Dow Corning's CPF Lens
As it is Utilized in
Contrast Sensitivity
With Low Vision Patients

by:
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ABSTRACT

The Dow Corning CPF lens series is utilized often in the management of the low vision patient to reduce glare and increase contrast. Subjectively, it is common to obtain favorable results when these lenses are demonstated. Objectively however, there has been some question as to the actual contrast threshold variance. This project was designed to utilize contrast sensitivity testing in order to determine, through the use of collected data, the objective increase or decrease of contrast sensitivity in the low vision patient. We will also compare these results to the results of normal patients' contrast sensitivity.

INTRODUCTION

In recent years there has been many investigations performed on the usefulness of contrast sensitivity in a clinical setting. There have also been studies to determine its aid in early detection of some ocular pathologies. From these studies it has been shown that contrast sensitivity can be a valuable addition in the evaluation of the visual system.

It has been demonstrated that the visual system works basically as a filtering system. In this system, there are different channels which are more sensitive to information of different spatial frequencies.. The visual system takes information from all these spatial frequencies and puts it together to give us the picture of what we see. This works basically the same as a modulation transfer function, (Fourier Analysis). In MTF an object is broken down into its basic components of differing spatial frequencies. Then if we take and combine all the individual components back together we will get a reproduction of that object. If we vary the spatial frequencies we use, we will vary the amount of information that we utilize in the perception of the original object.

There has also been research which shows that different spatial frequencies are responsible for different areas of vision.. If a person has his vision filtered so as to only see lower spatial frequencies they can still have enough information to differentiate forms and classify them. In order for a person to see finer details of an object they must have higher spatial frequencies present in the system. In testing snellen acuity, we are testing objects at very high contrast. In a normal environment objects have a lower contrast than with typical snellen. Therefore, we are not testing persons in their normal environment with snellen acuity. This is because we are only testing a very narrow range of the spectrum. When we test with contrast sensitivity, we select certain channels of the system to measure. By this we determine which channels are more sensitive in each individual. In this way we may find a person is able to see normal 20/20, but has a reduction in their ability to assimilate lower spatial frequency information.

BODY

In past studies of the effect of CPF lenses on contrast sensitivity in normal patients, the results have shown no significant differences, (Lynch & Brilliant). Most patients in these studies felt that the lenses did make objects more distinct.. In our study, we wanted to investigate if CPF lenses have any effect on contrast sensitvity function of normal patients. We also investigated what effect CPF lenses had on the contrast sensitivity of low vision patients.

Low vision patients are considered generally to have low vision because they have reduced snellen acuity. From this fact we feel it is possible that low vision patients may have a greater reduction in the higher spatial frequencies.. We wanted to investigate if CPF lenses had any different effects upon different spatial frequencies. In this study we also ran contrast sensitivity on normal patients with +3.00 D. lenses to induce blur. These lenses effect higher spatial frequencies to a much greater extent than they do lower frequencies. Because of this we felt we could simulate a low vision situation with the +3.00 D. lenses and investigate the CPF lenses effect on contrast sensitivity.

We performed contrast sensitivity on 23 subjects who had normal snellen acuity, 7 subjects with decreased snellen acuity due to pathology, and 5 subjects blurred with +3.00 D. lenses to simulate low vision. Each subject was run through four trials: without CPF lenses, with CPF550, with CPF527, with CPF511. The test distance was sixty inches. The patient was measured three times at spatial frequencies of .78, 1.78, 3.12, 4.26, 6.24 and 8.32. The screen contained vertical sinusoidal grids generated by the Caldwell Contrast Sensitivity unit. The subjects turned the screen to maximum contrast then decreased the contrast until they could no longer see the grid.. The subjects were tested binocularly with thier habitual spectacle prescription. Three trials of each frequency were run successively.

From the testing we have run on on our subjects we found that normals with and without CPF lenses had the highest contrast sensitivity to spatial frequency 3.12. Low vision patients and those with three diopters of blur with and without CPF lenses showed highest contrast sensitivity to a frequency of 1.78. The normals consistantly had their lowest sensitivity to a frequency of .78, while the low vision subjects were consistantly low to the 8.32 band. This was with and without CPF lenses. **Refer to data sheet "A" Sensitivity Rankings and chart and also data sheet "B" Comparison of Normals to Low Vision and chart**

The next questionwe asked was what changes did we find for normals in their contrast sensitivity with the CPF lenses. We compared all results of normals with CPF lenses to the mean and standard deviation of those normals without CPF lenses. From this data we computed z scores for each frequency with each lens to determine if the results were significant. **See data sheets C, D, E, F and accompaning chart**

All normal subjects showed a positive z value when wearing any of the CPF lenses. The lowest z value was +.31@ 3.12 Hz with CPF 511 and the highest was +1.71 @ .78 Hz with CPF 527. The majority of z values were greater than +.5 and a few were greater than +1.00. The frequency that had the highest z value for all lenses was .78. This shows that .78 Hz was affected more by the use of CPF lenses. The frequency with the next greatest z value was 1.78. The remainder of the frequencies show approximately the same z value.

From these results it seems that the CPF 527 and CPF 550 caused the greatest increase in contrast sensitivity and had their greatest effect on the frequencies of .78 and 1.78. The improvement with these two lenses was very closely matched by comparing their z values. From our results here it seems as though all CPF lenses cause a significant improvement in the lower spatial frequencies, while having less of an effect on higher spatial frequencies in normal subjects.

In looking at our low vision subject's contrast sensitivity without CPF lenses, we wanted to compare them to the normal's results without CPF lenses to find where they rank in sensitivity. All low vision subjects showed a negative z value in relation to the normal's mean and standard deviation without CPF lenses except at .78 Hz which had a +.39 value. The values ranged from +.39 to -1.74, with the majority -1.00 or more. The greatest reduction in the contrast sensitivity was at spatial frequencies 3.12, 4.16, 6.24, and 8.32.

Our next objective was to determine if CPF lenses had any effect on low vision patients. To do this we first compared all low vision subjects; determining their mean response for each spatial frequency without CPF lenses. We then calculated the mean value for each spatial frequency for each lens worn and the z value for each of the frequencies with each of the lenses worn. This z value was in comparison to their data without CPF lenses.

Using the group data of all low vision patients showed little difference in comparing values with and without CPF lenses. The z value for all three lenses varied from +.37 to -.48, with the majority between +.05 to -.2.

By comparing the data in this manner it would seem that CPF lenses made very little difference in the contrast sensitivity function of our low vision subjects. **The above data and calculations can be seen in data sheet I and its accompaning chart** When we compared data between individual subjects there was a great amount of variability in response values; as can be seen by comparing patient number 1 and patient number sixes data and graphs. We feel that because of this large variability that using group averaged means may hide an individuals improvement with a specific lens at a single frequency.

To determine if there was any validity in this idea we decided to only compare an individual to themselves. We used their response values without CPF lenses as the baseline to compare to their responses with CPF lenses on. **The data for these comparisons is contained in data sheets H, Ha and graphs for patient number one through eight**

From this comparison method it is seen that some subjects are helped more by the CPF lenses than other subjects are, and some subjects are not helped at all. It is also seen that the amount of response difference varies greatly from one individual to another.

We can look at some individual cases to see what kind of differences the CPF lenses made:

Subject number one:

It can be seen that subject number one had very high response values without any lenses on. When thissubject wore the CPF lenses there was a reduction in contrast sensitivity. This patients response values were also very high as compared to the other low vision subjects.

Subject number two:

Subject two showed the greatest change in contrast sensitivity with the use of the CPF 550 lenses at 1.78 and 3.12 Hz. With the other lenses and at the other frequencies there was not much of a change.

Subject number three:

In this subject the CPF 511 seemed to be most helpful at 1.78 Hz, but less helpful at the other frequencies. The CPF 527 and 550 seemed to be most helpful at 3.12 and 4.16 Hz.

Subject number four:

Subject four showed improvement with all CPF lenses. This subject also showed improvement in the higher spatial frequencies, which has not been very typical of most of our patients.

Subject number five:

Subject five showed some improvement in the lower spatial frequencies with all lenses, with the greatest change being with the CPF 511.

Subject number six:

Subject six only showed improvement with the 550 lens.

Subject number seven:

Subject seven showed marked improvement in spatial frequencies 0.78 and 1.78 with the CPF 511 and 527. At the other frequencies there was very little change.

Subject number eight:

Subject eight showed the greatest improvement with CPF 511 in the lower spatial frequencies.

We feel that from this data that low vision subjects should just be compared to themselves to see if there is any benefit from the CPF lenses. Trying to compare their response to a groups average does not work because of the great variability in responses.

