Oral Lecithin and Linoleic Acid in Friedreich's Ataxia: II. Clinical Results

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groups showed negative mean values in

SUMMARY: Twenty-two patients with Friedreich's Ataxia and ten normal controls were followed for one year and assessed as to their clinical performance after two successive six-month periods of lecithin or safflower oil. Results demonstrated no significant difference in performance scores according to group assignation, neither in patients nor in controls. According to stages, two patients in stage I and to a lesser degree, one patient in stage IV showed better scores for muscle strength and some motor accuracy and coordination tests with lecithin. Controls as groups maintained positive scores in all tests. Patients as

RÉSUMÉ: Nous avons suivi l'évolution de vingt-deux ataxiques et de dix témoins normaux durant un an et mesuré leur performance clinique après deux périodes de six mois suivant la prise de lécithine ou d'huile de carthame. Les résultats ne démontrèrent aucune différence dans la moyenne de performance des groupes de patients comparés entre eux.

Selon les stades fonctionnels, deux patients de stade I et à un moindre degré, un patient de stade IV, améliorèrent leur force musculaire et leur coordination motrice avec la lécithine. Les témoins, comme groupes, ont amélioré leur performance dans toutes les épreuves auxquelles ils furent soumis. Chez les patients, par groupes, seuls les résultats des tests de dynamométrie et de coordination s'avénine out of eleven tests. Again as groups, patients receiving safflower oil demonstrated a mean 8% less deterioration than patients receiving lecithin. This study demonstrates that objective clinical tests and the participation of normal controls are a must in a therapeutic trial implicating patients with a progressive disorder such as Friedreich's Ataxia. The possible role of linoleic acid as the active factor from which clinical improvement proceeded in some specific patients and with early functional stages of the disease, has to be considered and reevaluated in the near future.

rèrent améliorés. Les neuf autres paramètres cliniques se sont détériorés chez eux après supplémentation en lécithine ou en huile de carthame. Cette détérioration fut d'environ 8% moins importante après la période de prise d'huile de carthame. Cette étude met l'emphase sur la nécessité d'inclure des témoins normaux et des méthodes objectives d'évaluation clinique dans la réalisation d'un essai thérapeutique pour une maladie évolutive comme l'ataxie de Friedreich. Les résultats surprenant obtenus à l'aide de l'huile de carthame, remettent en question l'implication relative de la choline et de l'acide linoléique dans l'amélioration perçue chez certains patients. Ceci devrait faire l'objet d'une réévaluation dans un avenir prochain.

INTRODUCTION

In a recent publication, Livingstone et al. (1981) reported some functional improvement in upper limb coordination in three of seven patients with Friedreich's Ataxia, four of six patients with primary cerebellar degeneration and three of seven patients with mixed ataxia, after twelve weeks of oral choline chloride supplements. More recently, Pentland et al, (1981) failed to demonstrate any significant difference in upper limb functions (timed handwriting, spiral drawing and rapid repetitive finger movements) in twelve patients with Friedreich's Ataxia supplemented with pure lecithin during the first and the third month of a threemonth period.

The present study was initiated in the early months of 1980 and terminated in the summer of 1981. Twenty-two patients with Friedreich's Ataxia and ten normal controls were given oral supplements of either lecithin or placebo in a double-blind crossover study which aimed at confirming previously published reports, stating some clinical improvements in muscle strength and coordination after lecithin therapy.

A detailed description of the patients, materials and methods will be found in the previous paper of this issue. We wish to report here the results of a thorough clinical appraisal and discuss the effect of lecithin on some specific clinical features of Friedreich's Ataxia.

RESULTS

The data were gathered according to group assignation (A or B) and functional stages (0 to V). The abbreviations used in the text and table are as follows: A and B refer to patients

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Reprint requests for the entire supplement on Friedreich's Ataxia (Phase Three, Part Two) to: Prof. André Barbeau, Clinical Research Institute of Montreal, 110 West Pine Avenue, Montreal, Quebec, Canada, H2W 1R7. group; cA and cB to controls for respective group; 1 or r to left or right; L to lecithin and P to placebo (which was made of a linoleic acid-rich preparation of safflower oil). I refers to improved, W to worsened and S to stable.

a) Joint mobility and musculoskeletal deformities

We observed very little change in the degree of amplitude of the four joints studied (tables Ia and Ib). Flexion of the shoulder and flexion of the first toe were reduced during the second sixmonth period in both groups whether on lecithin or safflower oil. No noticeable deformities were observed in any patient during the twelve-month therapeutic trial.

b) Muscle function

Results of the *semi-quantitative* evaluation of muscle strength are shown in tables IIa and IIb. Safflower oil was more effective than lecithin in stabilizing the muscular performance in both groups: A and B and in stage I and II patients.

Results of the dynamometer studies are detailed in tables III to XI. Most patients improved their performance and did so to a greater extent after the second six-month period, whether on lecithin or safflower oil. Stage I patients demonstrated a significant mean improvement of 17% in muscle strength with lecithin in comparison with safflower oil (table XII). Stage II patients showed no significant difference in improvement with either supplement. Stage III patients had an apparent 9% mean improvement in muscle strength with lecithin but this result could be ascribed to two specific muscle functions: extension of the second finger (table VII) and eversion of the foot (table XI). With regards to this last function, their placebo score was the only negative mean value encountered during the dynamometer study. Our single stage IV patient showed a mixed pattern of improvement in favour of placebo for the upper extremities and lecithin for the lower extremities.

c) Ataxia, coordination and motor accuracy

The corridor test (table XIII) disclosed a marked difference between patients and controls; there was a slight advantage in favour of safflower oil over lecithin in both groups of patients, and to some extent in stage I patients. Comparable results were observed with repetitive movements of the foot (table XIV). The other two coordination and motor accuracy tests for the knee (table XV) and hip (XVI) showed deterioration in patient's performance after the second six-month period without regard for the supplement used. The timed stability tests were not altered by either lecithin or safflower oil supplements (table XVII). It was felt that stationary equilibrium was best evaluated with eyes closed in stage I patients, and with eyes opened in stages II and III patients.

UPPER EXTREMITIES

Results of the SCSIT motor accuracy test (table XVIII) revealed major improvement in accuracy scores after the second trial period. However when these scores were adjusted for time needed to complete the test, it became obvious that practice had little to do with the results. Safflower oil was more effective than lecithin in group A patients but less so in group B patients. According to stages, lecithin proved effective on accuracy alone. It was impossible to suggest any trend towards improvement by one or the other supplement with adjusted scores. The number of repetitive movements of the finger increased with time rather than with therapy except for the two stage I and the one stage IV patients on placebo (table XIX). Distal coordination improved (table XX) and proximal coordination deteriorated (table XXI) when group A patients went from lecithin to safflower oil. Group B patients were unaffected by the crossover. Patients from stages II and III appeared to benefit from safflower oil supplements with regards to distal coordination only (table XX). Results of the meter-nose test went to the advantage of lecithin for the normal controls and for the single stage IV patient (table XXII).

d) Functional tests

The climbing and sitting tests had to be eliminated from the original battery because of difficulty in interpretation and excessive fatigue and stress for some patients.

Results of five timed functional tests which could be correlated with the results of the questionnaire are given in tables XXIII and XXIV. The minus (-) sign means improvement over the pretrial evaluation. Running without or with support deteriorated slightly with repetition. On the contrary, the "tshirt" and the "lacing" tests improved with practice. "Speech" was slightly improved in both groups of patients while on safflower oil. According to stages (table XXIV), lecithin was more effective with regards to "clothing" for stages I, II and III, while safflower oil was more valuable for "shoe lacing" and "speech" in stages II, III and IV.

The untimed functional tests results are given in table XXV. There was an overall loss in mean achievement for both groups. Lecithin was more effective than safflower oil in minimizing the ill-effects of the disease according to group assignation. There was however no trend towards improvement with lecithin according to stages other than stage IV.

e) Questionnaire

In answer to the questionnaire, patients in group A felt that they were improved with either supplements, while patients in group B felt deteriorated (table XXVI). According to stages, safflower oil was subjectively more effective than lecithin. Details of the answers appear in table XXVII. Difficulties in transfer and hygiene were of major concern to patients and parents. Answers as to feelings of improvement or worsening for feeding, clothing and speech were in agreement with data gathered through quantitative tests (table XXIII). The subjective improvement in handwriting was not in agreement with the results of the SC-SIT test (table XVIII) which showed an equal number of gain and loss.

A summary of the mean percent changes in all clinical parameters tested over a one-year period is shown in table XXVIII. This summary demon-

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PEF	CENT CHANGES IN	ti JOINT M	ABLE Ia OBILITY BY G	ROUP OF PAT	IENIS	
		AND SING	LE ARTICULAT	ION		
HOULDER	Flexi		Int.	Rotation	Ext. F	otation
	left	right	left	right	left	right
L	-2.7	-0.3	0	0	-2.7	0
Ρ.	-6.8	-1.1	0	0	0	0
Р	-7.7	-1.8	-0.9	-1.8	0	0
L	-11.5	-9.1	-0.9	-0.9	0	0
<u>19</u>	Extens	sion	Int.	Rotation	Ext. I	otation
	left	right	left	right	left	right
L	0	0	0	+1.4	0	0
Р	+4.5	+5.4	0	0	0	0
P	-1.4	-1.4	0	0	+1.4	+0.9
L	-0.9	+0.9	-1.4	-1.4	+0.9	0
NKLE	Dorsal fl	exion	Ev	ersion	Inve	ersion
	left	right	left	right	left	right
L	+0.9	-1.1	0	+0.9	-2.3	-2.7
P	+0.2	-0.9	0	0	+0.9	-0.9
þ	+2.7	+4.1	0	0	0	0
	-0.7	-6.4	0	0	0	0
IRST TOE		<u> </u>	Flexi	on		
			Left	Right		
L			+1.1	-1.4		
Ρ			-2.4	-3.6		
P			-3.4	+0.4		
L			-7.3	+2.3		
			TABLE Ib			-
	MEAN PER	CENT CHAN	KGE IN JOINT	MOBILITY (A	<u>AT</u>	
	ARTICU	LATIONS A	ND ALL PATIE	NTS GROUPE	<u>))</u>	
JOINT		P (Sa	fflower)		L (Lecithin)	
Shoulder		-	1.6%		-2.3%	
Hip		+	0.7%		0.0%	
Ankle		+	0.5%		-0.9%	
First toe		-	-2.28		-1.3%	
	PERCENT CHANG	e in muso	TABLE IIa	(SEMI-OUAN	FITATIVE)	
	AC	CORDING 1	TO GROUP ASS	IGNATION	/	
GROUP	MFAN		RANG	5	OUTCOME	
 AL	-2.78		(-20 to +5	- 5.4)	I = 5 W = 6	
AP	-1,7%		(-9.6 to +)	3.6)	I=5 W=6	
BP	/10		(-6.2 to +0	9.4)	I = 5 W = 5	S = 1
BI.	-4 19		(-9.7 to /	3.0)	T = 0 W = 9	- S=2
-						

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		TABLE IIb	
	MEAN PERCENT	CHANCE IN MUSCLE STRENCTH	(SEMI-QUANTITATIVE)
		ACCORDING TO STAGES	
STAGES	<u>n</u>	P (SAFFLOWER)	L (LECITHIN)
I	(2)	+6.1%	-2.0%
11	(11)	+1.4%	-1.8%
III	(8)	-3.8%	-6.3%
IV	(1)	-4.5%	-3.7%

