-1.46	-1.29	-	-	.533	.533	-	-
1/13/77	44.37	44.29	44.54	44.79	.17	.50	- .71	- .58	-	-	.530	.535	-	-
1/20/77	44.16	44.08	44.71	44.66	.55	.58	-1.08	- .62	-	-	.540	.540	-	-
1/25/77	44.24	44.08	44.45	44.67	.21	.59	-1.04	- .75	-	-	.553	.527	-	-
3/9/77	-	-	-	-	-	-	-	-	44.67 45.04@90	44.52 45.35@90	-	-	.584	.580

The Ocular Changes Occuring in A.A. Who
Switched Fitting Methods Midway into the Project

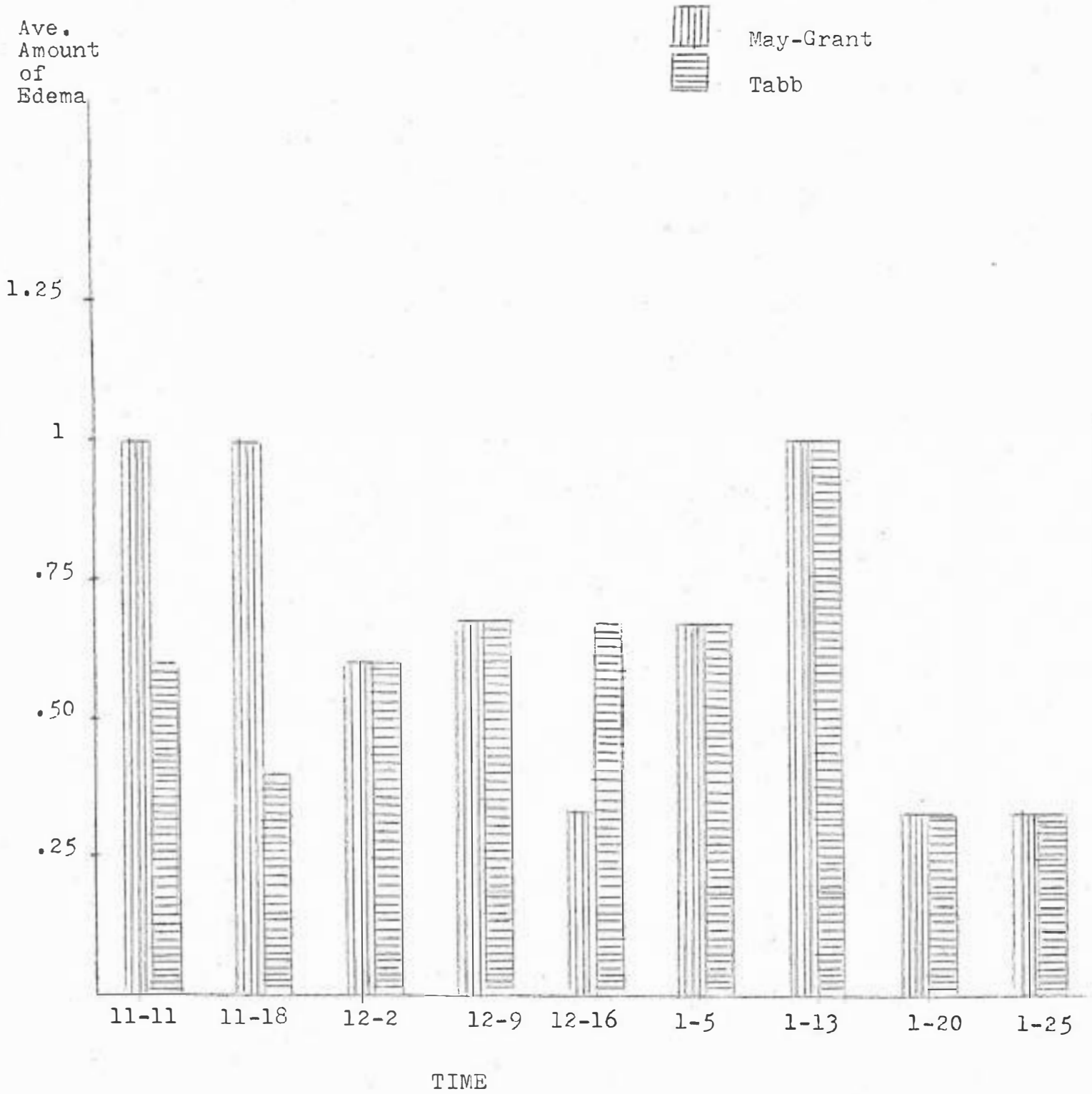
	Horizontal K-Readings		Vertical K-Readings		Amount of Corneal Cylinder		Refractive Error (Sphere Equivalent)		Central Corneal Curvature (PEK)		Corneal Thickness (Pachometry)		Corneal Thickness (Ultrasound)	
DATE	MGM	TABB	MGM	TABB	MGM	TABB	MGM	TABB	MGM	TABB	MGM	TABB	MGM	TABB
9/30/76	45.18	44.62	44.62	44.25	.56	.37	-2.62	-3.00	45.44 / 44.86@90	44.84 / 44.55@60	.54	.55	.647	.639
11/11/76	45.50	44.87	45.00	44.75	.50	.12	-3.12	-3.12	-	-	.54	.54	-	-
11/23/76	45.12	44.37	44.87	44.50	.25	.12	-2.62	-2.75	-	-	.55	.58	-	-
12/2/76	44.75	44.00	44.12	44.25	.37	.25	-1.87	-2.12	-	-	.58	.58	-	-
12/9/76	44.50	44.50	44.00	44.12	.50	.37	-2.12	-2.37	44.98 / 44.52@90	44.25 / 44.32@90	.58	.58	.681	.682
Switch	TABB	MGM	TABB	MGM	TABB	MGM	TABB	MGM	TABB	MGM	TABB	MGM	TABB	MGM
12/16/76	44.50	44.12	44.37	44.37	.12	.25	-1.37	-2.25	-	-	.56	.58	-	-
1/5/77	44.37	43.75	43.87	44.00	.50	.25	-1.12	-2.00	-	-	.56	.58	-	-
1/13/77	44.25	44.00	43.75	44.00	.50	0	-1.37	-1.87	-	-	-	-	-	-
1/20/77	44.62	43.87	44.37	44.00	.25	.12	-1.87	-2.12	-	-	-	-	-	-
Switch	MGM	MGM	MGM	MGM	MGM	MGM	MGM	MGM	MGM	MGM	MGM	MGM	MGM	MGM
1/25/77	44.50	43.75	44.37	44.00	.12	.25	-2.00	-2.25	-	-	.60	.60	-	-
3/9/77	-	-	-	-	-	-	-	-	44.77 / 44.59@90	43.97 / 44.17@90	-	-	.663	.655