In order to justify using normals with +3.00 diopters of blur as simulated low vision patients we made a comparison of their results to those of the low vision subjects in our study. We found the z value for the normals with +3.00 ranged from +.16 to -.17 in comparison to low vision subjects, both samples data was without CPF lenses. We feel this difference was not significant, thus allowing us to use these subjects as simulated low vision subjects. **See data sheet B and the accompaning chart**

In this justification we must also include that these subjects with +3.00 may not simulate all low vision subjects. Most of the low vision subjects in our study had the condition of senile macular degeneration, therefore our use of these conditions and comparisons may only simulate this pathological condition. Other low vision conditions may need to be simulated in another manner.

DISCUSSION

In viewing the data collected from normal patients it seems that there was a significant increase in contrast sensitivity with the use of CPF lenses. At the same time, we found no significant change in the contrast sensitivity of low vision patients using CPF lenses.

As with any study, the testing proceedures must be scrutinized. We utilized a stationary sinusoidal grating in a seeing to non-seeing technique. This type of contrast sensitivity testing may have produced a variance in findings as compared to a non-seeing to seeing technique. We did compare mormal's c ntrast sensitivity without CPF lenses utilizing both techniques and found a slight rise in sensitivity in the seeing to non-seeing mode. It is possible that this rise was caused by an after-image effect.

If an after-image effect did cause this rise, it may be possible that this effect also causes changes in the contrast sensitivity while wearing the CPF lenses. It could also be possible that this after-image effect might give a false impression of a change in sensitivity. This may be an interesting study, comparing the two methods with and without lenses and seeing what difference there

An interesting aspect in the patient response to CPF lenses is that they feel borders become sharper and more distinct with the lenses. From most previous investigations there has been no change in the actual sensitivity. When we performed the contrast sensitivity testing, we utilized a black and white grid. Perhaps we do not measure an increase in contrast due to the fact that CPF lenses affect colored light. The lenses cut off shorter wavelengths of light while having little effect on longer wavelengths. Possibly in the natural environment this could cause an increase in contrast that is not measured with a black and white grid. It would be interesting if contrast sensitivity were run with colored grids. This may more naturally assimilate the normal world, and possibly the lenses would then show a change in contrast sensitivity.

CONCLUSION

Our testing showed that there was an improvement in contrast sensitivity in normal patients while wearing the CPF lenses. The low Vision patients showed very little difference when taken as a group, but when compared to themselves, some do show large improvements in sensitivity. It would probably be best in low vision patients to just compare if the lenses improve their sensitivity at any point, rather than compare them to a large group of normals.

Spatial Frequency Sensitivity Ranking**

Normal Patients

Without CPF	3.12	4.16	6.24	1.78	8.32	0.78
With CPF 511	3.12	1.78	4.16	6.24	8.32	0.78
With CPF 527	3.12	1.78	4.16	6.24	8.32	0.78
With CPF 550	3.12	4.16	1.78	6.24	8.32	0.78

Low Vision Patients

Without CPF	1.78	0.78	3.12	4.16	6.24	8.32
With CPF 511	1.78	4.16	0.78	3.12	6.24	8.32
With CPF 527	1.78	0.78	3.12	4.16	6.24	8.32
With CPF 550	3.12	1.78	4.16	0.78	6.24	8.32

**The ranking is from most sensitive to least senstive.

Comparison of Normals with +3.00 to Low Vision Patients.

Low Vision Without CPF's

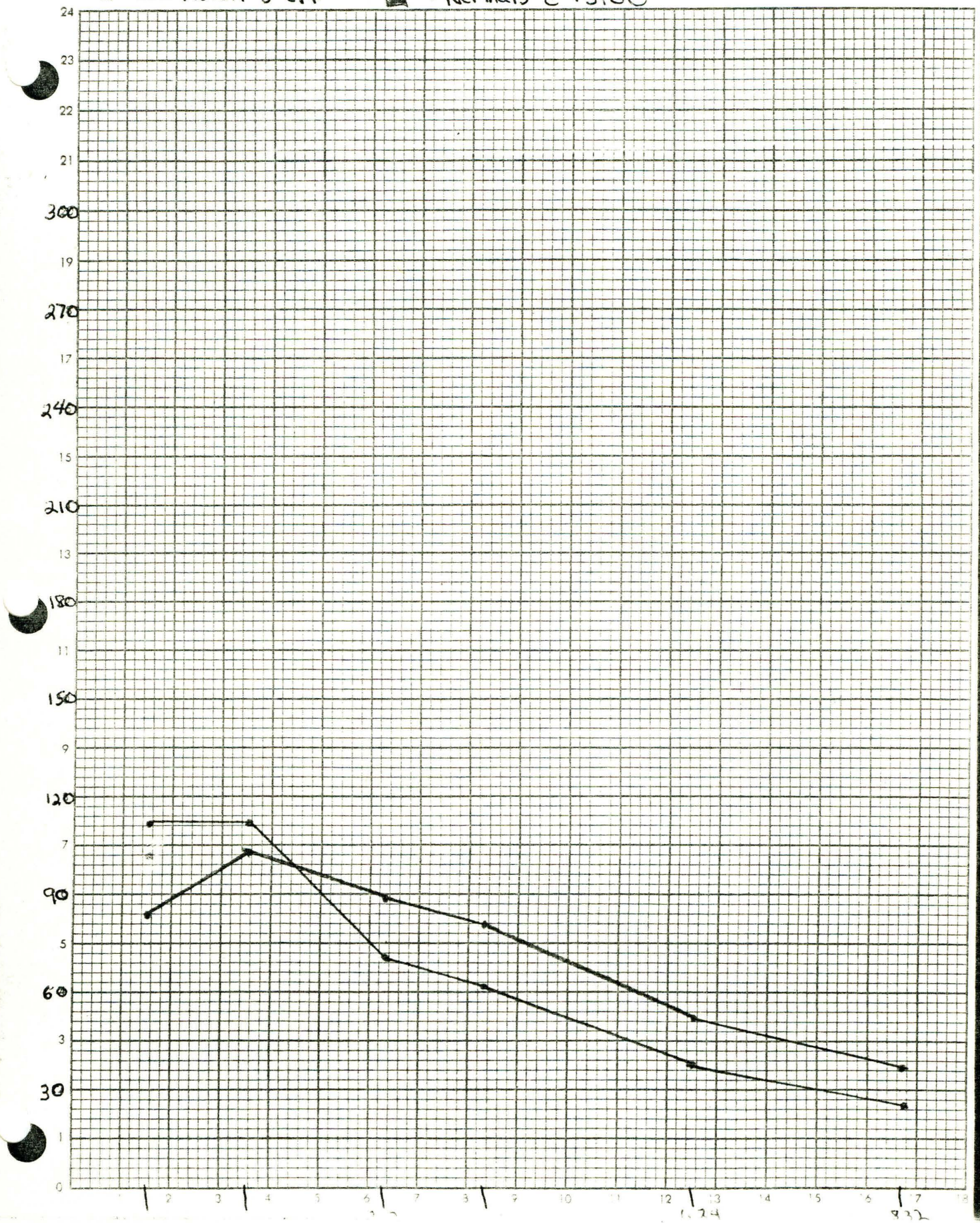
	0.78	1.78	3.12	4.16	6.24	8.32
Total Scores	586	723	624	569	366	256
Mean Score	84	103	89	81	52	37
Standard Dev.	157	133	147	145	102	69