		TABLE III	
QUANT	ITATIVE MUSCLE STREN	GTH EVALUATION IN FRIEDR	EICH'S ATAXIA:
	FLE	XION OF THE NECK	
GROUP	MEAN	RANGE	OUTCOME
AL.	+29.4%	(-18 to +108%)	I=9 W=2
AP	+46.9%	(-13 to +158%)	I = 8 W = 3
BP	+26.7%	(-31 to +166%)	I = 8 W = 3
BL	+62.0%	(-14 to + 300%)	I = 9 W = 2
STAGES	<u>n</u>	P (Safflower)	L (lecithin)
I	2	+ 26%	+ 22%
II	11	+ 35%	+ 57%
111	8	+ 27%	+ 24%
IV	1	+158%	+108%

		TABLE TV	
QUA	NTITATIVE MUSCLE STR	ENGTH EVALUATION IN FRIED	REICH'S ATAXIA:
	ABDUCT	FION OF THE SHOULDERS	
GROUP	MEAN	RANGE	OUTCOME
AL1	+ 52.7%	(-12 to +182%)	I = 10 W = 1
ALr	+64.6%	(- 0 to +190%)	I = 9 W = 0 S = 2
	+57.1%		
AP1	+54.4%	(- 7 to +136%)	I = 9 W = 2
APr	+60.5%	(- 4 to +126%)	I = 9 W = 1 S = 1
	+ 57.4%		
BP1	+ 45.5%	(-20 to +189%)	I = 9 W = 2
BPr	+86.7%	(-19 to +333%)	I = 9 W = 1 S = 1
	+66.1%		
BLI	+67.3%	(-10 to +187%)	I=9 W=2
BLr	+94.4%	(- 0 to +350%)	I =11
	+80.8%		
STAGES	<u>n</u>	P_(Safflower)	L (lecithin)
I	2	+148	+ 36%
11	11	+ 69%	+ 79%
III	8	+ 46%	+ 478
TV	1	+ 158%	+186%

