Horizontal effect of the surgical weakening of the oblique muscles

Efeito horizontal do debilitamento cirúrgico dos músculos oblíquos

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ABSTRACT

Purpose: To evaluate the influence of the oblique muscles surgical weakening on the horizontal alignment in the primary position (PP) and its efficacy on the correction of the "A" and "V" anisotropies.

Methods: In order to study the influence of bilateral superior oblique muscles (SO) weakening on the horizontal alignment in PP, we analyzed the files of 12 patients who underwent only that operation; no other muscle was operated on. We took the opportunity of those 12 patients to analyze the effect of their operation on the correction of "A" incomitance. For evaluating the effect of the inferior oblique muscles (IO) weakening on the correction of the "V" pattern, we analyzed retrospectively the files of 67 anisotropic patients who underwent a bilateral SO weakening. In 10 of them, the only operation was the oblique muscles weakening and, in 57 patients, the horizontal recti were also operated on for the horizontal deviations in primary position. These patients were divided into two groups: 50 were esotropic and 17 exotropic. There was not any mixed anisotropy.

Results: The mean value of the preoperative "V" incomitance of the 50 esotropic patients was $24.25^{\Delta} \pm 10.15^{\Delta}$; the mean postoperative correction was $15.56^{\Delta} \pm 8.74^{\Delta}$. The mean correction between the PP and upgaze was $7.52^{\Delta} \pm 7.47^{\Delta}$ and from the PP to downgaze was $8.56^{\Delta} \pm 9.21^{\Delta}$. The same values of the 17 exotropic patients was: preoperative $31.88^{\Delta} \pm 9.4^{\Delta}$; primary position to upgaze was $13.11^{\Delta} \pm 4.9^{\Delta}$ and primary position to downgaze $14.11^{\Delta} \pm 12.48^{\Delta}$. The mean preoperative value of the "A" incomitance among the 12 patients who underwent isolated SO weakening was $30.50^{\Delta} \pm 19.25^{\Delta}$ and the postoperative was of $9,92^{\Delta}$, therefore a mean correction of $22.58^{\Delta} \pm 17.54^{\Delta}$. Among these ones, in 5 there was no alteration of the deviation in primary position, in 4 there was an exo-effect and in 3 there was an eso-effect. The mean alteration of the deviation in PP was an exo-shift of 2.25^{Δ}.

Conclusions: 1) There was no difference in the relative correction of "V" pattern between the esotropic and exotropic patients, although the absolute numbers were greater in the exotropic ones. 2) The correction of the "V" pattern was between 65 and 75 % from the initial values. 3) The IO weakening corrected similarly the anisotropia between the superior and inferior components among the esotropic patients, but among the exotropic ones the correction was greater in the inferior component. 4) The SO weakening did not cause an eso-effect in the deviation in primary position.

Keywords: Oculomotor muscles/surgery; Ophthalmologic surgical procedures; Strabismus/surgery

RESUMO

Objetivos: *Avaliar a influência do debilitamento cirúrgico dos músculos oblíquos sobre o alinhamento horizontal na posição primária do olhar (PPO) e na correção das anisotropias em "A" e "V".*

Métodos: *Para estudar a influência do debilitamento bilateral dos músculos oblíquos superiores (OS) no alinhamento horizontal na posição primária do olhar, analisamos prontuários de 12 pacientes com debilitamento isolado desses músculos. Aproveitamos para verificar o seu efeito na correção da anisotropia em "A". Para avaliar eficácia do debilitamento dos oblíquos inferiores (OI) na correção da incomitância em "V", analisamos retrospectivamente os prontuários de 67 pacientes com debilitamento bilateral desses músculos. Em 10 pacientes, a única operação foi o debilitamento dos OI e em 57 operaram-se também os retos horizontais, para o desvio na PPO. Destes, 50 tinham esotropia e 17 exotropia. Nenhum tinha anisotropia mista.*