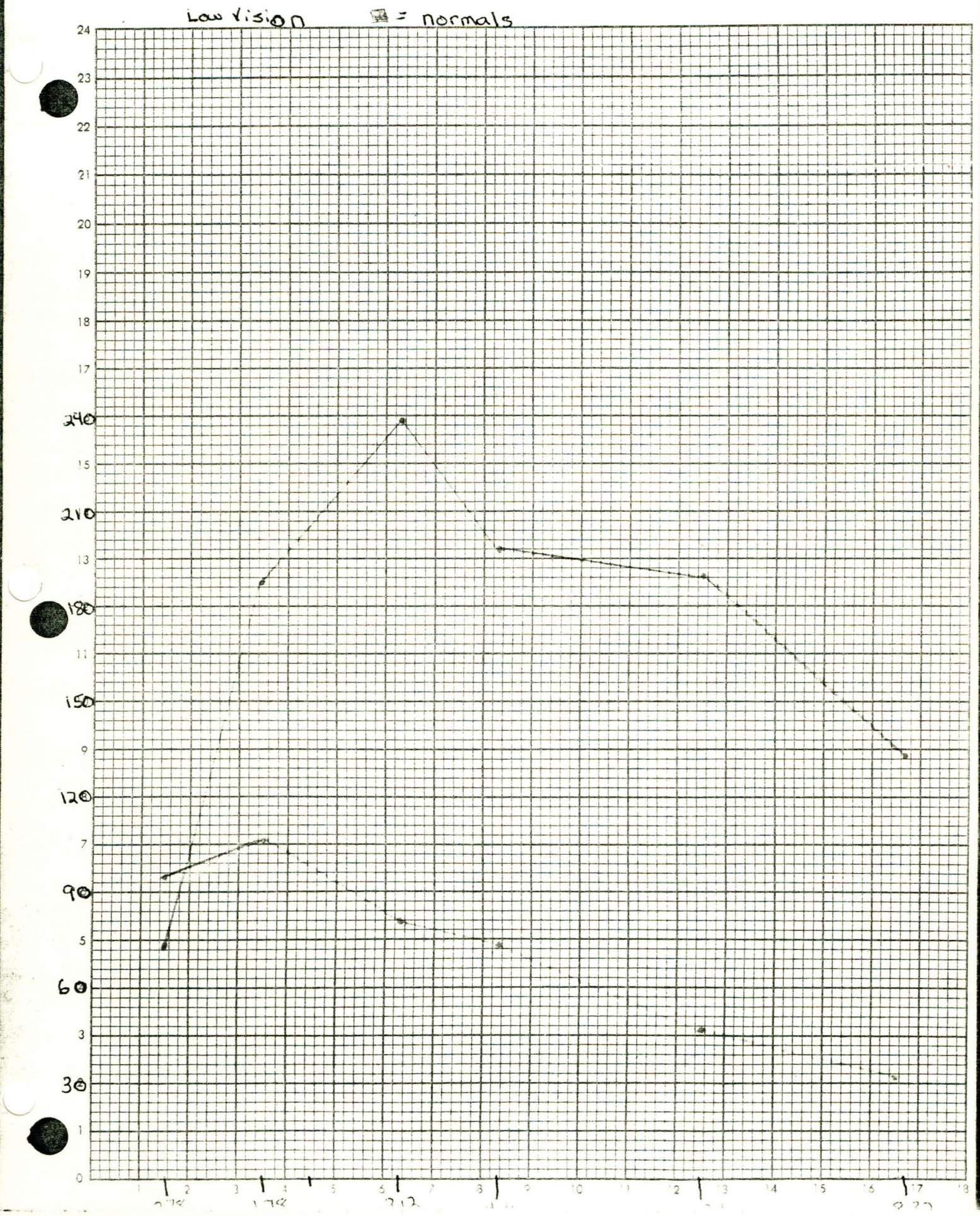
Normals with +3.00 without CPF's

	0.78	1.78	3.12	4.16	6.24	8.32
Total Scores	559	558	350	308	190	124
Mean Score	112	112	70	62	38	25
Standard Dev.	67	80	53	66	20	26
Z Value*	+.17	+.06	-.13	-.14	-.14	-.17

* Z Value is in relation to low vision patients without CPF lenses.

■ - Low vision 3 CPF ■ = Normals ≥ +3.00




Low Vision
= normals
24
23
22
21
20
19
18
17
240
15
210
13
180
11
150
9
120
7
90
5
60
3
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1
0
1
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3
4
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16
17
18

Data of Normal Patients Without CPF Lenses "C"

	0.78	1.78	3.12	4.16	6.24	8.32
Steve Garant	31	141	187	246	169	155
[illegible]e Hafner	85	134	168	224	108	177
Bob Molter	204	197	479	293	208	238
Dale Wittkop	63	263	232	232	273	210
Carol Beegle	31	157	274	171	258	143
Greg Herbart	62	256	288	228	225	201
Mark Liebetreau	67	215	272	285	291	164
Brian Allen	41	171	217	199	127	71
J. Smith	36	262	347	296	318	233
Sid Morse	86	173	151	146	121	49
Jeff Rautio	180	244	375	238	299	250
Mike Wallace	23	49	95	112	138	56
Doug Weber	110	259	278	182	170	162
Pam Waite	9	14	22	26	21	19
Julie Marvin	71	134	168	158	151	76
Sue Schlegel	83	108	178	208	132	109
Tom Casey	162	352	394	371	317	256
Lori Luplow	11		31	13		37
[illegible] Shea	19	37	53	74	68	36
Deb Lockwood	83	267	425	245	220	190
Michelle	149	366	371	312	256	101
Share Stendel	49	194	240	183	175	99
Julia Chaffin	51	134	233	120	127	36
Total	1706	4127	5478	4562	4172	3067
Mean	74	188	238	198	190	133
Standard Deviation	54	93	124	89	83	77

Data of Normal Patients with CPF 511 "D"

	0.78	1.78	3.12	4.16	6.24	8.32
Steve Garant	121	267	306	239	245	163
Bruce Hafner	194	231	224	207	78	104
Bob Molter	438	363	544	379	458	465
Dale Wittkop	68	147	287	349	248	195
Carol Beegle	30	266	344	427	305	372
Mark Liebetreau	133	322	365	448	371	354
Brian Allen	116	190	214	171	158	78
J. Smith	89	325	434	339	281	203
Sid Morse	124	142	187	191	209	267
Jeff Rautio	85	503	434	477	551	526
Mike Wallace	37	83	128	78	37	19
Doug Weber	216	517	392	257	60	65
Pam Waite	16	45	37	28	189	168
Julie Marvin	81	205	169	153	132	72
Sue Scjlegel	208	302	315	334	261	189
Tom Casey	341	407	591	459	288	109
Lori Luplow	37		30	50		39
Jill Shea	13	52	35	44	32	35
Lockwood	125	396	319	326	184	153
Michelle	134	259	320	388	243	128
Shari Stendel	148	195	299	161	254	187
Julia Chaffin	41	153	132	102	81	40
Total	2795	5370	6106	5607	4665	3931
Mean	127	256	278	249	222	179
Standard Dev.	105	134	154	145	134	140
Z Value*	+.97	+.73	+.31	+.56	+.39	+.59

* Zvalue is in relation to Normals without CPF lenses

"E"

Data of Normal Patients with CPF 527

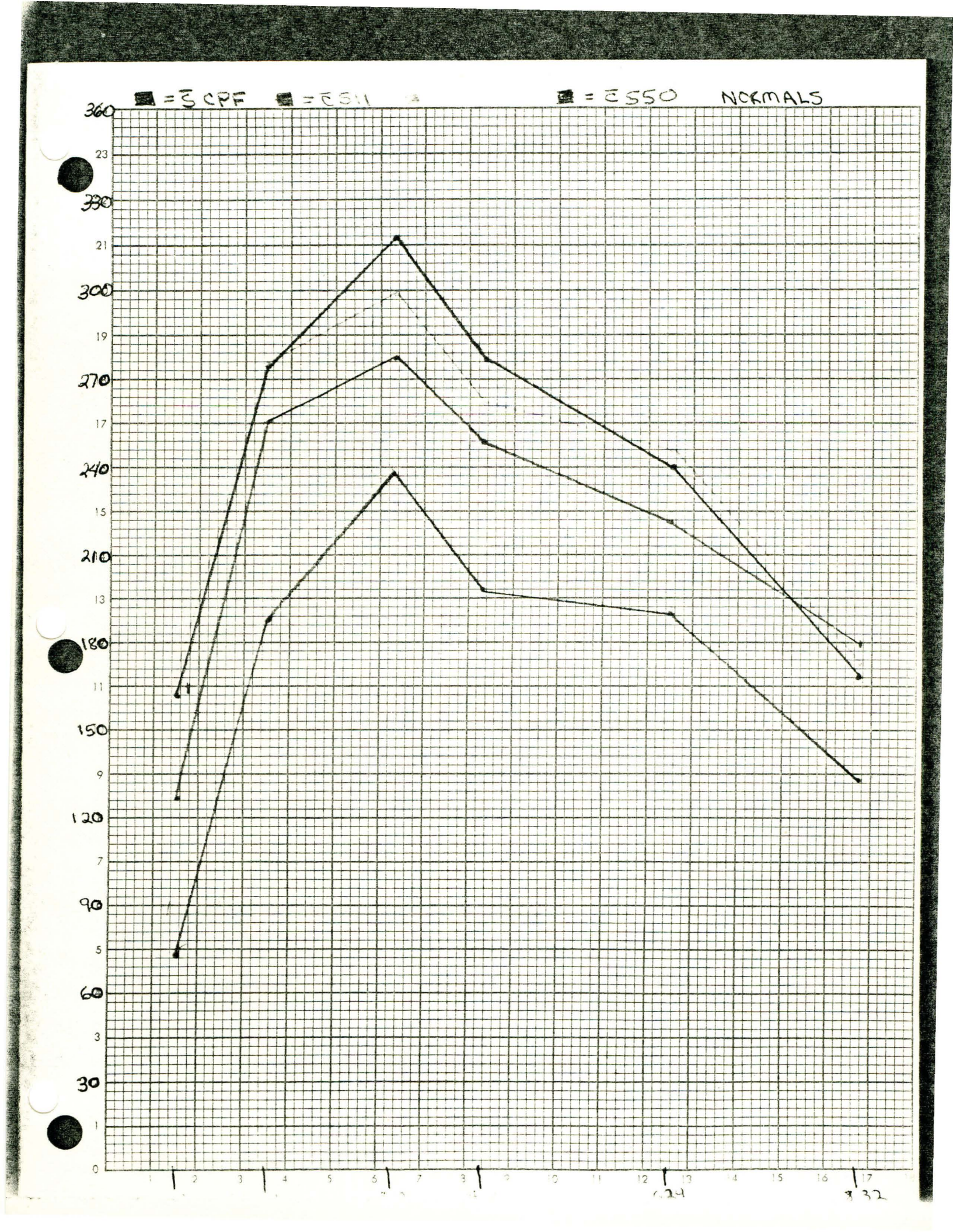
	0.78	1.78	3.12	4.16	6.24	8.32
[illegible]ve Garant	100	278	267	280	267	217
Rance Hafner	106	275	321	270	225	149
Bob Molter	342	298	321	383	468	349
Dale Wittkop	88	330	378	454	383	298
Carol Beegle	527	455	193	519	551	541
Mark Liebetreu	155	376	535	353	458	319
Brian Allen	83	166	238	170	131	80
J. Smith	185	371	408	315	348	201
Sid Morse	145	401	373	272	156	110
Jeff Rautio	234	508	485	558	527	414
Mike Wallace	35	60	113	115	54	22
Doug Weber	120	319	454	293	278	116
Pam Waite	8	20	38	27	20	10
Julie Marvin	72	139	218	148	112	53
Sue Schlegel	345	459	417	254	248	75
Tom Casey	499	491	523	325	308	160
Lori Luplow	33	24	23	25	36	22
[illegible] Shea	19	26	32	46	57	53
Deb Lockwood	179	274	448	380	349	283
Michelle	190	331	324	270	205	105
Shari Stendel	167	283	275	201	203	193
Julia Chaffin	44	194	183	111	44	32
Total	3676	6078	6567	5769	5428	3802
Mean	167	276	299	262	246	173
Standard Dev.	145	152	156	149	164	143
Z Value*	+1.71	+.96	+.48	+.71	+.69	+.51