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		TABLE V		l I		TABLE VII	
QUANTI	ITATIVE MUSCLE STREN	OTH EVALUATION IN FRIEDRE	CICH'S ATAXIA:				
	ABDUCTIC	IN OF THE FIFTH FINGER		QUANITIA	TIVE MUSCLE STRENGT	VEVALUATION IN FRIEDREICH	SATAXIA AND
GROUP	MEAN	RANGE	OUTCOME		NORMAL CONTROLS:	EXTENSION OF THE SECOND F	INGER
AL1	+ 52%	(-13 to +160%)	I = 8 W = 3	GROUP	MEAN	RANGE	OUTCOME
ALr	+ 21%	(-45 to +300%)	$I = 5 W \approx 5 S \equiv 1$	AL	+ 44%	(-23 to +233%)	I = 9 W = 2
	+36%			CAL	+ 26%	(+21 to + 36%)	I = 4
AP1	+99%	(+6 to +270%)	I = 11		. 200	())	
APr	+62%	(0 to +260%)	I = 10 S = 1	AP	+ 72%	(-20 to +471 s)	I = 8 W = 1 S = 2
	+80%			CAP	+ 56%	(0 to +10/%)	1 <u>-</u> 3 S = 1
BP1	+ 36%	(-14 to +120%)	I = 10 W = 1	BP	+55%	(-27 to +200%)	I =10 W = 1
BPr	+43%	(-45 to +156%)	I = 8W = 1S = 2	CBP	+ 20%	(+8 to + 26%)	I = 6
	+ 39%			70	+1179	(-38 to +2338)	T - 10 W - 1
	+ 700				+ 559	(30 to + 2338)	
BLI	+ 78%	(-9 to +1668)	1 = 9 W = 1 5 = 1		956 1	(120 00 + 308)	1=4 5=2
BLT	+83%	(- / to + 3208)	1 = 10 w = 1				
	+808						
				STAGES	n	P (Safflower)	L (Lecithin)
STAGES	n	P_(Safflower)	L (Lecithin)	0	10	+ 34%	+ 33%
I	2	+ 7%	+ 39%	I	2	+ 36%	+63%
11	11	+ 68%	+ 55%	11	11	+ 74%	+ 70%
III	8	+ 46%	+65%	III	8	+ 32%	+ 77%
IV	1	+121%	+ 55%	IV	1	+ 269%	+109%
				1			
		TABLE VI				TABLE VIII	
QUANT	NITATIVE MUSCLE STRE	TABLE VI	EICH'S ATAXIA:	QUANTI	TATIVE MUSCLE STREM	TABLE VIII	ICH' S ATAX TA-
QUANT	NITATIVE MUSCLE STRE PALMAR INT	TABLE VI NGTI' EVALUATION IN FRIEDR EROSSEOUS (SECOND FINGER)	eich's ataxia:	QUANTI	ITATIVE MUSCLE STREM	TABLE VIII STH EVALUATION IN FRIEDRE FION OF THE HIP	ICH'S ATAXIA:
QUANT	nitative muscle stree Paimar int Mean	TABLE VI NGD' EVALUATION IN FRIEDR EROSSEOUS (SECOND FINGER) RANGE	EICH'S ATAXIA:	QUANT	ITATIVE MUSCLE STREM <u>ABDUCT</u> <u>MEAN</u>	TABLE VIII ETH EVALUATION IN FRIEDRE FION OF THE HIP RANGE	ICH'SATAXIA: OUTCOME
<u>QUANT</u> <u>GROUP</u> AL1	NITATIVE MUSCLE STRE PAIMAR INT MEAN +218	TABLE VI NGB' EVALUATION IN FRIEDR EROSSEDUS (SECOND FINGER) <u>RANGE</u> (-54 to + 85%)	EICH'S ATAXIA: <u>OUTOOME</u> I = 7 W = 4	QUANT GROUP	ITATIVE MUSCLE STREM <u>ABDUCT</u> <u>MEAN</u>	TABLE VIII 3TH EVALUATION IN FRIEDRE FION OF THE HIP RANSE	ich'sataxia: Outoome
<u>QUANT</u> <u>GROUP</u> ALL ALT	NTATIVE MUSCLE STRE PALMAR INT MEAN +218 +218	TABLE VI NGTI' EVALUATION IN FRIEDR EROSSEDUS (SECOND FINGER) RANGE (-54 to + 85%) (-45 to +100%)	EICH'S ATAXIA: $\frac{OUTCOME}{I = 7 W = 4}$ $I = 7 W = 4$	QUANTI GROIP ÀLI	ITATIVE MUSCLE STREM ABDUCT MEAN +1408	TABLE VIII STH EVALUATION IN FRIEDRE FION OF THE HIP RANSE (- 5 to +800)	<u>CCH'SATTAXIA:</u> <u>OUTCOME</u> I = 8 W = 2 S = 1
<u>QUANT</u> <u>GROUP</u> ALL ALL	NTATIVE MUSCLE STRE PALMAR INT MEAN + 218 + 218 + 218	TABLE VI NGD' EVALUATION IN FRIEDR EROSSEOUS (SECOND FINGER) RANGE (-54 to + 85%) (-45 to +100%)	<u>OUTCOME</u> I = 7 W = 4 I = 7 W = 4	QUANTI GROUP ÀLL ALT	ITATIVE MUSCLE STREM ABDUCT MEAN +1408 +1358	TABLE VIII <u>ETH EVALUATION IN FRIEDRE</u> <u>FION OF THE HIP</u> <u>RANGE</u> (- 5 to +800) (0 to +780)	<u>OUTCOME</u> I = 8 W = 2 S = 1 I = 10 W = 1
QUANT GROUP ALL ALT AP1	MUSCLE STEE PAIMAR INT MEAN + 21% + 21% + 21% + 50%	TABLE VI NGD' EVALUATION IN FRIEDR EROSSEDUS (SECOND FINGER) RANGE (-54 to + 85%) (-55 to +100%) (- 8 to +140%)	<u>OUTICOME</u> I = 7 W = 4 I = 7 W = 4 I = 10 W = 1	QUANTI GROUP ÀLI ALI	ITATIVE MUSCLE STREM ABDUCT MEAN +1408 +1358 +1378	TABLE VIII <u>STH EVALUATION IN FRIEDRE</u> <u>FION OF THE HIP</u> <u>RANGE</u> (- 5 to +800) (0 to +780)	<u>CONTCOME</u> I = 8 W = 2 S = 1 I = 10 W = 1
QUANT GROUP AL1 AL1 AL1 AP1 AP1	MUSCLE STRE PAIMAR INT MEAN + 218 + 218 + 218 + 508 + 638	TABLE VI NGD' EVALUATION IN FRIEDR EROSSEOUS (SECOND FINGER) RANSE (-54 to + 85%) (-45 to +100%) (-8 to +140%) (-31 to +275%)	<u>OUTCOME</u> I = 7 W = 4 I = 7 W = 4 I = 10 W = 1 I = 8 W = 3	<u>QUANT</u> <u>GROIP</u> AL1 ALr AP1	ITATIVE MUSCLE STREM ABDUCT MEAN + 140% + 135% + 137% + 47%	TABLE VIII TH EVALUATION IN FRIEDRE FION OF THE HIP RANSE (- 5 to +800) (0 to +780) (-10 to +85)	<u>OUTCOME</u> I = 8 W = 2 S = 1 I = 10 W = 1 I = 8 W = 1
<u>Quant</u> <u>Group</u> All Alr Ap1 Ap1	MITATIVE MUSCLE STRE PALMAR INT MEAN + 21% + 21% + 50% + 63%	TABLE VI NGD' EVALUATION IN FRIEDR EROSSEOUS (SECOND FINGER) RANGE (-54 to + 85%) (-45 to +100%) (-8 to +140%) (-31 to +275%)	<u>OUTCOME</u> I = 7 W = 4 I = 7 W = 4 I = 10 W = 1 I = 8 W = 3	<u>QUANTI</u> GROUP ÅLI ALr AP1 AP1	ITATIVE MUSCLE STREM MEAN +1408 +1358 +1378 + 478 + 678	TABLE VIII STH EVALUATION IN FRIEDRE: FION OF THE HIP RANCE (- 5 to +800) (- 5 to +800) (- 5 to +800) (- 10 to +780) (-10 to +85) (-46 to +200)	<u>OUTCOME</u> I = 8 W = 2 S = 1 I = 10 W = 1 I = 8 W = 1 I = 9 W = 1
<u>QUANT</u> GROUP ALL ALL AP1 AP1	NTATIVE MUSCLE STRE PALMAR INT MEAN + 21% + 21% + 21% + 50% + 63% + 56%	TABLE VI NSTB' EVALUATION IN FRIEDR EROSSEOUS (SECOND FINGER) RANSE (-54 to + 85%) (-45 to +100%) (-8 to +140%) (-31 to +275%)	<u>OUTCOME</u> I = 7 W = 4 I = 7 W = 4 I = 10 W = 1 I = 8 W = 3	<u>QUANTI</u> <u>GROUP</u> ÀLI ALI AP1 AP1	ITATIVE MUSCLE STREM ABDUCT MEAN +1408 +1358 +1378 + 478 + 678 + 578	TABLE VIII GTH EVALUATION IN FRIEDRE: FION OF THE HIP RANCE (-5 to +800) (0 to +780) (-10 to +85) (-46 to +200)	<u>OUTCOME</u> I = 8 W = 2 S = 1 I = 10 W = 1 I = 8 W = 1 I = 9 W = 1
QUANT GROUP AL1 AL1 AP1 AP1 BP1	NTATIVE MUSCLE STEE PAIMAR INT MEAN + 21% + 21% + 21% + 50% + 63% + 55% + 53%	TABLE VI NGD' EVALUATION IN FRIEDR EROSSEDUS (SECOND FINGER) RANSE (-54 to + 85%) (-54 to + 85%) (-45 to +100%) (-31 to +275%) (-33 to +200%)	<u>OUTICOME</u> I = 7 W = 4 I = 7 W = 4 I = 10 W = 1 I = 8 W = 3 I = 9 W = 2	<u>QUANT</u> <u>GROUP</u> AL1 ALr AP1 AP1 APr BP1	ITATIVE MUSCLE STREM MEAN +1408 +1358 +1378 + 478 + 678 + 578 + 638	TABLE VIII <u>3TH EVALUATION IN FRIEDRE</u> <u>FION OF THE HIP</u> <u>RANSE</u> (- 5 to +800) (0 to +780) (-10 to +85) (-46 to +200) (-21 to +440)	<u>ICH'SATAXIA:</u> <u>OUTCOME</u> I = 8 W = 2 S = 1 I = 10 W = 1 I = 8 W = 1 I = 9 W = 1 I = 8 W = 2 S = 1
QUANT GROUP AL1 ALr AP1 AP1 APr BP1 BP1	MUSCLE STREE PAIMAR INT MEAN + 218 + 218 + 218 + 508 + 638 + 538 + 638	TABLE VI NGD' EVALUATION IN FRIEDR EROSSEOUS (SECOND FINGER) RANGE (-54 to + 85%) (-45 to +100%) (-31 to +140%) (-31 to +275%) (-33 to +200%) (-13 to +160%)	EICH'S ATAXIA: OUTCOME I = 7 W = 4 I = 7 W = 4 I = 10 W = 1 I = 8 W = 3 I = 9 W = 2 I = 9 W = 1 S = 1	QUANTI GROUP ALI ALI AP1 AP1 AP1 BP1 BP1 BP1	ITATIVE MUSCLE STREM MEAN + 1408 + 1358 + 1378 + 478 + 678 + 578 + 638 + 968	TABLE VIII ETH EVALUATION IN FRIEDRE FION OF THE HIP RANGE (- 5 to +800) (0 to +780) (-10 to +85) (-46 to +200) (-21 to +440) (-15 to +440)	$\frac{\text{OUTCOME}}{\text{I} = 8 \ \text{W} = 2 \ \text{S} = 1}$ $I = 8 \ \text{W} = 2 \ \text{S} = 1$ $I = 10 \ \text{W} = 1$ $I = 8 \ \text{W} = 1$ $I = 9 \ \text{W} = 1$ $I = 8 \ \text{W} = 2 \ \text{S} = 1$ $I = 7 \ \text{W} = 3 \ \text{S} = 1$
QUANT GROUP AL1 ALr AP1 AP1 APr BP1 BP1	NTATIVE MUSCLE STRE PALMAR INT MEAN + 218 + 218 + 218 + 508 + 638 + 558 + 538 + 638 + 538 + 538	TABLE VI NGD' EVALUATION IN FRIEDR EROSSEOUS (SECOND FINGER) (-54 to + 85%) (-45 to +100%) (-8 to +140%) (-31 to +275%) (-33 to +200%) (-13 to +160%)	EICH'S ATAXIA: <u>OUTCOME</u> I = 7 W = 4 I = 7 W = 4 I = 10 W = 1 I = 8 W = 3 I = 9 W = 2 I = 9 W = 1 S = 1	QUANTI GROUP ÅLI ALT AP1 AP1 BP1 BP1 BP1	ITATIVE MUSCLE STREM MEAN +1408 +1358 +1358 +1378 + 478 + 678 + 578 + 638 + 968 + 798	TABLE VIII STH EVALUATION IN FRIEDRE: FION OF THE HIP RANCE (-5 to +800) (0 to +780) (-10 to +85) (-46 to +200) (-21 to +440) (-15 to +440)	<u>OUTCOME</u> I = 8 W = 2 S = 1 I = 10 W = 1 I = 8 W = 1 I = 9 W = 1 I = 8 W = 2 S = 1 I = 7 W = 3 S = 1
QUANT GROUP AL1 ALT AP1 AP1 APr EP1 BPr EL1	MEAN +21% +21% +21% +50% +63% +53% +53% +63% +58% +66%	TABLE VI NGD' EVALUATION IN FRIEDR EROSSEOUS (SECOND FINGER) (-54 to + 85%) (-45 to +100%) (-45 to +100%) (-31 to +275%) (-33 to +200%) (-13 to +160%) (-40 to +266%)	EICH'S ATAXIA: OUTCOME I = 7 W = 4 I = 7 W = 4 I = 10 W = 1 I = 8 W = 3 I = 9 W = 2 I = 9 W = 1 S = 1 I = 9 W = 2	QUANTI GROUP ÀLI ALI AP1 AP1 APr BP1 BP1 BP1 BP1 BP1	ITATIVE MUSCLE STREM ABDUCT MEAN +1408 +135% +137% + 47% + 67% + 57% + 63% + 96% + 79% + 80%	TABLE VIII <u>STH EVALUATION IN FRIEDRE</u> <u>FION OF THE HIP</u> <u>RANGE</u> (-5 to +800) (0 to +780) (-10 to +85) (-46 to +200) (-21 to +440) (-15 to +440) (0 to +240)	$\frac{\text{OUTCOME}}{\text{I} = 8 \ \text{W} = 2 \ \text{S} = 1}$ $I = 8 \ \text{W} = 2 \ \text{S} = 1$ $I = 10 \ \text{W} = 1$ $I = 8 \ \text{W} = 1$ $I = 9 \ \text{W} = 1$ $I = 8 \ \text{W} = 2 \ \text{S} = 1$ $I = 7 \ \text{W} = 3 \ \text{S} = 1$ $I = 9$
QUANT GROUP AL1 ALr AP1 APr BP1 BPr BL1 BL1 BLr	NTATIVE MUSCLE STEE PALMAR INT MEAN + 21% + 21% + 21% + 50% + 63% + 55% + 53% + 63% + 56% + 66% + 87%	TABLE VI NGD' EVALUATION IN FRIEDR EROSSEDUS (SECOND FINGER) RANKE (-54 to + 85%) (-45 to +100%) (-45 to +100%) (-31 to +275%) (-33 to +200%) (-13 to +160%) (-40 to +266%) (+2 to +260%)	EICH'S ATAXIA: OUTCOME I = 7 W = 4 I = 7 W = 4 I = 10 W = 1 I = 8 W = 3 I = 9 W = 2 I = 11	QUANTI GROUP ÀLL ALT AP1 AP1 AP7 BP1 BP7 BL1 ELT	ITATIVE MUSCLE STREM ABDUCT MEAN +1408 +1358 +1358 +1378 + 478 + 678 + 578 + 638 + 968 + 798 + 808 + 718	TABLE VIII ETH EVALUATION IN FRIEDRE: TION OF THE HIP RANGE (-5 to +800) (0 to +780) (-10 to +85) (-46 to +200) (-21 to +440) (-15 to +440) (0 to +240) (-42 to +300)	<u>COTCOME</u> I = 8 W = 2 S = 1 I = 10 W = 1 I = 8 W = 1 I = 9 W = 1 I = 8 W = 2 S = 1 I = 7 W = 3 S = 1 I = 9 I = 9 W = 1
QUANT GROUP AL1 ALr AP1 AP1 APr BP1 BPr BL1 BLr	MEAN +218 +218 +218 +218 +218 +508 +508 +538 +568 +538 +538 +588 +588 +668 +878 +765	TABLE VI NGD' EVALUATION IN FRIEDR EROSSEOUS (SECOND FINGER) (-54 to + 85%) (-45 to +100%) (-45 to +100%) (-31 to +275%) (-33 to +200%) (-13 to +160%) (-40 to +266%) (+2 to +260%)	EICH'S ATAXIA: OUTCOME I = 7 W = 4 I = 7 W = 4 I = 7 W = 4 I = 10 W = 1 I = 8 W = 3 I = 9 W = 2 I = 11	QUANTI GROUP ÀLI ALI API API BPI BPI BPI BLI ELI	ITATIVE MUSCLE STREM ABDUCT MEAN + 1408 + 1358 + 1358 + 1378 + 478 + 678 + 578 + 638 + 968 + 798 + 808 + 718 + 758	TABLE VIII STABLE VIII STABLE VIII STABLE VIII ITON OF THE HIP RANCE (-5 to +800) (0 to +780) (-10 to +85) (-46 to +200) (-21 to +440) (-15 to +440) (-15 to +240) (-42 to +300)	$\frac{OUTCOME}{I = 8 \ W = 2 \ S = 1}$ $I = 8 \ W = 2 \ S = 1$ $I = 10 \ W = 1$ $I = 8 \ W = 1$ $I = 9 \ W = 1$ $I = 7 \ W = 3 \ S = 1$ $I = 9$ $I = 9 \ W = 1$
QUANT GROUP AL1 ALr AP1 AP1 BP1 BP1 BPr BL1 BLr	MUSCLE STEE PALMAR INT MEAN + 21% + 21% + 21% + 50% + 63% + 56% + 53% + 66% + 87% + 76%	TABLE VI NGD' EVALUATION IN FRIEDR EROSSEDUS (SECOND FINGER) RANKE (-54 to + 85%) (-45 to +100%) (-45 to +140%) (-31 to +275%) (-33 to +200%) (-13 to +160%) (-40 to +266%) (+2 to +260%)	EICH'S ATAXIA: OUTCOME I = 7 W = 4 I = 7 W = 4 I = 0 W = 1 I = 8 W = 3 I = 9 W = 2 I = 9 W = 1 S = 1 I = 9 W = 2 I = 1 S = 1	QUANTI GROUP ALI ALr AP1 AP1 APr BP1 BP1 BP1 BP1 BP1 BL1 EL1	ITATIVE MUSCLE STREM MEAN + 1408 + 1358 + 1378 + 478 + 678 + 578 + 638 + 968 + 798 + 80% + 718	TABLE VIII ETH EVALUATION IN FRIEDRE: FION OF THE HIP RANGE (-5 to +800) (0 to +780) (-10 to +85) (-46 to +200) (-21 to +440) (-15 to +440) (0 to +240) (-42 to +300)	ICH'SATAXIA: OUTCOME I = 8 W = 2 S = 1 I = 10 W = 1 I I = 8 W = 1 I I = 9 W = 1 I = 8 W = 2 S = 1 I = 7 W = 3 S = 1 I = 9 I = 9 N = 1
QUANT GROUP AL1 ALr AP1 AP1 APr EP1 BPr BL1 BLr STAGES	MISCLE STREE PALMAR INT MEAN + 218 + 218 + 218 + 508 + 508 + 538 + 638 + 588 + 668 + 878 + 766	TABLE VI NGD' EVALUATION IN FRIEDR EROSSEDUS (SECOND FINGER) (-54 to + 85%) (-54 to + 85%) (-45 to +100%) (-45 to +100%) (-31 to +275%) (-33 to +200%) (-13 to +160%) (-40 to +266%) (+2 to +260%) P (Safflorer)	EICH'S ATAXIA:	QUANTI GROUP ALI ALI AP1 AP1 AP1 BP1 BP1 BP1 BP1 BP1 BL1 ELI	MEAN +1408 +1358 +1378 + 478 + 678 + 578 + 638 + 968 + 798 + 808 + 718 + 758	TABLE VIII STABLE VIII (-10 to + 85) (-21 to + 440) (-12 to + 240) (-42 to + 300)	ICH'SATAXIA: OUTCOME I = 8 W = 2 S = 1 I = 8 W = 1 I I = 8 W = 1 I I = 8 W = 2 S = 1 I = 7 W = 3 S = 1 I = 9 I = 9 N = 1
QUANT GROUP AL1 ALr AP1 AP1 APr BP1 BPr BL1 BLr STAGES I	MIATIVE MUSCLE STEP PALMAR INT MEAN + 21% + 21% + 21% + 50% + 63% + 55% + 63% + 53% + 66% + 87% + 76% <u>n</u> 2	TABLE VI NSTD' EVALUATION IN FRIEDR EROSSEDUS (SECOND FINGER) (-54 to + 85%) (-54 to + 85%) (-45 to +100%) (-45 to +100%) (-31 to +275%) (-33 to +200%) (-13 to +160%) (-40 to +266%) (+2 to +260%) P (Safflower) +26%	EICH'S ATAXIA:	QUANTI GROUP ÀLL ALI API API BPI BPI BLI ELI ELI ELI ELI	ITATIVE MUSCLE STREM ABDUCT MEAN + 1408 + 1358 + 1358 + 1378 + 478 + 678 + 578 + 638 + 968 + 798 + 80% + 718 + 758	TABLE VIII <u>STH EVALUATION IN FRIEDRE</u> <u>FION OF THE HIP</u> <u>RANGE</u> (-5 to +800) (0 to +780) (-10 to +85) (-46 to +200) (-21 to +440) (-21 to +440) (-15 to +440) (-15 to +440) (-42 to +300) <u>P (Safflower)</u> + 300	$\frac{\text{OUTCOME}}{\text{I} = 8 \ \text{W} = 2 \ \text{S} = 1}$ $I = 8 \ \text{W} = 2 \ \text{S} = 1$ $I = 10 \ \text{W} = 1$ $I = 8 \ \text{W} = 1$ $I = 9 \ \text{W} = 1$ $I = 7 \ \text{W} = 3 \ \text{S} = 1$ $I = 9 \ \text{I} = 9 \ \text{W} = 1$ $I = 9 \ \text{W} = 1$ $\frac{I}{\text{I}} = 9 \ \text{W} = 1$ $\frac{I}{\text{I}} = 1 \ \text{W} = 1$ $\frac{I}{\text{I}} = 1 \ \text{W} = 1$
QUANT GROUP ALL ALr AP1 APr BP1 BPr BL1 BLr STAGES I I JI	NTATIVE MUSCLE STEP PAIMAR INT MEAN + 21% + 21% + 21% + 50% + 63% + 55% + 55% + 55% + 56% + 56% + 56% + 56% + 56% + 56% + 56% + 56% + 56% + 56% + 56% + 56% + 57% + 76% <u>1</u> 2 11	TABLE VI NGD' EVALUATION IN FRIEDR EROSSEDUS (SECOND FINGER) RANKE (-54 to + 85%) (-54 to + 85%) (-45 to +100%) (-31 to +275%) (-33 to +200%) (-13 to +160%) (-40 to +266%) (+2 to +260%) P (Safflorer) +26% +65%	EICH'S ATAXIA:	QUANTI GROUP ÀLL ALr AP1 AP1 AP1 BP1 BP7 ELL ELT ELL ELT I	ITATIVE MUSCLE STREM ABDUCT MEAN +1408 +1358 +1378 + 478 + 678 + 578 + 638 + 968 + 798 + 808 + 718 + 758	TABLE VIII ETH EVALUATION IN FRIEDRE: TION OF THE HIP RANCE (-5 to +800) (0 to +780) (-10 to +85) (-46 to +200) (-21 to +440) (-21 to +440) (-15 to +440) (-15 to +440) (0 to +240) (-42 to +300) $\frac{P (Safflower)}{+ 308}$	$\frac{\text{CCF'SATAXIA:}}{\text{CUTCOME}}$ $I = 8 \ W = 2 \ S = 1$ $I = 10 \ W = 1$ $I = 8 \ W = 1$ $I = 9 \ W = 1$ $I = 8 \ W = 2 \ S = 1$ $I = 7 \ W = 3 \ S = 1$ $I = 9 \ W = 1$ $I = 9 \ W = 1$ $\frac{L \ (\text{Lecithin})}{+ 388}$
QUANT GROUP ALL ALr AP1 AP1 APr BP1 BPr BL1 BLr STAGES I II III	NTATIVE MUSCLE STEE PALMAR INT MEAN + 218 + 218 + 218 + 508 + 638 + 558 + 638 + 558 + 668 + 878 + 766 11 8	TABLE VI NSD' EVALUATION IN FRIEDR EROSSEDUS (SECOND FINGER) RANSE (-54 to + 85%) (-54 to + 85%) (-45 to +100%) (-45 to +140%) (-31 to +275%) (-33 to +200%) (-13 to +160%) (-40 to +266%) (+2 to +260%) P (Safflower) +26% +50%	EICH'S ATAXIA:	CUANTI GROUP ALI ALI API API BPI BPI BPI BLI ELI ELI ELI I I I I I I I I I I I I I	ITATIVE MUSCLE STREM MEAN +1408 +1358 +1378 + 478 + 678 + 578 + 638 + 968 + 79% + 80% + 71% - 11 2 11 6	TABLE VIII ETH EVALUATION IN FRIEDRE FION OF THE HIP RANSE (-5 to +800) (0 to +780) (-10 to +85) (-46 to +200) (-21 to +440) (-15 to +440) (-15 to +440) (-15 to +440) (-42 to +300) $\frac{P (Safflower)}{+ 308}$ + 61% + 978	$\frac{\text{ICF}'SATAXIA:}{\text{OUTCOME}}$ $I = 8 \ W = 2 \ S = 1$ $I = 10 \ W = 1$ $I = 8 \ W = 1$ $I = 9 \ W = 1$ $I = 8 \ W = 2 \ S = 1$ $I = 7 \ W = 3 \ S = 1$ $I = 9 \ W = 1$ $I = 9 \ W = 1$ $\frac{L \ (\text{Lecithin})}{4 \ 388}$ $+ \ 668$ $+ \ 673$
QUANT GROUP ALL ALr AP1 AP1 APr BP1 BPr BL1 BLr STAGES I II III III IV	MISCLE STREE PALMAR INT MEAN + 218 + 218 + 218 + 218 + 508 + 638 + 538 + 638 + 538 + 668 + 878 + 766 1 8 1	TABLE VI NGD' EVALUATION IN FRIEDR EROSSEDUS (SECOND FINGER) (-54 to + 85%) (-54 to + 85%) (-45 to +100%) (-45 to +100%) (-31 to +275%) (-33 to +200%) (-13 to +160%) (-13 to +160%) (-40 to +266%) (+2 to +260%) P (Safflower) +26% +65% +50% +65%	EICH'S ATAXIA:	QUANTI GROUP ALI ALI API API BPI BPI BPI BLI ELI ELI II III III	ITATIVE MUSCLE STREM MEAN + 1408 + 1358 + 1358 + 1378 + 478 + 678 + 578 + 638 + 968 + 798 + 808 + 718 + 758 11 6 1	TABLE VIII 5TH EVALUATION IN FRIEDRE: FION OF THE HIP RANCE (-5 to +800) (0 to +780) (-10 to +85) (-46 to +200) (-21 to +440) (-15 to +440) (-15 to +440) (-15 to +440) (-42 to +300) $\frac{P(Safflower)}{+308}$ + 618 + 878 + 1108	$\frac{\text{OUTCOME}}{\text{I} = 8 \ \text{W} = 2 \ \text{S} = 1}$ $I = 8 \ \text{W} = 2 \ \text{S} = 1$ $I = 10 \ \text{W} = 1$ $I = 8 \ \text{W} = 1$ $I = 9 \ \text{W} = 1$ $I = 7 \ \text{W} = 3 \ \text{S} = 1$ $I = 7 \ \text{W} = 3 \ \text{S} = 1$ $I = 9 \ \text{W} = 1$ $\frac{\text{I} = 9 \ \text{W} = 1}{\text{I} = 9 \ \text{W} = 1}$ $\frac{\text{L} (\text{Lecithin})}{\text{I} + 388}$ $+ 668$ $+ 638$ $+ 7808$