The Ocular Changes Occuring in D.M. Who
Switched Fitting Methods Midway into the Project

	Horizontal K-Readings		Vertical K-Readings		Amount of Corneal Cylinder		Refractive Error (Sphere Equivalent)		Central Corneal Curvature (PEK)		Corneal Thickness (Pachometry)		Corneal Thickness (Ultrasound)	
DATE	MGM	TABB	MGM	TABB	MGM	TABB	MGM	TABB	MGM	TABB	MGM	TABB	MGM	TABB
9/30/76	43.75	43.50	44.50	44.50	.75	1.00	-1.37	-1.37	44.00 / 44.18@95	44.90 / 44.31@95	.46	.47	.550	.559
11/11/76	44.25	43.87	44.62	44.25	.37	.37	-1.62	-1.37	-	-	.62	.62	-	-
11/18/76	44.00	43.25	44.50	44.00	.50	.75	-1.75	-1.25	-	-	.58	.53	-	-
12/2/76	44.25	43.62	44.87	44.00	.62	.37	-1.50	-1.37	-	-	.52	.52	-	-
Switch	TABB	MGM	TABB	MGM	TABB	MGM	TABB	MGM	TABB	MGM	TABB	MGM	TABB	MGM
12/9/76	44.25	43.75	44.50	44.00	.25	.25	-1.50	-1.25	44.49 / 44.97@90	43.51 / 44.71@95	.52	.52	.570	.574
12/14/76	43.75	44.00	44.37	44.62	.62	.62	-1.75	-1.75	-	-	.55	.55	-	-
Switch	TABB	TABB	TABB	TABB	TABB	TABB	TABB	TABB	TABB	TABB	TABB	TABB	TABB	TABB
1/5/77	43.50	43.75	44.12	43.87	.62	.12	-1.00	- .50	-	-	.52	.54	-	-
1/13/77	44.00	43.62	44.25	44.00	.25	.37	-1.75	-1.50	-	-	.52	.52	-	-
1/20/77	43.75	43.50	44.00	44.00	.25	.50	- .37	- .50	-	-	.52	.52	-	-
1/25/77	43.75	44.00	44.12	44.50	.37	.50	- .75	- .37	-	-	.52	.52	-	-
3/9/77	-	-	-	-	-	-	-	-	43.90 / 44.09@90	43.78 / 44.24@90	-	-	.565	.593

COMPARING THE AVERAGE AMOUNT OF EDEMA

IN THE TWO FITTING METHODS WITH TIME



Refraction.