* Z Value is in relation to Normals without CPF lenses.

Data of Normal Patients with CPF 550 "F"

	0.78	1.78	3.12	4.16	6.24	8.32
[illegible]ve Garant	183	262	250	250	213	124
Rance Hafner	248	391	303	270	284	143
Bob Molter	236	311	481	463	464	370
Dale Wittkop	107	362	471	556	565	89
Carol Beegle	300	499	258	249	261	469
Mark Liebetreu	213	360	556	501	329	328
Brian Allen	101	206	241	153	144	55
J. Smith	115	305	491	367	310	174
Sid Morse	180	354	343	231	222	173
Jeff Rautio	197	500	555	501	594	535
Mike Wallace	46	54	41	67	32	21
Doug Weber	72	278	545	382	314	157
Greg Herbart	176	388	272	299	269	163
Pam Waite	23	34	25	62	49	54
Julie Marvin	75	156	164	101	105	36
Sue Schlegel	323	419	386	279	108	68
Tom Casey	348	484	585	536	293	233
[illegible] Luplow	37	69	50	56	32	28
Jill Shea	27	29	118	37	90	47
Deb Lockwood	250	433	418	340	331	237
Michelle	128	101	316	230	188	86
Shari Stendel	235	250	372	332	285	252
Julia Chaffin	113	83	52	126	48	32
Total [illegible]	3733	6327	7293	6388	5530	3874
Mean	162	275	317	278	240	168
Standard Dev.	97	156	181	162	158	143
Z Value*	+1.62	+.94	+.63	+.89	+.61	+.45

Z Value is in relation to Normals without CPF lenses.


= 5 CPF
= 5511
= 5550
NORMALS
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Data of Normal Patients with +3.00 "G"

Without CPF Lenses

	0.78	1.78	3.12	4.16	6.24	8.32
Dale Wittkop	211	120	137	102	66	68
Jill Shea	26	36	29	20	48	28
Deb Lockwood	108	126	114	158	35	7
Shari Stendel	124	44	16	11	28	11
Julia Chaffin	90	232	54	17	13	10

With CPF 511

	0.78	1.78	3.12	4.16	6.24	8.32
Dale Wittkop	57	59	39	23	14	31
Jill Shea	19	23	40	48	30	17
Deb Lockwood	63	127	68	67	58	48
Share Stendel	65	44	19	20	15	31
Julia Chaffin	39	47	33	15	20	9

With CPF 527

	0.78	1.78	3.12	4.16	6.24	8.32
Dale Wittkop	72	49	25	16	6	6
Jill Shea	20	20	63	34	52	19
Deb Lockwood	136	66	48	36	17	12
Shari Stendel	184	208	25	27	19	55
Julia Chaffin	37	52	46	21	19	13

With CPF 550

	0.78	1.78	3.12	4.16	6.24	8.32
Dale Wittkop	65	55	35	164	9	51
Jill Shea	13	22	113	30	24	24
Deb Lockwood	51	39	79	60	30	8
Shari Stendel	115	83	38	19	39	88
Julia Chaffin	60	58	48	17	13	26

Low Vision Patients Data

#1 Virginia Geiger

	0.78	1.78	3.12	4.16	6.24	8.32
Without CPF	438	390	416	407	282	191
With CPF 511	182	430	183	469	62	53
With CPF 527	248	162	212	295	66	68
With CPF 550	71	332	303	318	118	32

#2 Genespencer Turrentine

	0.78	1.78	3.12	4.16	6.24	8.32
Without CPF	42	98	77	54	25	26
WithCPF 511	35	126	92	85	39	45
With CPF 527	41	110	59	71	21	17
With CPF 550	34	170	138	48	43	25

#3 Robert Shannon

	0.78	1.78	3.12	4.16	6.24	8.32
Without CPF	19	72	80	62	32	19
With CPF 511	21	143	68	73	46	28
With CPF 527	23	69	120	85	61	87
With CPF 550	22	68	122	104	52	50

#4 Jasper Olendorf

	0.78	1.78	3.12	4.16	6.24	8.32
Without CPF	13	15	18	14	9	5
With CPF 511	21	21	27	39	56	5
With CPF 527	26	60	91	49	69	49
With CPF 550	32	44	49	60	113	90

#5 Potts

	0.78	1.78	3.12	4.16	6.24	8.32
Without CPF	16	19	16	16	7	5
With CPF 511	33	42	52	22	6	5
With CPF 527	42	34	31	24	5	5

Low Vision Patients Data

"Ha"

#6 John Wright

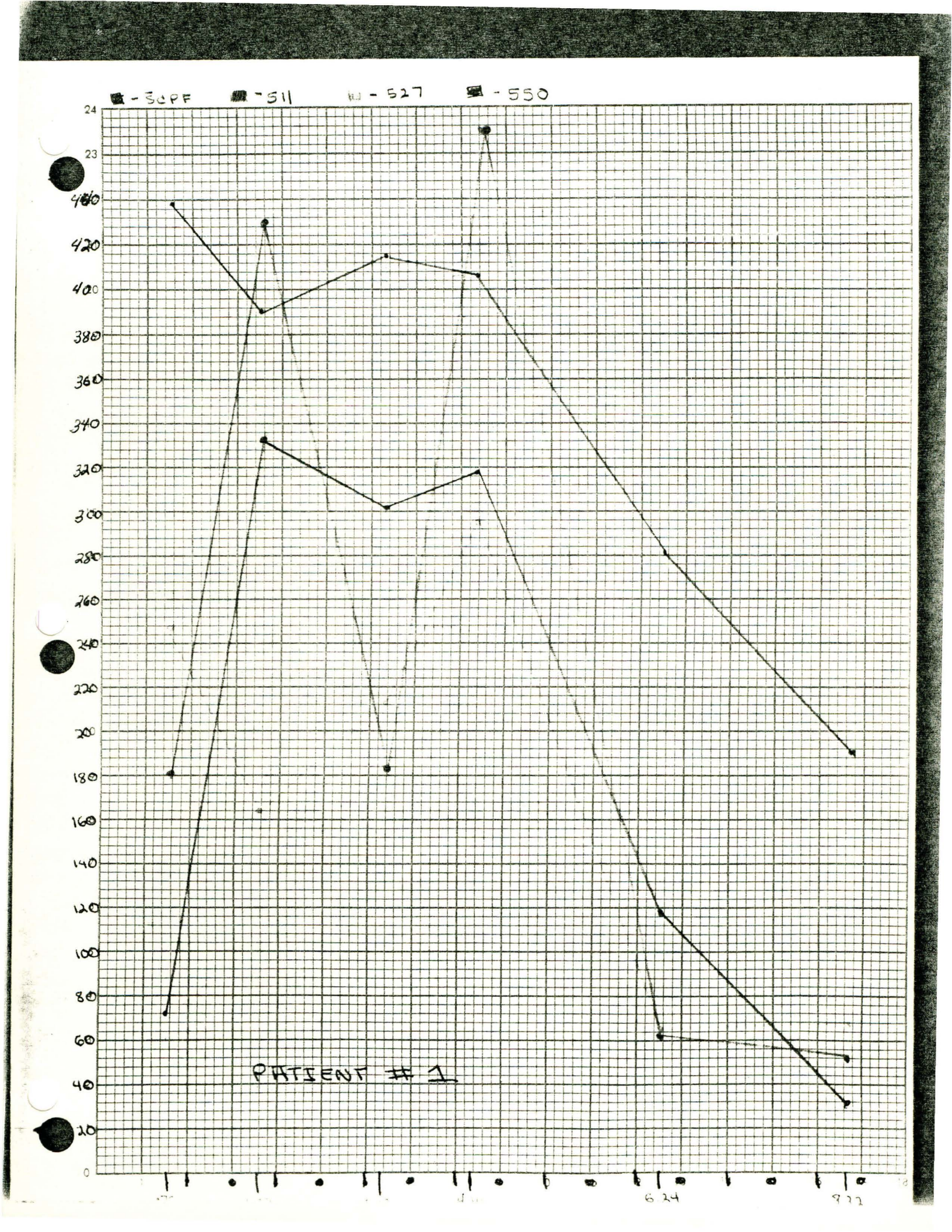
	0.78	1.78	3.12	4.16	6.24	8.32
Without CPF	5	16	6	7	5	5
With CPF 550	13	15	30	20	15	5