TABLE XI QUANTITATIVE MUSCLE STRENGTH EVALUATION IN FRIEDREICH'S ATAXIA

		TABLE IX	
QUANFIT	ATIVE MUSCLE STREM	IGTH EVALUATION IN FRIEDRI	EICH SATAXIA:
	EXTEN	ISION OF THE KNEE	
GROUP	MEAN	RANGE	OUTCOME
ALI	+18%	(-38 to +77)	I = 8 W = 3
ALr	+24%	(-25 to +81)	I = 9 W = 2
	+21%		
AP1	+ 31%	(-45 to +96)	I = 8 W = 2
APr	+ 33%	(-50 to +84)	I = 9 W = 1
	+32%		
BP1	+ 74%	(+5 to +322)	I =11
BPr	+ 27%	(-26 to + 94)	I =10 S = 1
	+50%		
BLI	+108%	(0 to + 374)	I =10 W = 1
BLr	+ 45%	(-36 to +133)	I = 8 W = 3
	+ 76%		
<u> </u>			
STAGES	<u>n</u>	P (Safflower)	L (Lecithin)
I	2	+ 7%	+ 29%
11	10	+ 45%	+ 45%
111	8	+ 49%	+ 55%
IV	1	+ 18%	+ 28%

	AND NORMAL CONTROLS:	EVERSION OF THE FOOT	(PERONEAL)
GROUP	MEAN	RANGE	OUTCOME
AL	+ 42%	(-53 to +136%)	I = 7 W = 2
CAL	+ 59%	(+66 to +112%)	I = 2
АР	+ 38%	(-79 to +150%)	I = 7 W = 2
CAP	+115%	(+92 to +153%)	I = 2
BP	+ 10%	(-100 to +150%)	I=6 W=4
CBP	+ 42%	(+12 to + 78%)	I = 3
BL	+ 63%	(- 2 to +133%)	I = 9 W = 2
CBL	+ 62%	(+41 to + 88%)	I = 2
STAGES	<u>n</u>	P (Safflower)	L (Lecithin)
0	5	+ 71%	+608
I	2	+ 5%	+318
11	11	+448	+63%
111	6	-12%	+ 38%
īv	1	NP*	NP*

QUANTITATIVE MUSCLE STRENGTH EVALUATION IN FRIEDREICH'S ATAXIA AND NORMAL CONTROLS: DORSIFLEXION OF THE FOOT

TABLE X

GROUP	MEAN	RANGE	OUTCOME
AL	+11.7%	(-36 to +80%)	1 = 6 W = 2 S = 1
CAL	+21.2%	(-10 to +73%)	I = 3 W = 1
АР	+12.2%	(-31 to +105%)	I=4 W=4 S=1
CAP	+ 58.8%	(+1 to +170%)	I = 3
BP	+28.1%	(-100to +100%)	I=9 S=1
CBP	+28.0%	(-27 to +62%)	I = 4 W = 1
BL	+24.2%	(-54 to +74%)	I = 9 W = 1
CBL	+ 20.0%	(-35 to +62%)	I = 3 W = 1
STAGES	n	P (Safflower)	L (Lecithin)
0	9	+ 39%	+ 20%
I	2	+10%	+ 22%
II	11	+24%	+ 22%
111	5	+12%	+ 48
īv	1	NP*	NP*

* Not possible

Melancon et al.