Comparing the subjective and objective (retinoscopy) refractions, the majority of the exams showed both to be equal ± .25 D. Of the cases in which the difference was greater than .25 D., there were approximately the same number of cases where the subjective refraction was more plus as the objective refraction being more plus. The resulting differences in the refractions were the same with contact lenses as without lenses. All three clinicians were involved with both refractions. Differences may be due to clinical error.

Hydration.

Lenses were verified with a lensometer and radiuscope in each visit for changes in base curve and power. There was no significant change in power. The base curves, however, flattened on the average of .06 mm, with a range from 0 to 2.0 mm. Modifications and polishing of the lenses were performed during this period which may have contributed to the large degree of flattening. One -.75 lens flattened from 7.67 to 7.87 in two days upon hydration without any modifications being done on it. Two lenses did not change. The others flattened maximally in an average of one and a half months.

Keratometry.

The ratio of K reading change to refractive error change is tabulated on the following page. Three of the ten eyes showed a 1:1 ratio. One eye had 0 flattening of the cornea (by keratometry) with a decrease in myopia. Two eyes had a steepening

	RATIO OF CHANGE IN K-READINGS TO CHANGE IN REFRACTIVE ERROR		RATIO OF CHANGE IN K-cyl TO CHANGE IN REFRACTIVE CYLINDER	
	MGM	TABB	MGM	TABB
DM	no change in K's	K's steepened	1:1.68	1.35:1
BM	1:25	"	no change in K-cyl	K-cyl decreased RE cyl increased
KR	1:6.3	1:2	K-cyl decreased RE cyl increased	no change in RE cyl
DB	2.5:1	1:1	"	K-cyl decreased KRE cyl increased
AA	1:1	1:1	1.76:1	1:4.17
mean of each method	1:1.6	1:2.4	K-cyl decreased RE cyl increased	K-cyl decreased RE cyl increased
mean of all eyes	1:1.93		The average K-cyl decreased by .23. The average RE cyl increased by .19.	

Note- values are taken from the start of the program and the end of the project (9/30/76 and 1/25/77).

indicated by keratometry yet a reduction of the refractive error. In one eye there was greater flattening of the cornea than refractive error 2.5:1. The average ratio of refractive error to keratometry was 1.93 to 1 or ≃ 2 to 1 which is similar to that reported in the literature.

As far as refractive cylinder changes as compared to corneal cylinder changes, findings show an unpatterned behavior. Most individual cases showed a decrease in the cornea cylinder with an increase in refractive cylinder. The average change of all eyes was:

1. Corneal cylinder decreased by .23 D.
2. Refractive cylinder increased by .19 D.

PEK.

In our study it was found that measurements of the corneal curvature did not agree for the keratometer and the PEK, with reading taken on the same day within several minutes of each other. On some subjects PEK readings were as much as 1.0 diopters steeper than keratometer findings and on other subjects was as much as 0.30 diopters flatter than the keratometer. However, for the majority of readings, the PEK findings were approximately 0.37 diopters steeper than those found by the keratometer. Even with this discrepancy, both instruments generally agreed on the overall amount of central flattening or steepening for an extended time period. For example, both the PEK and keratometer would agree on the same amount of flattening or steepening in two months even though the corneal measurements didn't agree.

Shape factor on the PEK printout defines the rate of peripheral flattening. A high shape factor (0.50) indicates a high rate of peripheral corneal flattening while a low shape factor (0.1) indicates almost no peripheral flattening, and a negative shape factor (-0.8) indicates peripheral steepening. The average population shape factor for the Wesley-Jessen Corneal Analysis printout is 0.25. Our study shows that at the start of Ortho-K the average horizontal/vertical shape factor was 0.247/0.188. After approximately 2 months the shape factors measured 0.121/0.061, and after 2 months more read 0.298/0.204. This indicates that on the average after 2 months of Ortho-K, the peripheral corneas actually steepened while the central part of the cornea was being flattened. Then after 2 more months the peripheral corneas flattened back toward their original curvature. However, the PEK printout also gives readouts on 6 more rings going out to the periphery. According to the readouts, the average peripheral corneal curvatures seemed to become progressively flatter 2 months after Ortho-K was started and also 4 months after the beginning. Therefore indicating as the central cornea was being flattened, the peripheral cornea was flattening also.