#7 Ellen Boyce

	0.78	1.78	3.12	4.16	6.24	8.32
Without CPF	53	113	11	9	6	5
With CPF 511	138	157	28	9	5	5
With CPF 527	207	230	35	18	5	5

#8 Letha Amrock

	0.78	1.78	3.12	4.16	6.24	8.32
Without CPF	16	19	16	16	7	5
With CPF 511	33	42	52	22	6	5
With CPF 527	42	34	31	24	5	5
With CPF 550	27	37	13	27	5	5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- 511
- 527
- 550
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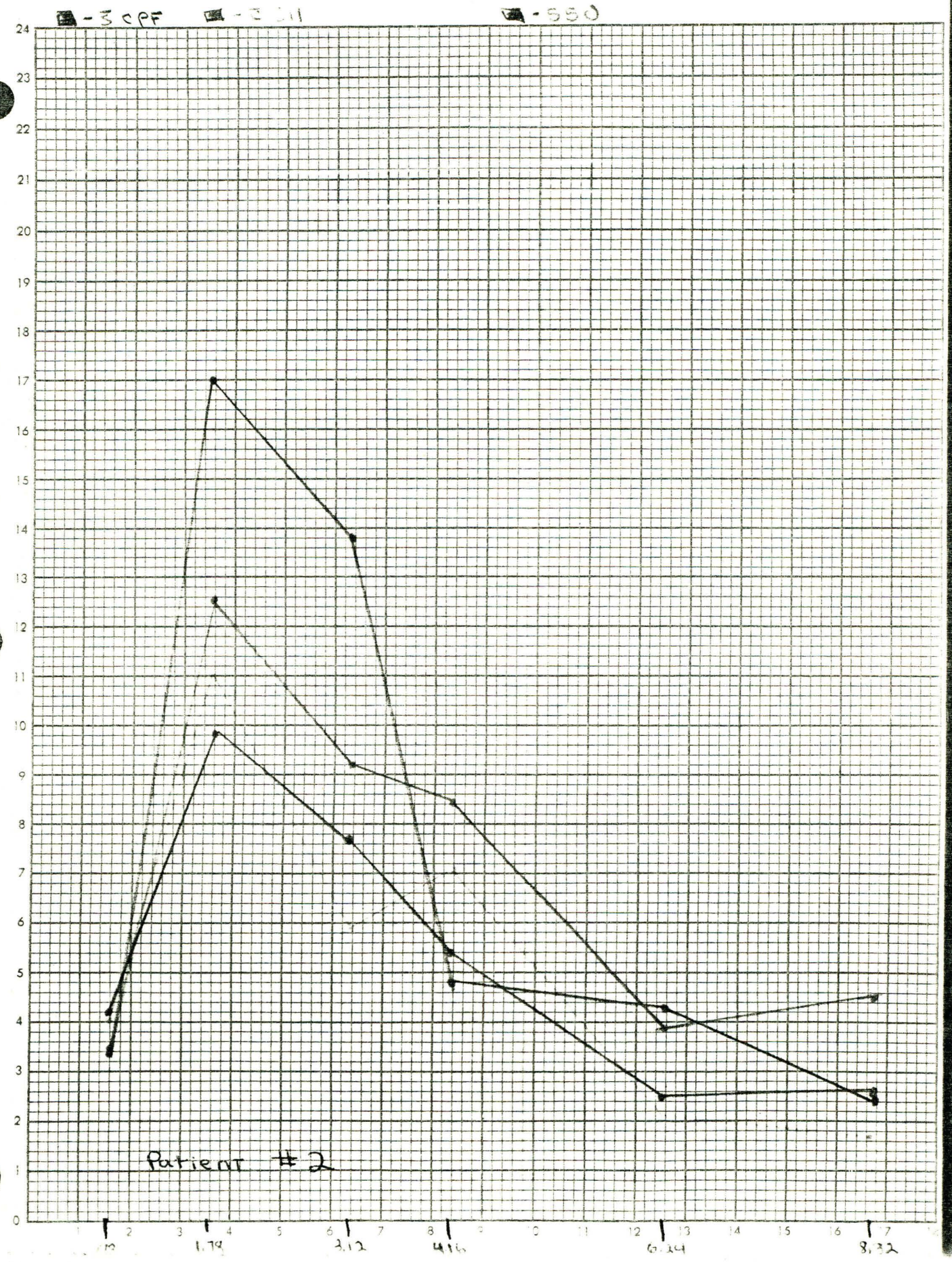
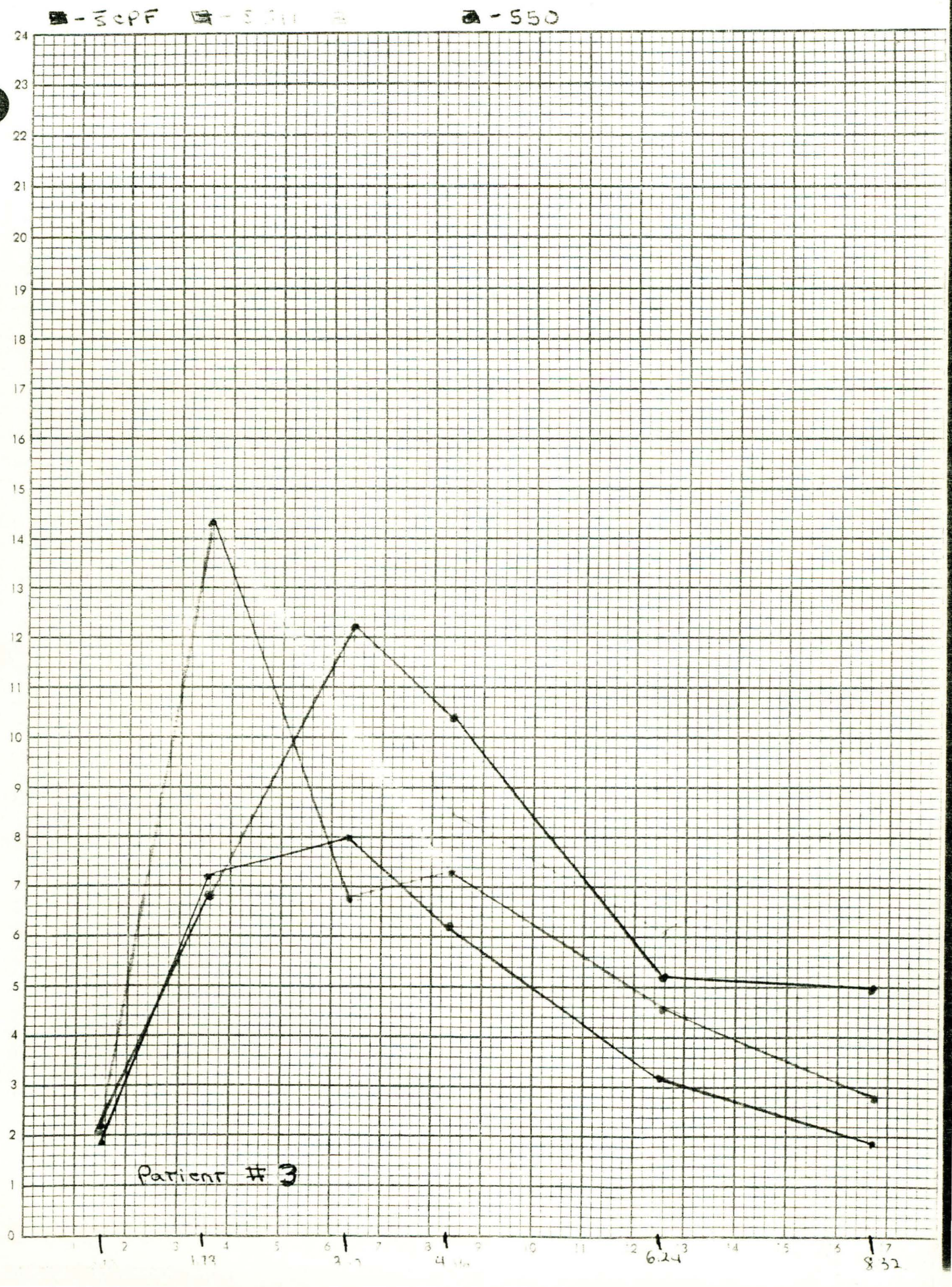
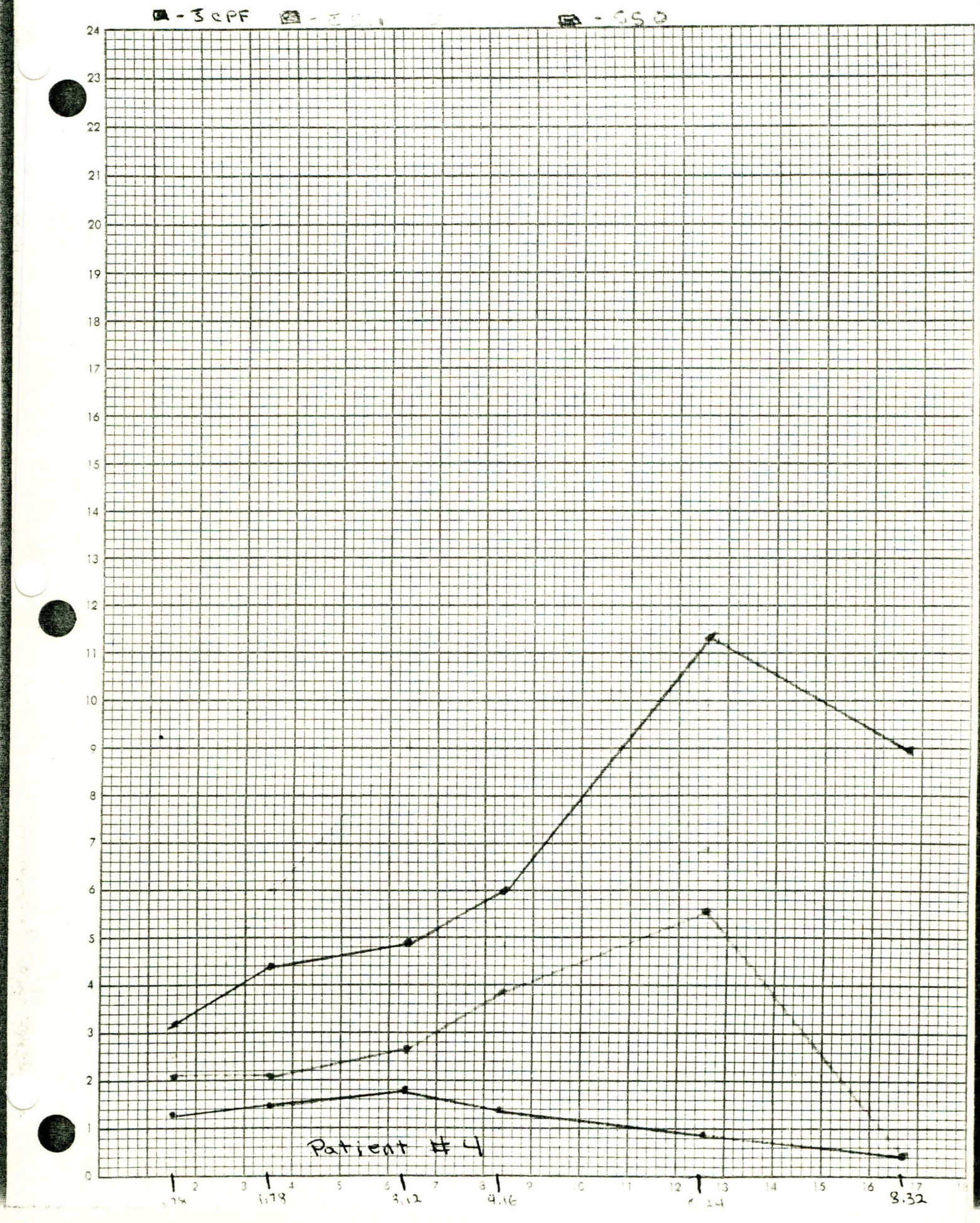
6.24
PATIENT # 1