* Not possible

TABLE XII

QUANTITATIVE MUSCLE STRENGTH EVALUATION IN FRIEDREICH'S ATAXIA: CUMULATIVE MEAN PERCENT IMPROVEMENT IN NINE MUSCLE FUNCTIONS WITH SAFFICMER OIL (P) AND LECITHIN '(L) ACCORDING TO FUNCTIONAL STAGE

	STAGES											
	.0		I		II	[11	1	п	,	I-1	v
MUSCLE FUNCTION	P	L	P	Ľ	P	L	P	L	P	L	P	_L
Neck Flexion	-	-	26	22	35	57	27	24	158	108	36	44
Shoulder Abduction	-	-	14	36	69	79	46	47	158	186	60	68
Finger Abduction	-	-	7	39	69	55	46	65	121	55	57	57
Palmar Interosseous	-	-	36	39	65	49	50	40	65	62	56	45
Finger Extension	34	33	26	63	74	70	32	77	269	109	64	74
Hip Abduction	-	-	30	38	61	66	37	63	110	780	68	98
Knee Extension	-	-	7	29	45	45	49	55	18	28	42	46
Foot Dorsiflexion	39	20	10	22	24	22	12	4	-	-	19	17
Foot Eversion	71	70	5	31	44	63	-12	38	-	-	22	52
MEAN TOTAL GAIN	48	38	18*	35*	54	56	37	46	128	190	47	56
ISD ± SD	-	-	±12	±12	±17	±17	±28	±22	±80	±265	±18	±23