Resultados: *O valor médio da incomitância em "V" pré-operatória dos pacientes esotrópicos era $24.25^{\Delta} \pm 10,15^{\Delta}$ e a correção média pós-operatória foi $15.56^{\Delta} \pm 8,74^{\Delta}$ (68,0 %). O componente superior era de $10,98^{\Delta}$ e a correção foi de $7,52^{\Delta} \pm 7,47^{\Delta}$ (68,5 %) e, entre a PPO e a infraversão, o valor era de $13,28^{\Delta}$ e a correção foi de de $8,56^{\Delta} \pm 9,21^{\Delta}$ (64,5 %). Esses valores nos 17 exotrópicos foram: pré-operatório $31.88^{\Delta} \pm 9.4^{\Delta}$ e correção de $20,93^{\Delta}$; no componente superior a incomitância era de $13.11^{\Delta} \pm 4.9^{\Delta}$ e a correção foi de $6,82^{\Delta}$ (52,0 %); da PPO à infraversão, o incomitância era de $18,76^{\Delta}$ e a correção foi de $14.11^{\Delta} \pm 12.48^{\Delta}$ (75,2 %). A incomitância em "A" dos 12 pacientes com debilitamento isolado dos OS era $32,17^{\Delta} \pm 19,25^{\Delta}$ e a pós-operatória era de $9,92^{\Delta}$, correção, portanto, de $22,25^{\Delta} \pm 17,54^{\Delta}$. Entre estes, em 5 não houve alteração do desvio na PPO, em 4 houve exo-efeito e em 3 houve eso-efeito nessa posição; a alteração média foi um exo-efeito de $2,25^{\Delta}$.*

Conclusões: *1) Não houve diferença na correção relativa da incomitância em "V" entre esotrópicos e exotrópicos; embora os números absolutos tenham sido maiores entre estes. 2) A correção da forma em "V" foi entre 65 e 75% dos valores iniciais. 3) O debilitamento dos OIs corrigiu similarmente a anisotropia entre os componentes superior (da PPO à supraversão) e inferior (da PPO à infraversão) entre esotrópicos, mas entre exotrópicos, a correção foi maior no componente inferior. 4) O debilitamento dos OS não provocou eso-efeito do desvio na PPO.*

Descritores: *Músculos oculomotores/cirurgia; Procedimentos cirúrgicos oftalmológicos; Estrabismo/cirurgia*

INTRODUCTION

Until the decade of 1950, strabismologists used to measure horizontal strabismus only in the primary position when planning surgeries. After the observations of White & Brown in 1939[1] and Urrets-Zavalia in 1948[2], who pointed out the differences between the magnitudes of the horizontal deviations in up and downgaze observed in some patients, there is no doubt about the fact that the dysfunctions of the oblique muscles are the main pathogenic factors of the alphabetic anisotropies. Urretz-Zavalia also demonstrated that the inferior oblique overaction causes some relative divergence in upgaze[2]. In 1959, Knapp confirmed the theory that implicates the oblique muscles dysfunction as the main cause of "A" and "V" anisotropies[3], which led the strabismologists to consider more seriously the horizontal action of the oblique muscles when planning their surgeries.

But there are certainly other unknown factors in the pathogenesis of the anisotropies, recognized by the fact that there are some cases of this incomitance without oblique muscles dysfunctions and some cases of oblique muscles dysfunctions without anisotropy. In other cases, there is a sum of both factors, which is probably the

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explanation to the fact that the horizontal effect of the oblique muscles weakening surgery is so variable on these incomitances. There are some cases in which the strabismologist predicts that a so low overaction of the oblique muscles cannot be the only pathogenic factor of a so large anisotropy; in those cases one must associate to the oblique muscles weakening a vertical transposition of the horizontal rectus muscles, or a horizontal transposition of the vertical recti, in order to eliminate all the incomitance, a blind (but effective) surgery since it does not act upon the real unknown mechanic cause. There are some theories that try to point out that factor[4,5] but they are still lacking evidence.

However, in spite of the variability of the results, it is important to have an idea about the magnitude of the anisotropies´ correction caused by the oblique muscles weakening surgery. Besides, it is important to know if the weakening of these muscles has any influence on the horizontal alignment in the primary position. There is a classic concept that the inferior oblique muscle weakening causes an "eso shift" of 5$^{\Delta}$ to 10$^{\Delta}$ and the superior oblique muscles weakening causes an "eso shift" of 10$^{\Delta}$ to 15$^{\Delta}$ on the primary position alignment[6]. That knowledge would oblige the surgeon to take it in consideration during the planning of the horizontal surgery.

The object of this work was to evaluate the influence of the superior oblique muscles weakening on the horizontal alignment of the eyes in the primary position and secondarily the efficacy of the oblique muscles surgical weakening on the correction of the "A" and "V" anisotropies.