-3 cpf
-550
Patient #2
1.79
3.12
4.16
6.24
8.32


a - 550
Patient # 3
6.24
8.32


- 3 cPF
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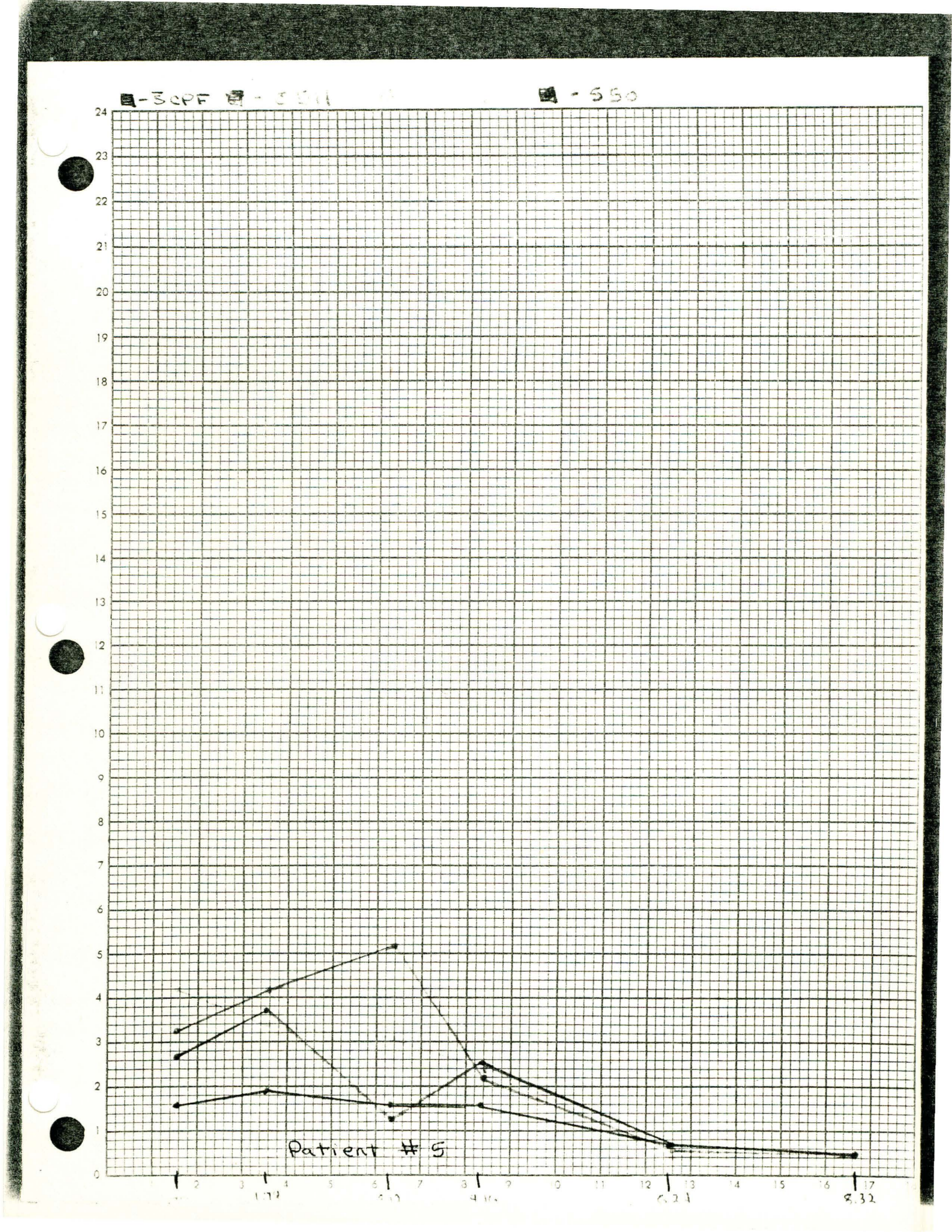
Patient # 4