* p < .01 for difference between safflower oil and lecithin

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		TABLE XIII				TABLE XV	
	MEAN CHANGES IN ST	EADINESS OF GAIT (CORRID	DR TEST)		COORDINATION A	ND MOTOR ACCURACY: REPE	TITIVE
					MOV	EMENIS OF THE KNEE	
GROUP	MEAN	RANGE	OUTCOME				
AL	-10.0 cm	(- 300 to + 30 cm)	I=1 W=3 S=2	GROUP	MEAN	RANGE	OUTCOME
CAL	+2.5 cm	(0 to + 10 cm)	I=1 S=3	AL	+ 9%	(-100 to + 44%)	I = 7 W = 3
AP	- 5.0 cm	(- 30 to + 30 cm)	I = 1 W = 2 S = 3	CAL	- 4%	(- 44 to + 22%)	I = 3 W = 1
CAP	+3.3 cm	(0 to +10 cm)	I = 1	AP	-138	(-100 to + 65%)	I = 4 W = 6
BP	-53.7 cm	(-100 to 0 cm)	I=0 W=5 S=3	CAP	- 48	(- 38 to + 26%)	I=1 W=1 S=1
CBP	+2.0 cm	(0 to + 10 cm)		77	50		
ы. cBI.	-62.5 cm +5.0 cm	(-100 to 0 cm)	1 = 0 = 5 = 3	GBP	- 5%	(-32 to + 18%)	I = 3 W = 6
		(0 0 110 0)		C.D.t	1136	(0.001.454)	1 = 5
				BL	-15%	(- 60 to + 23%)	I = 2 W = 6 S = 1
				CBL	+ 25%	(- 8 to + 59%)	I = 2 W = 1 S = 1
STAGES	<u>n</u>	P (Safflower)	L (Lecithin)				
0	8	+ 2.5 cm	+3.7 cm	STACES		D (Safflower)	L (Lecithin)
I	2	-15 cm	-50 cm	5145125	<u></u>	<u>r (surrower)</u>	
11	11	-30 cm	-32.7 cm	0	9	+ 6%	+14%
111	1*	-100 Em	-100 An	I	2	- 88	- 17%
			_		11	+ 6%	+ 5%
					6	- 306	1/0
" Patient	lost additty to walk	during the first six mont	th period				
- Patient		maple vil	ch period		<u></u>		
- Patlent	lost ability to walk (TABLE XIV	ch period			TABLE XVI	
	INATION AND MOTOR ACCU	TABLE XIV	VIS OF THE FOOT		COORDINATION AND	TABLE XVI MOTOR ACCURACY: REPETT	TIVE
	DINATION AND MOTOR ACCU	TABLE XIV RACY: REPETITIVE MOVEMENT	NTS OF THE FOOT		COORDINATION AND	TABLE XVI MOTOR ACCURACY: REPETT MENTS OF THE HIP	TIVE
<u>COORD</u>	INATION AND MOTOR ACCU	TABLE XIV RACY: REPETITIVE MOVEMENT RACY: REPETITIVE MOVEMENT	VITS OF THE FOOT	GROUP	COORDINATION AND MOVE	TABLE XVI MOTOR ACCURACY: REPETT MENTS OF THE HIP RANCE	TIVE
<u>COORD</u> GROUP ALL	MEAN - 14.28	TABLE XIV RACY: REPETITIVE MOVEMENT RANGE (-100 to +130)	$\frac{\text{VTS OF THE FOOT}}{\text{OUTCOME}}$ $I = 3 W = 6 S = 1$	GROUP	COORDINATION AND MOVE	TRELE XVI MOTOR ACCURACY: REPETT MENTS OF THE HIP RANCE	<u>tive</u> <u>Outcome</u>
<u>Coord</u> GROUP ALL ALT	MEAN - 14.28 - 27.28	TABLE XIV TABLE XIV RACY: REPETITIVE MOVEMENT RANGE (-100 to +130) (-100 to + 26)	MTS OF THE FOOT $\frac{OUTCOME}{1 = 3 W = 6 S = 1}$ $I = 3 W = 5 S = 2$	<u>GROU</u> P ALL	COORDINATION AND MOVED MEAN + 7.3% + 4.18	TABLE XVI MOTOR ACCURACY: REPETT MENTS OF THE HIP RANGE (-100 to + 83) (-100 to + 33)	$\frac{\text{OUTCOME}}{\text{I} = 6 \text{ W} = 3 \text{ S} = 1}$
<u>COORD</u> GROUP ALL ALL	MEAN - 14.28 - 27.28 - 20.78 -	TABLE XIV RACY: REPETITIVE MOVEMEN RANGE (-100 to +130) (-100 to + 26)	WIS OF THE FOOT OUTCOME . I = 3 W = 6 S = 1 I = 3 W = 5 S = 2	<u>GROUP</u> ALL ALZ	<u>COORDINATION AND</u> <u>MOVE</u> + 7.38 + 4.18 [+ 5.68]	TABLE XVI MOTOR ACCURACY: REPETT MENTS OF THE HIP RANCE (-100 to + 83) (-100 to + 38)	<u>OUTCOME</u> I = 6 W = 3 S = 1 I = 7 W = 1 S = 2
<u>COORD</u> <u>GROUP</u> ALL ALT AP1	Institution and motor accu MEAN - 14.28 - 27.28 - 20.78 - 25.78 - 40.95	RANGE (-100 to + 130) (-100 to + 26) (-100 to + 26)	$\frac{\text{OUTCOME}}{\text{I} = 3 \text{ W} = 6 \text{ S} = 1 \text{ I} = 3 \text{ W} = 5 \text{ S} = 2 \text{ I} = 2 \text{ W} = 8 \text{ I} = 2 \text{ W} = 8 \text{ I} = 2 \text{ W} = 8 \text{ S} = 1 \text{ I} = 2 \text{ W} = 8 \text{ S} = 1 \text{ I} = 2 \text{ W} = 8 \text{ S} = 1 \text{ I} = 2 \text{ W} = 8 \text{ S} = 1 \text{ I} = 2 \text{ W} = 8 \text{ S} = 1 \text{ I} = 2 \text{ W} = 8 \text{ S} = 1 \text{ I} = 2 \text{ W} = 8 \text{ S} = 1 \text{ I} = 2 \text{ W} = 8 \text{ S} = 1 \text{ I} = 2 \text{ W} = 8 \text{ S} = 1 \text{ I} = 2 \text{ W} = 8 \text{ S} = 1 \text{ I} = 2 \text{ W} = 8 \text{ S} = 1 \text{ I} = 2 \text{ W} = 8 \text{ S} = 1 \text{ I} = 2 \text{ W} = 8 \text{ I} = 2 \text{ I} = 2 \text{ W} = 8 \text{ I} = 2 \text$	GROUP ALL ALT	COORDINATION AND MOVE MEAN + 7.3% + 4.1% (+ 5.6%) - 15.9%	TABLE XVI MOTOR ACCURACY: REPETT MENTS OF THE HIP RANGE (-100 to + 83) (-100 to + 38)	$\frac{\text{OUTCOME}}{\text{I} = 6 \text{W} = 3 \text{S} = 1}$ $\text{I} = 7 \text{W} = 1 \text{S} = 2$ $\text{I} = 6 \text{W} = 4$
COORD GROUP ALL ALT AP1 APT	MEAN - 14.28 - 27.28 - 25.78 - 40.98 (- 33.38)	RACY: REPETITIVE MOVEMENT RANSE (-100 to +130) (-100 to + 26) (-100 to + 46) (-100 to + 20) (-100 to + 20)	$\frac{\text{OUTCOME}}{\text{I} = 3 \text{ W} = 6 \text{ S} = 1 \text{ I} = 3 \text{ W} = 5 \text{ S} = 2 \text{ I} = 2 \text{ W} = 8 \text{ I} = 1 \text{ W} = 8 \text{ S} = 1 \text{ I} = 2 \text{ W} = 8 \text{ I} = 1 \text{ I} = 2 \text{ W} = 8 \text{ I} = 1 \text{ I} = 2 \text{ I} = 8 \text{ I} = 1 \text{ I} = 2 \text{ I} = 8 \text{ I} = 1 \text{ I} = 2 \text{ I} = 8 \text{ I} = 1 \text{ I} = 2 \text{ I} = 8 \text{ I} = 1 \text{ I} = 2 \text{ I} = 8 \text{ I} = 1 \text{ I} = 2 \text{ I} = 8 \text{ I} = 1 \text{ I} = 2 \text{ I} = 8 \text{ I} = 1 \text{ I} = 2 \text{ I} = 8 \text{ I} = 1 \text{ I} = 2 \text{ I} = 8 \text{ I} = 1 \text{ I} = 2 \text{ I} = 2 \text{ I} = 1 \text{ I} = 2 \text{ I} = 2 \text{ I} = 1 \text{ I} = 2 \text$	<u>GROUP</u> ALL ALE AP1 AP1	COORDINATION AND MOVE MEAN + 7.3% + 4.1% + 5.6% - 15.9% - 16.0%	TABLE XVI MOTOR ACCURACY: REPETT RANCE (-100 to + 83) (-100 to + 38) (-100 to + 105) (-100 to + 67) (-100 to + 67)	$\underline{OUTCOME}$ $I = 6 W = 3 S = 1$ $I = 7 W = 1 S = 2$ $I = 6 W = 4$ $I = 4 W = 6$
COORD GROUP ALL ALT AP1 AP1 AP1 BP1	MEAN - 14.28 - 27.28 - 20.78 - 25.78 - 40.98 - 33.38 +51.18	TABLE XIV RACY: REPETITIVE MOVEMED RANGE (-100 to +130) (-100 to + 26) (-100 to + 46) (-100 to + 20) (-2 to +275)	WIS OF THE FOOT OUTCOME \cdot I = 3 W = 6 S = 1 I = 3 W = 5 S = 2 I = 2 W = 8 I = 2 W = 8 S = 1 I = 2 W = 8 S = 1	<u>GROUP</u> ALL AL <i>x</i> AP1 AP1	<u>COORDINATION AND</u> <u>MOVE</u> + 7.38 + 4.18 (+ 5.68) - 15.98 - 16.08 (- 15.98)	TABLE XVI MOTOR ACCURACY: REPETT MENTS OF THE HIP RANCE (-100 to + 83) (-100 to + 38) (-100 to + 105) (-100 to + 67)	$\frac{\text{OUTCOME}}{1 = 6 \ \text{W} = 3 \ \text{S} = 1}$ I = 7 W = 1 S = 2 I = 6 W = 4 I = 4 W = 6
COORD GROUP ALL ALT AP1 AP1 APT BP1 RPT	MEAN - 14.28 - 27.28 - 27.28 - 25.78 - 40.98 - 33.38 + 51.18 + 8.98	TABLE XIV TABLE XIV RACY: REPETITIVE MOVEMENT (-100 to +130) (-100 to + 26) (-100 to + 46) (-100 to + 46) (-100 to + 20) (- 2 to +275) (- 17 to + 37)	TTS OF THE FOOT OUTCOME. I = 3 W = 6 S = 1 I = 3 W = 5 S = 2 I = 2 W = 8 I = 2 W = 8 S = 1 I = 7 W = 1 I = 6 W = 3	GROUP ALL ALr AP1 APr BP1	COORDINATION AND MOVES MEAN + 7.3% + 4.1% + 5.6% - 15.9% - 16.0% - 15.9% + 11.3%	TABLE XVI MOTOR ACCURACY: REPETT MENTS OF THE HIP RANGE (-100 to + 83) (-100 to + 38) (-100 to + 105) (-100 to + 67) (- 26 to + 90)	TIVE $\begin{array}{c} \underline{OUTCOME} \\ I = 6 W = 3 S = 1 \\ \Box = 7 W = 1 S = 2 \\ I = 6 W = 4 \\ I = 4 W = 6 \\ I = 4 W = 4 \end{array}$
GROUP ALL ALL AP1 AP1 AP1 BP1 BP1 BP1	MEAN - 14.28 - 27.28 - 25.78 - 40.98 - 33.38 + 51.18 + 8.98 - 33 8	TABLE XIV TABLE XIV RACY: REPETITIVE MOVEMENT (-100 to + 130) (-100 to + 26) (-100 to + 26) (-100 to + 20) (-2 to + 275) (-17 to + 37)	$\frac{\text{OUTCOME}}{\text{I} = 3 \text{ W} = 6 \text{ S} = 1 \text{ I} = 3 \text{ W} = 5 \text{ S} = 2 \text{ I} = 2 \text{ W} = 8 \text{ I} = 2 \text{ W} = 8 \text{ S} = 1 \text{ I} = 7 \text{ W} = 1 \text{ I} = 6 \text{ W} = 3 \text{ S} = 1 \text{ I} = 6 \text{ W} = 3 \text{ S} = 1 \text{ I} = 1 \text{ I} = 6 \text{ W} = 3 \text{ I} = 3 \text$	GROUP ALI ALr AP1 APr BP1 BP1 BPr	COORDINATION AND MEAN + 7.3% + 4.1% + 5.6% - 15.9% - 16.0% - 15.9% + 11.3% + 44.1%	TABLE XVI MOTOR ACCURACY: REPETT MENTS OF THE HIP RANCE (-100 to + 83) (-100 to + 38) (-100 to + 105) (-100 to + 67) (- 26 to + 90) (- 19 to + 300)	$\frac{\text{DUTCOME}}{\text{I} = 6 \text{W} = 3 \text{S} = 1}$ $\text{I} = 7 \text{W} = 1 \text{S} = 2$ $\text{I} = 6 \text{W} = 4$ $\text{I} = 4 \text{W} = 6$ $\text{I} = 4 \text{W} = 4$ $\text{I} = 4 \text{W} = 4$
COORD GROUP ALL ALT AP1 APT BP1 RPT BLL	MEAN - 14.28 - 27.28 - 20.78 - 25.78 - 40.98 - 33.38 + 51.18 + 8.98 + 30 8 + 29.38	RACY: REPETITIVE MOVEMENT RACY: REPETITIVE MOVEMENT (-100 to +130) (-100 to + 26) (-100 to + 26) (-100 to + 46) (-100 to + 20) (-2 to +275) (-17 to + 37) (-21 to +187)	$\frac{\text{VIS OF THE FOOT}}{\text{OUTCOME}}$ $I = 3 W = 6 S = 1$ $I = 3 W = 5 S = 2$ $I = 2 W = 8$ $I = 2 W = 8 S = 1$ $I = 7 W = 1$ $I = 6 W = 3$ $I = 4 W = 3$	GROUP ALI AL AP1 AP1 AP2 BP1 RP7	MEAN MOVE + 7.3% + 4.1% + 5.6% - 15.9% - 15.9% - 16.0% - 15.9% + 11.3% + 44.1% + 27.7%	TABLE XVI MOTOR ACCURACY: REPETT MENTS OF THE HIP RANCE (-100 to + 83) (-100 to + 38) (-100 to + 105) (-100 to + 67) (- 26 to + 90) (-19 to + 300)	$\frac{\text{OUTCOME}}{\text{I} = 6 \text{W} = 3 \text{S} = 1}$ $\text{I} = 7 \text{W} = 1 \text{S} = 2$ $\text{I} = 6 \text{W} = 4$ $\text{I} = 4 \text{W} = 6$ $\text{I} = 4 \text{W} = 4$ $\text{I} = 4 \text{W} = 4$ $\text{I} = 4 \text{W} = 4$
COORD GROUP ALL ALT AP1 AP1 APT BP1 RPT BLL BLT	$\frac{MEAN}{1} - 14.28$ $- 27.28$ $\frac{- 20.78}{- 25.78}$ $- 40.98$ $\frac{- 33.38}{+ 51.18}$ $+ 8.98$ $\frac{+ 30}{8}$ $+ 11.78$	TABLE XIV TABLE XIV RACY: REPETITIVE MOVEMENT (-100 to +130) (-100 to + 26) (-100 to + 26) (-100 to + 46) (-100 to + 20) (- 2 to +275) (- 17 to + 37) (- 21 to +187) (- 50 to + 37)	The period $\frac{\text{VTS OF THE FOOT}}{\text{OUTCOME}}$ $I = 3 W = 6 S = 1$ $I = 3 W = 5 S = 2$ $I = 2 W = 8$ $I = 2 W = 8 S = 1$ $I = 7 W = 1$ $I = 6 W = 3$ $I = 4 W = 3$ $I = 7 W = 1$	GROUP ALL ALr AP1 APr BP1 RPr BLL	COORDINATION AND MOVE MEAN + 7.3% + 4.1% + 5.6% - 15.9% - 16.0% - 15.9% + 11.3% + 44.1% + 27.7% - 21.6%	TABLE XVI MOTOR ACCURACY: REPETT MENTS OF THE HIP RANGE (-100 to + 83) (-100 to + 38) (-100 to + 105) (-100 to + 67) (- 26 to + 90) (- 19 to + 300) (- 47 to + 20)	TIVE CUTCOME I = 6 W = 3 S = 1 I = 7 W = 1 S = 2 I = 6 W = 4 I = 4 W = 6 I = 4 W = 4 I = 4 W = 4 I = 4 W = 4 I = 1 W = 6
COORD GROUP ALL ALT AP1 AP1 AP1 AP1 BP1 RP7 BL BL BLT	MEAN - 14.28 - 27.28 - 25.78 - 25.78 - 40.98 - 33.38 +51.18 + 8.98 +29.38 +11.78 +20.58	RANGE (-100 to +130) (-100 to +130) (-100 to + 26) (-100 to + 46) (-100 to + 20) (- 2 to +275) (-17 to + 37) (- 21 to +187) (- 50 to + 37)	The period $\frac{OUTCOME}{MTS OF THE FOOT}$ $\frac{OUTCOME}{1} = 3 W = 6 S = 1$ $I = 3 W = 5 S = 2$ $I = 2 W = 8$ $I = 2 W = 8 S = 1$ $I = 7 W = 1$ $I = 6 W = 3$ $I = 4 W = 3$ $I = 7 W = 1$	GROUP ALI ALr AP1 APr BP1 RPr BL1 ELL	COORDINATION AND MOVE MEAN + 7.3% + 4.1% + 5.6% - 15.9% - 16.0% - 15.9% + 11.3% + 44.1% + 27.7% - 21.6% - 35.3%	TABLE XVI MOTOR ACCURACY: REPETT MENTS OF THE HIP RANCE (-100 to + 83) (-100 to + 38) (-100 to + 105) (-100 to + 67) (- 26 to + 90) (- 19 to + 300) (- 47 to + 20) (- 58 to + 3)	TIVE CUTCOME I = 6 W = 3 S = 1 I = 7 W = 1 S = 2 I = 6 W = 4 I = 4 W = 6 I = 4 W = 4 I = 4 W = 4 I = 1 W = 6 I = 1 W = 5 S = 1
COORD GROUP ALL ALT AP1 AP1 APT BP1 RPT ELL BLT	MEAN - 14.28 - 27.28 - 20.78 - 25.78 - 40.98 - 33.38 + 51.18 + 8.98 + 30 % + 29.38 + 11.78 + 20.58	TABLE XIV RACY: REPETITIVE MOVEMENT (-100 to +130) (-100 to +26) (-100 to +26) (-100 to +26) (-100 to +20) (-2 to +275) (-17 to +37) (-21 to +187) (-50 to +37)	TTS OF THE FOOT $CUTCOME .$ $I = 3 \ W = 6 \ S = 1$ $I = 3 \ W = 5 \ S = 2$ $I = 2 \ W = 8$ $I = 2 \ W = 8 \ S = 1$ $I = 7 \ W = 1$ $I = 6 \ W = 3$ $I = 4 \ W = 3$ $I = 7 \ W = 1$	GROUP ALL AL AP1 AP1 APr BP1 RPr BL BL BL BL	MOVE MOVE MOVE + 7.3% + 4.1% + 5.6% - 15.9% - 16.0% - 15.9% + 11.3% + 44.1% + 27.7% - 21.6% - 35.3%	TABLE XVI MOTOR ACCURACY: REPETT MENTS OF THE HIP RANGE (-100 to + 83) (-100 to + 38) (-100 to + 105) (-100 to + 67) (-26 to + 90) (-19 to + 300) (-47 to + 20) (-58 to + 3)	TIVE OUTCOME I = 6 W = 3 S = 1 I = 7 W = 1 S = 2 I = 6 W = 4 I = 4 W = 6 I = 4 W = 4 I = 4 W = 4 I = 1 W = 6 I = 1 W = 5 S = 1
COORD GROUP ALL ALL ALL AP1 AP1 AP1 AP1 BP1 RP1 RP1 BP1 RP1 BL BL BLL BLL BLL BLL	MEAN - 14.28 - 27.28 - 27.28 - 25.78 - 40.98 - 33.38 + 51.18 + 8.98 + 29.38 + 11.78 + 20.58	EXPL EXPL EXPL RACY: REPETITIVE MOVEMED RANGE (-100 to +130) (-100 to +130) (-100 to +26) (-100 to + 46) (-100 to + 20) (-100 to + 20) (-2 to +275) (-17 to + 37) (-21 to +187) (-50 to + 37) (-50 to + 37)	$\frac{\text{OUTCOME}}{\text{OUTCOME}} \cdot \frac{1}{2} = 3 \text{W} = 6 \text{S} = 1 \\ \text{I} = 3 \text{W} = 5 \text{S} = 2 \\ \text{I} = 2 \text{W} = 8 \\ \text{I} = 2 \text{W} = 8 \\ \text{I} = 2 \text{W} = 8 \text{S} = 1 \\ \text{I} = 7 \text{W} = 1 \\ \text{I} = 6 \text{W} = 3 \\ \text{I} = 7 \text{W} = 1 \\ \text{I} = 7 \text{W} = 1 \\ \text{I} = 1 \text{W} = 1 \text{W} = 1 \\ \text{I} = 1 \text{W} = 1 \text{W} = 1 \\ \text{I} = 1 \text{W} = 1 \text{W} = 1 \text{W} = 1 \\ \text{I} = 1 \text{W} = 1 $	GROUP ALL ALr AP1 APr BP1 BP7 BLL BLr	COORDINATION AND MOVE MEAN + 7.38 + 4.18 + 5.68 - 15.98 - 16.08 - 15.98 - 16.08 - 15.98 + 11.38 + 44.18 + 27.78 - 21.68 - 35.38 - 28.48	TABLE XVI MOTOR ACCURACY: REPETT MENTS OF THE HIP RANCE (-100 to + 83) (-100 to + 38) (-100 to + 105) (-100 to + 67) (- 26 to + 90) (- 19 to + 300) (- 47 to + 20) (- 58 to + 3)	TIVE CUTCOME I = 6 W = 3 S = 1 I = 7 W = 1 S = 2 I = 6 W = 4 I = 4 W = 6 I = 4 W = 4 I = 4 W = 4 I = 1 W = 6 I = 1 W = 5 S = 1
COORD GROUP ALL ALT ALT AP1 AP1 APT BP1 RPT BL BLT BLT STAGES I	MEAN - 14.28 - 27.28 - 20.78 - 25.78 - 40.98 - 33.38 + 51.18 + 8.98 + 30 % + 11.78 + 20.58	Exercise First six month TABLE XIV RACY: REPETITIVE MOVEMED RANGE (-100 to +130) (-100 to +130) (-100 to +26) (-100 to + 46) (-100 to + 20) (-2 to +275) (-17 to + 37) (-21 to +187) (-50 to + 37) P (Safflower) +11.68	$\frac{\text{VTS OF THE FOOT}}{\text{OUTCOME}}$ $I = 3 W = 6 S = 1$ $I = 3 W = 5 S = 2$ $I = 2 W = 8$ $I = 2 W = 8 S = 1$ $I = 7 W = 1$ $I = 6 W = 3$ $I = 4 W = 3$ $I = 7 W = 1$ $\frac{L (\text{Lecithin})}{-2.18}$	GROUP ALL ALr AP1 APr BP1 RPr BL1 ELr	MOVE MOVE MOVE + 7.3% + 4.1% + 5.6% - 15.9% - 16.0% - 15.9% + 11.3% + 44.1% + 27.7% - 21.6% - 35.3%	TABLE XVI MOTOR ACCURACY: REPETT MENTS OF THE HIP RANCE (-100 to + 83) (-100 to + 38) (-100 to + 105) (-100 to + 67) (- 26 to + 90) (-19 to + 300) (- 47 to + 20) (- 58 to + 3)	TIVE OUTCOME I = 6 W = 3 S = 1 I = 7 W = 1 S = 2 I = 6 W = 4 I = 4 W = 6 I = 4 W = 4 I = 1 W = 6 I = 1 W = 5 S = 1
COORD GROUP ALL ALL ALL ALL AP1 AP1 AP1 AP1 BP1 RPT BLL BLT STACES I I II	MEAN - 14.28 - 27.28 - 25.78 - 40.98 - 33.38 + 51.18 + 8.98 + 29.38 + 11.78 + 20.58	TABLE XIV TABLE XIV RACY: REPETITIVE MOVEMENT (-100 to +130) (-100 to + 26) (-100 to + 26) (-100 to + 46) (-100 to + 20) (- 2 to +275) (- 17 to + 37) (- 21 to +187) (- 50 to + 37) $\frac{P (Safflower)}{+11.68}$ - 0.8%	$\frac{\text{VIS OF THE FOOT}}{\text{OUTCOME}}$ $I = 3 W = 6 S = 1$ $I = 3 W = 5 S = 2$ $I = 2 W = 8$ $I = 2 W = 8 S = 1$ $I = 7 W = 1$ $I = 6 W = 3$ $I = 4 W = 3$ $I = 7 W = 1$ $\frac{L (\text{Lecithin})}{-2.18}$ -0.68	GROUP ALL ALC AP1 AP7 BP1 RP7 BL1 BL2 ELC STAGES I	$\frac{\text{COORDINATION AND}}{\text{MOVE}}$ $\frac{\text{MEAN}}{+ 7.38}$ $+ 4.18$ $\frac{+ 5.68}{- 15.98}$ $- 16.08$ $\boxed{ 15.98}$ $+ 11.38$ $+ 44.18$ $\frac{+ 27.78}{- 21.68}$ $- 35.38$ $\boxed{ - 28.48}$ $\frac{n}{2}$	TABLE XVI MOTOR ACCURACY: REPETT ENTS OF THE HIP RANCE (-100 to + 83) (-100 to + 38) (-100 to + 105) (-100 to + 105) (-100 to + 67) (- 26 to + 90) (- 19 to + 300) (- 47 to + 20) (- 58 to + 3)	$\frac{\text{DUTCOME}}{\text{I} = 6 W = 3 S = 1}$ $I = 6 W = 1 S = 2$ $I = 6 W = 4$ $I = 4 W = 6$ $I = 4 W = 4$ $I = 1 W = 6$ $I = 1 W = 6$ $I = 1 W = 5 S = 1$ $\frac{L \text{ (Lecithin)}}{-328}$
COORD GROUP ALL ALL ALL ALL ALL API API BPI RPT BLI BLI BLI BLI BLI III III	MEAN - 14.28 - 27.28 - 20.78 - 25.78 - 40.98 - 33.38 + 51.18 + 8.98 + 30 % + 29.38 + 11.78 2 11 8	TABLE XIV TABLE XIV RACY: REPETITIVE MOVEMED (-100 to +130) (-100 to + 26) (-100 to + 26) (-100 to + 26) (-100 to + 20) (- 2 to +275) (- 17 to + 37) (- 21 to +187) (- 20 to + 37) $\frac{P (Safflower)}{+11.68}$ - 0.88 - 5.48	$\frac{\text{VTS OF THE FOOT}}{\text{OUTCOME}}$ $I = 3 W = 6 S = 1$ $I = 3 W = 5 S = 2$ $I = 2 W = 8$ $I = 2 W = 8 S = 1$ $I = 7 W = 1$ $I = 6 W = 3$ $I = 4 W = 3$ $I = 7 W = 1$ $\frac{1}{1} = 7 W = 1$ $\frac{1}{2} = 7 W = 1$ $\frac{1}{2} = 1$ $\frac{1}{2} = 1$ $\frac{1}{2} = 1$ $\frac{1}{2} = 1$	GROUP ALL ALT AP1 AP7 BP1 RP7 BLL BLT STAGES I I	$\frac{\text{COORDINATION AND}}{\text{MOVE}}$ $\frac{\text{MENN}}{+ 7.38}$ $+ 4.18$ $\frac{+ 5.66}{- 15.98}$ $- 15.98$ $- 16.08$ $\boxed{- 15.98}$ $+ 11.38$ $+ 44.18$ $\frac{+ 27.78}{- 21.68}$ $- 21.68$ $- 35.38$ $\boxed{- 28.48}$ $\frac{n}{2}$ 10	TABLE XVI MOTOR ACCURACY: REPETT MENTS OF THE HIP RANCE (-100 to + 83) (-100 to + 38) (-100 to + 105) (-100 to + 105) (-100 to + 67) (- 26 to + 90) (- 19 to + 300) (- 47 to + 20) (- 58 to + 3)	$\frac{\text{DITCOME}}{\text{I} = 6 \text{W} = 3 \text{S} = 1}$ $I = 6 \text{W} = 1 \text{S} = 2$ $I = 6 \text{W} = 4$ $I = 4 \text{W} = 4$ $I = 4 \text{W} = 4$ $I = 4 \text{W} = 4$ $I = 1 \text{W} = 6$ $I = 1 \text{W} = 6$ $I = 1 \text{W} = 5 \text{S} = 1$ $\frac{\text{L} (\text{Lecithin})}{-328}$ -58