An interesting observation from the PEK was that four out of five subjects that remained in the study after 2 months of Ortho-K showed printouts stating irregular corneas, readings difficult. Most of these were due to low shape factors. The fifth subject showed a shape factor of 0.81 in the right horizontal meridian, thereby indicating possible keratoconus.

Corneal thickness as measured by Pachometry and Ultrasonography.

Comparing measurement error between the two instruments, the standard deviation for pachometry with the Mentor slit lamp was .0053 mm; for ultrasonography, it was .002. Pachometry measurements were consistently smaller than ultrasound by approximately .043 mm. Due to the greater accuracy in measurement of ultrasonography, the study would have benefitted by more than the three measurements taken for each patient. However, the experimenters were looking more for a general trend with the pachometry.

Subjects were measured at the same hour each visit to avoid inconsistency due to diurnal variation of corneal thickness.

An anesthetic (1 drop of .5% Proparacaine) was used for the first measurements in ultrasound, which may have induced a transient swelling of the cornea. The next two measurements were taken without the anesthetic.

A general trend in thickness changes was not observed in pachometry. After the first week of contact lens wear, the corneas increased in thickness as expected. Sporadic changes then occured where inconsistent increases and decreases were measured until termination of the study.

Ultrasonography showed an increase in thickness midway through the study (ave = .031 mm). The last measurement showed a decrease (ave = .015 mm) with the thickness being the midpoint of the first two measurements.

A greater increase in thickness was observed with the Tabb-fitted eye during the initial stages of contact lens wear.

Throughout the study, greater variations were also observed with the Tabb-fitted eye having an average range of .04. The MGM-fitted eye had half the range.

As far as any relationship the corneal thickness might have with the visual acuity or refraction, our study does not agree with Polse's findings. He observed that the cornea thinned with a decrease in myopia with contact lens wear. This study does not find corneal thickness as playing a part in the refractive and acuity changes occuring with orthokeratology.

Summary.

Orthokeratology appears to be an effective technique for the reduction of myopia. Subjects' corneas appeared no different than those fitted with traditional contact lens techniques. Permanency of results and long term effects on corneal integrity are yet to be investigated.

REFERENCES

1. Anderson, R. H. "Apparent Arrest of Myopia by Contacts." Contacto, 12(4): 3-4, 1968.

2. Bailey, J. J. "Possible Factors in the Control of Myopia With Contact Lenses." Contacto, 2(5): 114-117, 1958.

3. Bailey, I. L. and L. G. Carney. "The Interrelationship of Corneal Thickness and Shape Changes." J. Am. Optom. Assn., 43(6): 669-672, June 1972.

4. Blomquist, R., J. Keene, T. Zook. "Diurnal Variation in Corneal Thickness." Pacific University Senior Thesis, May 1975.

5. Butler D. and T. Kelly. "The Present Position of Contact Lenses in Relation to Myopia." Br. J. Physiol. Optics, 26: 33-48, 1971.

6. El Hage, S. G., C. C. Hughes, K. R. Schauer, R. L. Jerrel. "Evaluation of Corneal Thickness Induced by Hard and Flexible Contact Lenses." Am. Journal of Optometry and Arch. Am. Acad. Opt., 51(1): 24-33, January 1974.

7. Erickson, P. "An Analysis of the Unexplained Changes in Refractive Error Resulting From Orthokeratology." Pacific University Senior Thesis, May 1976.

8. Grant, S. C. and C. H. May. "Effects of Corneal Curvature change of the Visual System." Contacto, 16(2): 65-69.

9. Grant, S. C. and C. H. May. "Orthokeratology - a Therapeutic Approach to Contact Lens Procedures." Contacto, 14(3): 3-16, 1970.

10. Grant, S. C. and C. G. May, "Orthokeratology - Control of Refractive Errors Through Contact Lenses." J. Am. Optom. Assn., 1971.