-3 CPF
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Patient # 5
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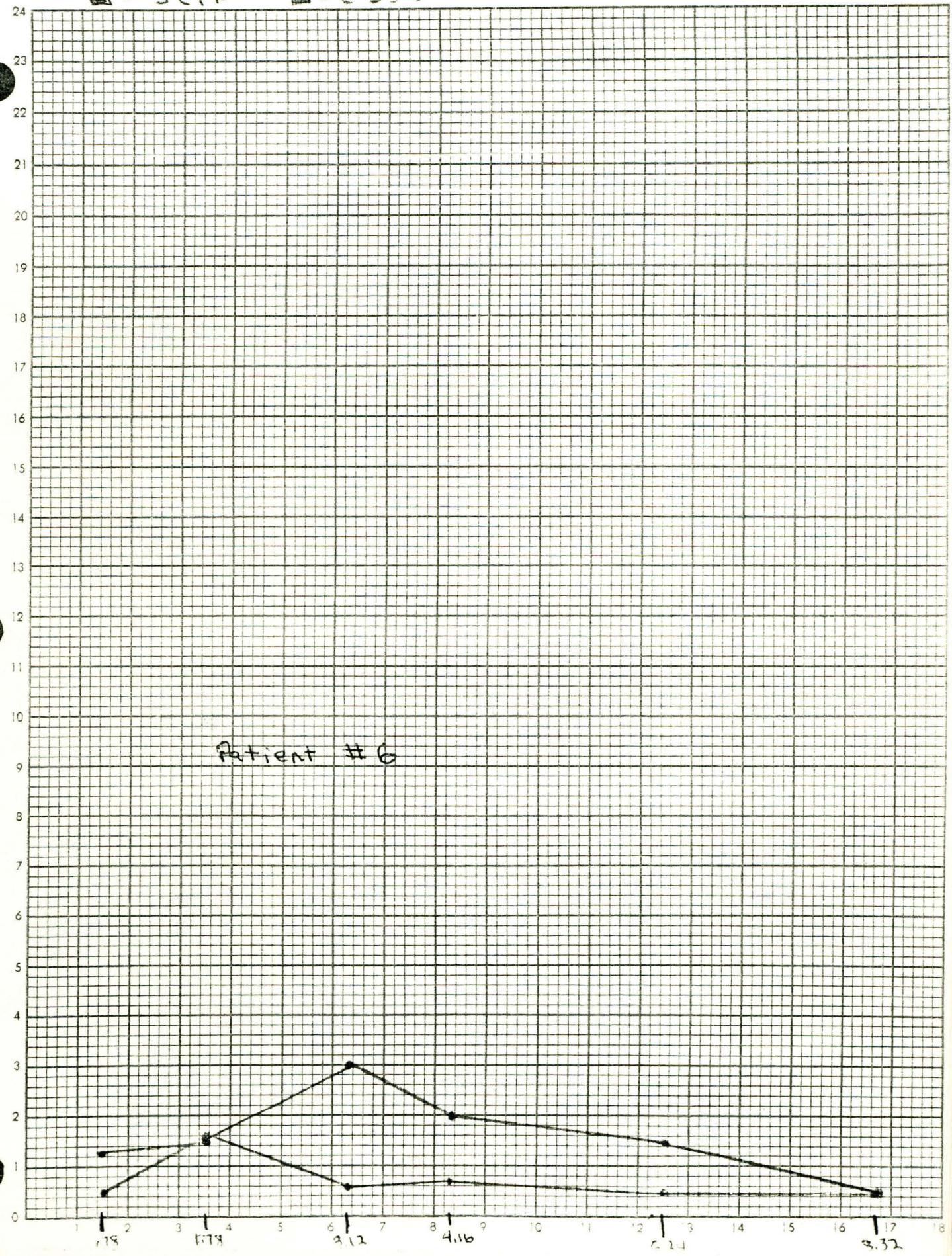
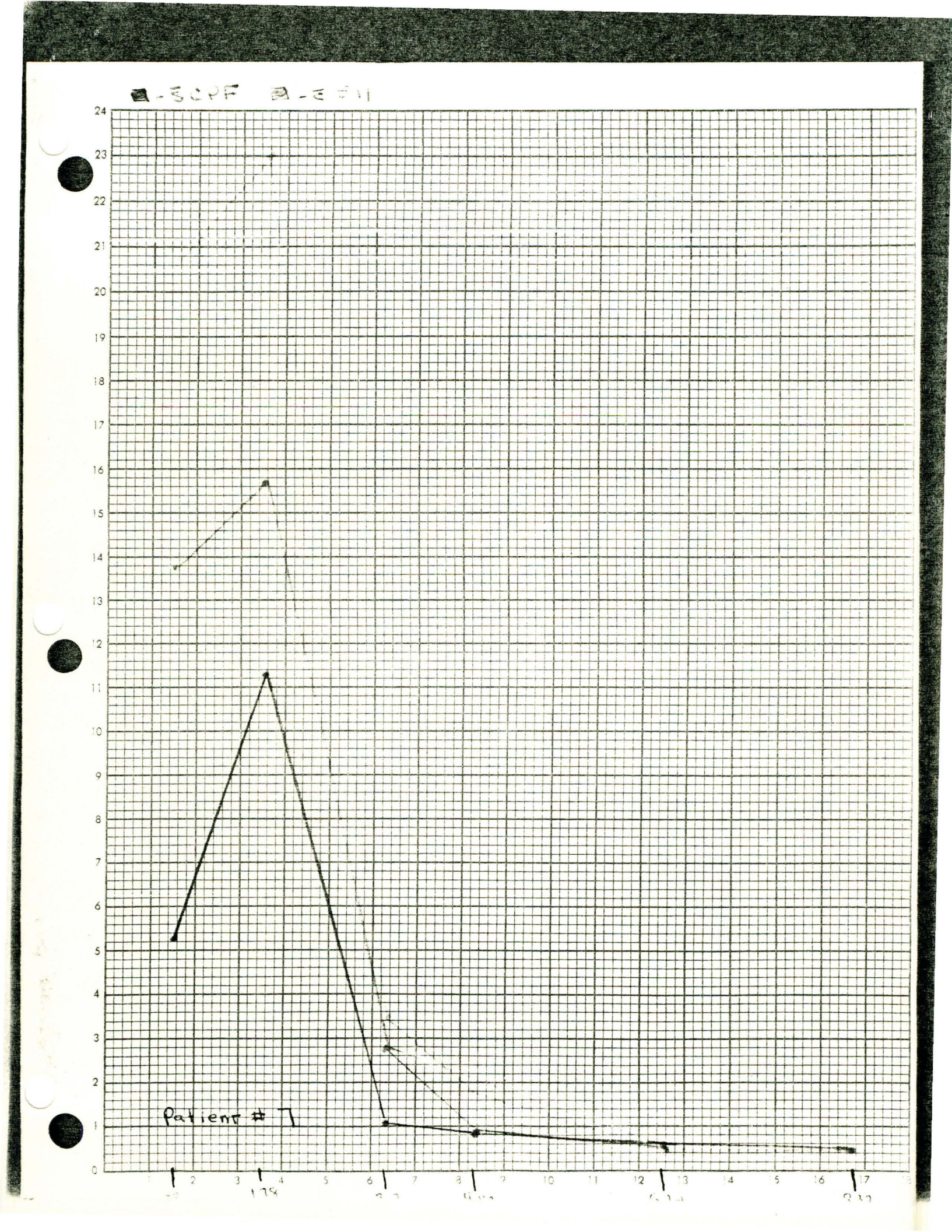
■ - SCPF ■ - ESO