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TABLE XIX

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	COORDINATION AND MOTO	R ACCURACY: REPETITIVE	- MOVEMENTS
	OF THE F	INGER (15 SECONDS)	
GROUP	MEAN	RANGE	OUTCOME
ALI	- 2.1%	(-33 to +34)	ï=4 W=6 S=1
ALr	+0.5%	(-43 to +62)	I=3 W=7 S=1
	- 0.8%		
APl	+4.4%	(-34 to +53)	I = 6 W = 5
APr	+9.5%	(-36 to +68)	I = 5 W = 6
	+6.9%		
BPl	- 7.7%	(-40 to +35)	I = 1 W = 7 S = 2
BPr	-11.3%	(-35 to +13)	I=1 W=9 S=1
	- 9.5%		
BL1	- 2.3%	(-27 to +15)	I = 4 W = 6
BLr	- 3.9%	(-29 to +30)	I = 5 W = 6
	- 3.18		
SINGES	<u>n</u>	P (Satflower)	L (Lecithin)
	2	+11.0%	- 2.1%
	11	- 0.8%	- 7.58
	8	- 5.48	- 3.36
1 IV	ĩ	+ 0.68	- 7.86

TABLE XVII

MEAN PERCENT CHANGE IN TIMED STABILITY (DOUILIBRIUM)

GROUP		TWO	FEET	TWO	FEET	ONE I	TOT	
		EYES	CLOSED	EYES	OPEN	EYES OPEN		
AL,		-	1.4%	-7	7.0%	+(0.5%	
AP		-	1.2%	+ :	3.3%	+(0.1%	
BP		-	-1.6%		-0.1%		-0.6%	
BL		-	-1.3% +5		5.6%	-:	-1.1%	
		-						
STAGES	<u>n</u>	<u>P</u>	Ŀ	<u>p</u>	Ŀ	P	Ŀ	
I	2	-5.4%	-5.8%	0%	0%	-0.3%	-2.2%	
II	11	-0.7%	-0.5%	+3.6%	+ 1.8%	-0.2%	-0.3%	
111	1	-2.0%	-2.0%	-21.0%	-21.0%	-1.0%	-1.0%	

TABLE XVIII

RESULTS OF THE SCSIT MOTOR ACCURACY TESTS* (& CHANGE)

ACCURACY SCORE					ADJUSTED SCORE			
GROUP		MEAN	OUTCOME	ŀ	IEAN	OUTCOME		
AL		- 3.3%	I ≃ 6 W = 4	-	7.5%	I = 5 W = 5		
AP		+17.0%	I = 6 W = 4	+ 1	16.5%	I = 5 W = 5		
BP		- 0.6%	I = 5 W = 6	-	3.4%	I = 5W = 6		
BL		+63.4%	I = 9 W = 2	-	7.4%	I = 5 W = 5		
STAGES	<u>n</u>	<u>P</u>	Ŀ	n	<u>P</u>	Ē		
I	2	+55.9%	+99.5%	2	- 1.6%	+20.8%		
II	11	+19.7%	+31.6%	10	+ 3.3%	- 6.7%		
III	7	-24.8%	+20.4%	8	-16.9%	-12.3%		
īv	1	+ 4.7%	+ 9.0%	1	+12.4%	-32.1%		

* Western Psychological Services, 12031 Wilshire Boulevard, Ios Angeles, California.