11. Harris, D. H. "Developmental Myopia and Orthokeratology." Contacto, 16(2): 49-57.

12. Jessen, G. N. "Contact Lenses as a Therapeutic Device." Am. J. Optom. and Arch. Am. Acad. Optom., 41(7): 429-435.

13. Kearns, R. L. "Research in Orthokeratology, Part I." J. Am. Optom. Assn., 47(8): 1047-1051, August 1976.

14. Kearns, R. L. "Research in Orthokeratology, Part II." J. Am. Optom. Assn., 47(10): 1275-1283, October 1976.

15. Kelly, T. S. B. "Contact Lenses and Myopia." "The Contact Lens. 3: 10-18, 1971

16. Ludlam W. M. and E. J. Giglio. "Ultrasound - A Diagnostic Tool For the Examination of the Eye." Am. J. Optom. Arch. Am. Acad. Optom., 43(11): 687-731, 1966.

17. Ludlam, W. M., E. J. Giglio, S. Wittenberg. "Improvement in the Measurement of Intraocular Distances Using Ultrasound" J. Acoustical Society Am., (44)5: 1359-1364, Nov. 1968.

18. Ludlam W. M. and M. Kaye. "Optometry and the New Metrology" Am. Journal of Opt., Aug. 1966.

19. Malacara, D. "Geometrical Ronchi Test of Aspherical Mirrors" Applied Optics, 4(11): 1371-1374, Nov. 1965.

20. Mandell R. B. and Harris, M. G. "Theory of Contact Lens Adaption Process." J. Am. Optom. Assn., 39: 260-261, March 1968.

21. Mandell, R. B. and Polse, K.A. "Corneal Thickness Changes Accompanying Central Corneal Clouding." Am. J. Optom. Arch. Am. Acad. Optom., 43(2): 139-142, Feb. 1971.

22. Mandell, R. B. and Polse, K. A. "Corneal Thickness Changes as a Contact Lens Fitting Index - Experimental Results and a Proposed Model." Am. J. Optom. Arch. Am. Acad. Optom., 46(7): 479-491, July 1969

23. Mandell, R. B. "Corneal Curvature Measurements By the Aid Of Moire Fringes." J. Am. Optom. Assn. 37(3): 219-220, March 1966.

24. Miller, B. "Can Progressive Myopia be Prevented by Corneal Lenses?" Contacto, 7(7): 196-199, 1962.

25. Morrison, R.J. "Contact Lenses and the Progression of Myopia." J. Am. Optom. Assn., 28(12): 711-713, 1957.

26. Morrison, R. J. "Observations on Contact Lenses and the Progression of Myopia." Contacto, 2(1): 20-25, 1958.

27. Nolan, J. A. "Approach to Orthokeratology." J. Am. Optom. Assn. March 26, 1968.

28. Nolan, J. A. "Myopia Control with Contact Lenses." Contacto, 11(4): 24-27, 1967.

29. Nolan, J. A. "Myopia Control and Correction." Contacto, 14(2): 18-26, 1970.

30. Nolan, J. A. "Myopia - Prevention and Orthokeratology." Opt. J. Rev. Optom., 111(3): 18-24, 1974.

31. Nolan J. A. "Progression of Myopia and Contact Lenses." Contacto, 10(1): 10-12, 1966

32. Nishijima, Y. and G. Oster. "Moire Patterns: Their Application to Refractive Index and Refractive Index Gradient Measurements." J. Optical Soc. Am., 54(1): 1-5, Jan. 1964.

33. Oster, G., M. Wasserman, C. Zwerling. "Theoretical Interpretation of Moire Patterns." J. Optical Soc. Am., 54(2): 169-175, Feb. 1964.

34. Rengstorff, R. H. and R. S. Arner. "Refractive Changes in the Cornea: Mathematical Considerations." Am. J. Optom. Arch. Am. Acad. Optom., 43(11): 913-918, 1971.

35. Rengstorff, R. H. "Relationship Between Myopia and Corneal Curvature Changes After Wearing Contact Lenses." Am. J. Optom. Arch. Am. Acad. Optom., 46(5): 357-362, 1969.

36. Saks, S. J. "Fluctuations in Refractive State in Adapting and Long Term Contact Lens Wearers." J. Am. Optom. Assn., 37(3): 228-229, 1966.

37. Stone, J. "Myopia Control After Contact Lens Wear." Brit. J. Physiol. Optics, 39(3): 93-108, 1974.

38. Weseley, N. K. "Progression of Myopia and Contact Lenses." Contacto, 10(1): 10-12, 1966.

39. Ziff, S. "Orthokeratology Part I." J. Am. Optom. Assn., Feb. 1967.