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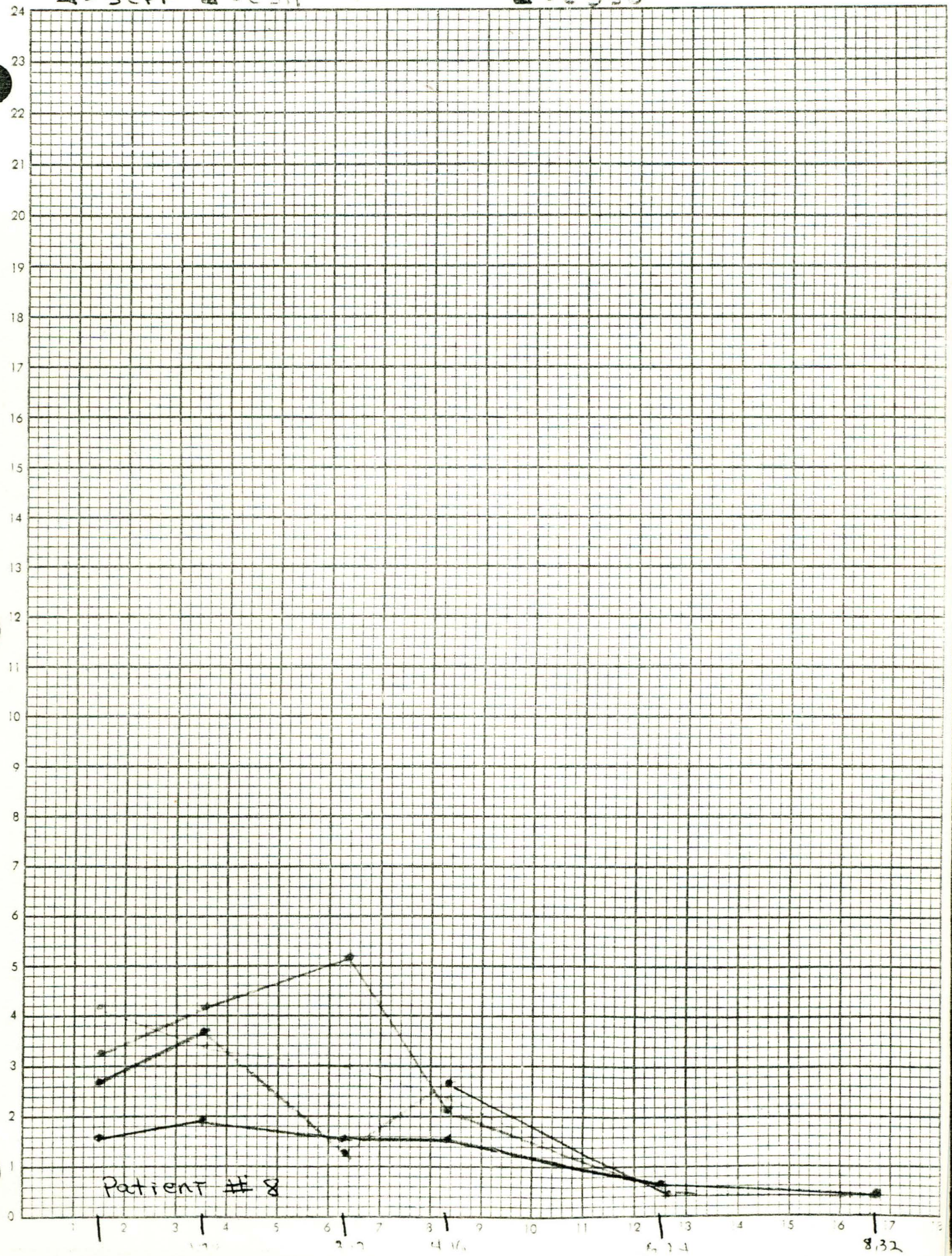
Patient # 7

■ - SCPF ■ - CSII ■ - SSD



Patient # 8

All Low Vision Data Compiled for Mean and Standard Deviation "I"

Low Vision Without CPF Lenses

	0.78	1.78	3.12	4.16	6.24	8.32
Total Scores	1145	1281	974	877	556	380
Mean Score	95	107	81	73	46	32
Standard Dev.	124	109	114	115	77	53
Z Value*	+.39	-.87	-1.26	-1.39	-1.74	-1.31

* Z Value is in relation to Normals without CPF lenses

Low Vision With CPF 511

	0.78	1.78	3.12	4.16	6.24	8.32
Total Scores	673	1219	649	870	351	277
Mean Score	61	111	59	79	32	25
Standard Dev.	53	59	47	132	21	18
Z Value*	-.28	+.37	-.19	+.05	-.19	-.12

* Z Value in relation to low vision without CPF lenses.

Low Vision With CPF 527

	0.78	1.78	3.12	4.16	6.24	8.32
Total Scores	1036	1060	755	676	340	336
Mean Scores	94	96	69	62	31	30
Standard Dev.	84	72	56	81	26	29
Z Value*	-.01	-.09	-.11	-.10	-.20	-.02

* Z Value is in relation to low vision without CPF lenses.

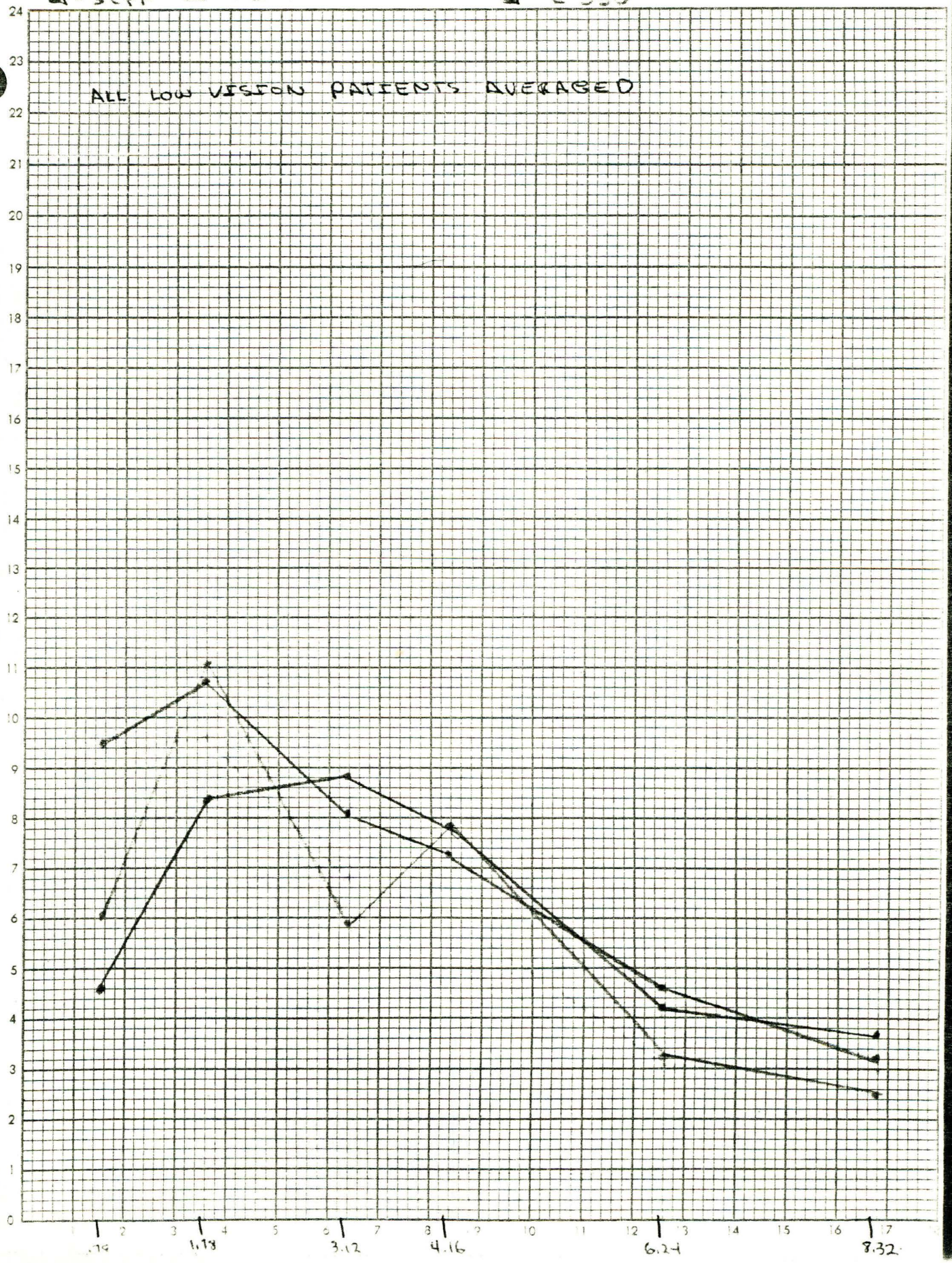
Low Vision with CPF 550

	0.78	1.78	3.12	4.16	6.24	8.32
Total Scores	503	923	968	865	464	404
Mean Score	46	84	88	79	42	37
Standard Dev.	31	92	83	91	39	30
Z Value*	-.4	-.21	+.06	+.05	-.05	+.09

* Z Value is in relation to low vision without CPF lenses.

*** All the above scores include the measurements on Low vision patients and simulated low vision patients wearing +3.00 lenses.

■ - SCPF ■ - [illegible] ■ - TSSO


ALL LOW VISION PATIENTS AVERAGED
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