TABLE XX

UPPER EXTREMITIES: DISTAL COORDINATION (30 SECONDS)

GROUP	MEAN	RANGE	OUTCOME
ALL	- 0.4%	(-17 to +20)	I = 5 W = 5 S = 1
ALr	- 3.6%	(-19 to +23)	I = 3 W = 6 S = 2
	- 2.0%		
AP1	+6.6%	(-20 to +50)	I = 6 W = 5
APr	+3.4%	(-11 to +45)	I = 5 W = 6
	+5.0%		
BP1	+4.5%	(-22 to +36)	I = 7 W = 3 S = 1
BPr	- 1.1%	(-15 to +17)	I = 4 W = 6 S = 1
I	+1.7%		
BL1	+4.5%	(- 7 to +18)	I = 6 W = 3 S = 2
BLr	- 3.1%	(-27 to +27)	I = 4 W = 5 S = 2
	+1.2%		

STAGES	<u>n</u>	P (Safflower)	L (Lecithin)
I	2	-0.4%	-3.5%
11	11	+5.4%	+0.5%
III	8	+3.6%	-14.5%
IV	1	-12.8%	+ 6.7%

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		TABLE XXI					TIMEI	TABLE X	XIII ONAL TES	TS			
	UPPER EXTREMITIES:	PROXIMAL COORDINATION (3	0 SECONDS)	GROUP				MEAN*				OUTTOOME	
				SIX METER DASH WI	ITHOUT HA	ANDRAIL						<u>coroq n</u>	
GROUP	MEAN	RANCE	OUTCOME	AL				- 0.02	(second	5)		I = 2 W	=
	0.00	()7 (-))0)		AP				+ 0.62	4			I=1 W	=
ALL Mar	- 2.28	(-17 to +18)	1 = 3 W = 5 5 = 3	BP BL				- 0.20	*			I = 2 W	=
ALT	+10.98	(-10 to +85)	1 = 4 W = 3 5 = 1										
	+ 0.36			SIX METER DASH WI	TH HAND	RAIL							
AP1	- 2.5%	(-17 to +25)	I = 4 W = 7	AL AP				+ 0.45	(second	5)		I = 4 W	=
APr	+ 2.1%	(-20 to +33)	I = 6 W = 5	BP				+ 0.40				1 = 2 W	_
	- 0.2%			BL				+ 1.30	"			I=1 W	=
BP1	- 4.0%	(-21 to +37)	I = 2 W = 8 S = 1				<u> </u>						
BPr	- 3.6%	(-20 to +18)	I = 2 W = 5 S = 4	AL	r			- 0.9	(seconds			1 = 6 W	-
	- 3.8%			АР				- 2.2				I = 7 W	=
BL1	- 4.6%	(-29 to +22)	I = 3 W = 7 S = 1	BP				+ 1.7				I = 3 W	=
BLr	- 2.2%	(-13 to +18)	I=3 W=6 S=2	BL				- 2.8	*			I = 7 W	=
	- 3.4%												
				TYING UP A SHOE				- 1 4 1	seconde	1		T - 4 W	_
				AP				-11.4	"			I = 2 W	=
STAGES	n	P (Safflower)	L (Lecithin)	BP				- 0.1				I = 5 W	=
I	2	-1.2%	-6.1%	BL				- 6.3				I=1 W	=
II	11	-1.2%	+0.8%										
111	8	-1.3%	+1.3%	SPEECH				• • •					
IV	1	-15.4%	+7.7%	AL AP				- 0.9	" (seconds			1 = 6 W	=
				BP				- 0.6	• •			I = 6 W	=
				BL * Minus sign mea	ins impro	ovement		+ 0.4	H			I = 5 W	•
		TABLE XXII											
	UPPER EXTREMIT	IES: METER-NOSE TEST (30	SECONDS)										
GROUP	MEAN	RANGE	OUTCOME										
AL	+1.0%	(-25 to +27%)	I = 6 W = 4 S = 1					TABLE	XXIV				
CAL	+9.5%	(-15 to +48%)	I = 2 W = 2			TIMED H	UNCTION	AL TEST	S ACCORE	ING TO	STAGES*	r	
AP	+2.5%	(-22 to +45%)	I = 6 W = 4 S = 1										
CAP	+3.0%	(-13 to +33%)	$I \equiv 1 W \equiv 2$	STACES	<u>n</u>	R	MNING	T	SHIRT	5	HOE	SPEEC	<u>11</u>
BP	- 1.7%	(-29 to +25%)	I = 5 W = 6	ļ.		<u>P</u>	Ē	<u>P</u>	Ŀ	P	\overline{r}	<u>P</u>	L
CBP	+2.0%	(-15 to +39%)	I = 2 W = 4										—
				I	(2)	-0.7	-0.6	-0.2	-2.8	-6.4	-15.2	2+2.4 +4	.6
BL,	- 1.6%	(-33 to +33%)	I = 6 W = 5	11	(10)	+0.5	+0.1	-0.1	-0.7	-3.1	- 0.6	5-1.0 -0).9
CBL	+14.0%	(0 to +28%)	1 = 4										
				III ·	(7)	NP	NP	+1.8	-2.2	-7.8	- 5.2	2 -1.0 +1	0
				1V	(1)	NP	NP	-13.0	-11.6	-16.7	- 7.3	3-4.0-2	2.8
STAGES	<u>n</u>	P (Safflower)	L (Lecithin)	* Minus	sign me	ans impro	ovement	in seco	nds				
0	10	+ 2.4%	+ 11.8%										
I	2	- 4.4%	- 2.7%										
11	11	+ 0.3%	+ 0.1%	l									
111	8	+ 3.1%	- 1.0%										
IV	1	- 22.2%	+ 11.1%										

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I = 2 W = 4

I = 4 W = 2

I = 2 W = 4

I = 1 W = 4 S = 1

I = 2 W = 5 S = 1

I = 1 W = 6 S = 1

I = 2 W = 5 S = 1 I = 1 W = 6 S = 1

I = 6 W = 3 S = 1

I = 3 W = 5 S = 3

I = 7 W = 3

I = 7 W = 4

I = 4 W = 6

I = 2 W = 8

I = 5 W = 5

I=1 W=9

I = 6 W = 4

I = 6 W = 3

I = 5 W = 4

I = 6 W = 4 S = 1

TABLE XXVII

RESULTS OF THE QUESTIONNAIRE ACCORDING TO STAGES AND SPECIFIC CRITERIA

TABLE XXV

UNTIMED FUNCTIONAL TESTS

GROUP	MEAN	RANGE	OUTCOME
AL	- 9.2%	(-78 to +50)	I = 3 W = 4 S = 4
AP	-19.5%	(-78 to +29)	I = 3 W = 5 S = 3
BP	-10.4%	(-67 to +12)	I = 2 W = 4 S = 5
EL	- 8.0%	(-38 to + 6)	I=1 W=3 S=7
STAGES	<u>n</u>	P (Safflower)	L (Lecithin)
I	2	. 08	08
II	11	+ 7%	- 2%

-45%

0%

- 27%

+ 50%

STAC	GES	TRAN	SFER	FEED	ING	HYGI	ENE	CLOT	HING	SPEI	хн	WRIT	FING	TOTAL
		+ /	′ -	+ /	-	+ /	· -	+	/ -	+/	-	+ ,	/ -	+/-
I	Р	o	1	0	0	0	0	0	0	0	1	0	0	0 / 2
	L	0	1	0	0	0	1	0	1	0	1	0	1	0/5
II	р	3	3	0	1	. 1	2	3	2	3	3	2	1	12/12
	L	1	5	1	1	2	3	3	2	4	2	4	1	15/14
III	Р	1	3	1	1	3	4	2	3	3	1	2	0	12/12
	L	1	4	1	0	3	3	3	3	1	1	2	0	11/11
IV	Р	0	1	0	0	0	0	0	0	0	0	0	0	0/1
	L	0	1	0	0	0	0	0	0	0	0	0	0	0/1
TOIN	AL.	6 /	19	3 /	3	9 /	′ 13	11	/ 11	11 /	9	10 ,	/ 3	50/58

TABLE XXVI

RESULTS OF THE QUESTIONNAIRE: MEAN CHANGE IN TOTAL SCORE

GROUP	MEAN	RANGE	OUTCOME
AL	+ 3.0%	(-36 to +35%)	I = 6 W = 3 S = 2
AP	+ 4.3%	(-43 to +36%)	I = 7 W = 4
BP	- 5.9%	(-39 to +50%)	I = 3 W = 7 S = 1
BL	- 8.9%	(-50 to +62%)	I = 2 W = 7 S = 2

STAGES	<u>n</u>	P_(Safflower)	L (Lecithin)
I	2	- 5%	-12%
II	11	- 1%	- 2%
111	8	+ 3%	- 18
IV	1	-12%	-12%

TABLE XXVIII

SUMMARY OF CHANGES IN ALL CLINICAL PARAMETERS IN 22 PATIENTS WITH FRIEDREICH'S ATAXIA AFTER A SIX-MOUTH TRIAL OF LECITHIN

OR SAFFLOWER OIL

	MEAN GAIN (+) OR PRE-TRLAL	LOSS (-) FROM SCORES
TESTS	P (SAFFLOVER)	L (LICITHEI)
JOINT MOBILITY	- 0.6%	- 3.5%
MUSCLE STRENGTH		
Semi-quantitative	- 0.1%	- 3.18
Dynamoneter	+47.0%	+56.0%
LOWER EXTREMITIES		
Gait	-29.3 cm	-36.2 cm
Meter tests	- 1.6%	- 4.9%
Stability	- 0.1%	- 0.8%
UPPER EXTRIMITIES		
Motor accuracy	+7.4%	+11.3%
Meter tests	+0.1%	- 0.3%
FUNCTIONAL TESTS		
Timed	- 1.2%	- 1.08
Untimed	-19.2%	- 8.6%
QUESTIONNALRE	- 0.8%	- 2.9%

III

īV

8

1

strates that only two clinical features, i.e. muscle strength and motor accuracy in the upper extremities have kept positive values in both trials of lecithin and safflower oil. There was however no evidence of significant difference between lecithin and safflower oil in the mean gain or loss in any specific clinical feature.

DISCUSSION

Contrary to previous reports of early and significant improvement in muscle strength and motor coordination with lecithin in patients with Friedreich's and other forms of spino-cerebellar ataxia (Barbeau, 1979: Livingstone et al, 1981) this study failed to demonstrate any beneficial effect, in any specific clinical parameter, which could be attributed to lecithin itself. Our results have showed that some patients improved with lecithin. These patients were mostly younger individuals from functional stage I and their level of improvement never passed control values. The only patient who surpassed normal control values in some specific muscle function tests while on lecithin, was our single stage IV patient. It is difficult to conclude in favour of lecithin under these circumstances.

The usefulness of a control group in such a trial, needs to be emphasized. Although our control group was small in comparison with the number of patients followed, we have gained some precious information from their contribution. First, contrary to patients, all mean scores for tests administered to controls resulted in positive values. Second, some individual controls lost points in specific tests, after either lecithin or safflower oil, in the same way some patients did. Third, we observed no difference in mean improvement scores for controls, whether on lecithin or safflower oil. Fourth, controls as well as patients learned to improve their performance, as demonstrated by the increment of test scores at the end of the second period of the trial in both groups.

Without the control group, it would have seemed logical to conclude that lecithin led to a 56% improvement in muscle strength and a 11% gain in coordination in the upper extremities in patients with Friedreich's Ataxia (table XXVIII). It is however more difficult to explain why patients on safflower oil, which does not contain phosphatidyl choline, had better scores in 7 out of 11 clinical parameters tested, and demonstrated a mean of 8% less deterioration in all clinical features other than muscle strength and coordination (table XXVIII).

Safflower oil contains 30% more linoleic acid per weight than lecithin (see previous article in this issue). The implication of linoleic acid in the composition of mitochondrial membranes and as a precursor of lipoic acid has been thoroughly reviewed by Barbeau (1980). It has not yet been established that previous observations of clinical improvement in Friedreich's Ataxia relates to the choline moiety rather than the linoleic acid-rich composition of lecithin. In view of the associated defects in the pyruvate and alphaketoglutarate dehydrogenase enzyme systems, which rely on lipoic acid as a cofactor, it would seem possible that the previously reported improvement in symptomatology in Friedreich's Ataxia with lecithin and our observed comparable effect with safflower oil proceed from the same basic principle, i.e. increased supply of linoleic acid to mitochondrial membranes and energy metabolism.

In conclusion, this study has fulfilled its two main objectives. With regards to (1) methods of clinical assessment, we believe that metered tests and timed functional tests provided the most reliable results. As for (2) concordance between objective tests results and patient's subjective feeling of changes in their clinical status, we noticed good correlation for most functions with the exception of transfer and writing. Finally we acknowledge the need for another clinical study in which the effect of pure linoleic acid alone would be assessed in patients with Friedreich's Ataxia and normal controls.

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