METHODS

In order to study the influence of bilateral superior oblique muscles weakening surgery on the horizontal alignment in primary position, we analyzed the files of 12 patients who underwent only that operation for the correction of "A" anisotropy; no other extraocular muscle was operated on. The mean age of these patients was 11.5 ± 8.44 years, ranging from 2 to 29 years. The follow-up time varied from 1 month to 3 years (average 14.41 ± 11.12 months). The weakening techniques employed for weakening the superior oblique muscles were: disinsertion (Gobin´s technique[7,8]), tenectomy close to the insertion (technique that we proposed in 1986[9,10]), tenotomy medially to the superior rectus (Berke´s technique[11]) and elongation of the tendon (Crawford´s technique[12]), according to the magnitude of the overaction. The details of age, preoperative deviations, surgical procedure and follow-up time can be seen in the table 3.

Utilizing the files of those 12 patients, we analyzed the effect of their operation on the "A" anisotropy. The preoperative data are exposed in the table 4.

For evaluating the effect of the inferior oblique muscles surgical weakening on the correction of the "V" anisotropy, we analyzed retrospectively the files of 67 anisotropic patients of our clinical practice who underwent a bilateral inferior oblique muscle weakening. In ten of them the only operation was the oblique muscles weakening and, in the other 57 patients, the horizontal recti were also operated on in order to correct horizontal deviations in the primary position. These 67 patients were divided into two groups: 50 of them had originally esotropic anisotropy and 17 had exotropic anisotropy. There was not any mixed anisotropy.

The mean age of the 67 patients was 8.0 ± 4.7 years, from one to 20 years. The average follow-up time was 14.98 ± 16.28 months, from 2 to 65 months.

We analyzed not only the correction of the full anisotropy (the difference of the values of the horizontal deviations between up and downgaze), but also the correction of the horizontal incomitance between upgaze and primary position (superior component of the anisotropy) and between primary position and downgaze (inferior component).

The inferior oblique muscles weakening techniques were recessions from 6 mm to 13 mm and myectomy with cauterization of the stump, according to the magnitude of the muscles overaction. The 6 mm recession was performed in a few cases in which the inferior oblique overaction was very mild, which otherwise would not require surgery, and the opposite inferior oblique presented a severe overaction, for averting the risk of postoperative increase of the overaction of that one.

Patients who had been operated for correction of strabismus associated to any oculomotor syndrome, as Duane's, Brown's, Graves' orbitopathy, congenital muscle fibrosis etc. were excluded from both the samples. Gender or race were not exclusion factors .

RESULTS

Concerning the efficacy of the inferior oblique weakening in correcting the "V" anisotropy, the results are summarized in the tables 1 and 2. The table 1 shows the mean magnitude of the preoperative anisotropy of the 50 esotropic patients (X), the average surgical reduction of the incomitance (Y), and the coefficient of correlation between these data (r). The left column contains these data in relation to the full anisotropy (from up to downgaze); the central column refers to the superior component and the right column refers to the inferior component of the anisotropy.

The table 2 shows the same aforementioned data referent to the 17 exotropic patients.

The table 3 exhibits analytically the reduction of the "A" anisotropy in those 12 patients who underwent isolated bilateral superior oblique weakening surgery, with special reference to the change of the alignment in the primary position.

The table 4 shows the mean effect of the isolated bilateral superior oblique weakening surgery on the correction of the "A" anisotropy in those 12 patients.

The table 4 also shows that in 4 patients there was an exo shift of the deviation in primary position (mean 10.5$^{\Delta}$ in 3 patients there was an eso shift (mean 4.5$^{\Delta}$ and in 5 patients there was no change on the deviation in the primary position.

DISCUSSION

The reason for separating the results between esotropic and exotropic patients in the first phase of this paper was the clinical impression that the "V" anisotropy is generally larger in exotropic than in esotropic patients, which was confirmed by the data of this work (31.88 ± 9.44 and 24.25 ± 10.15 prism diopters respectively). The reduction of the anisotropy in absolute numbers was larger in the exotropic than in esotropic patients with the same operation (20.94 ± 15.0 and 16.56 ± 8.74 prism diopters respectively), but it was almost identical in relative numbers (68.0% and 65.7% respectively).

Table 1. Mean correction, in prism diopters, of "V" anisotropia in 50 esotropic patients who underwent bilateral weakening surgery of the inferior oblique muscles, with especial reference of the correction in its superior and inferior components

X=24.25 ± 10.15	X=10.98 ± 8.60	X=13.28 ± 8.77
Y=15.56 ± 8.74	Y= 7.52 ± 7.47	Y= 8.56 ± 9.21
68.0% (2 to 40)	68.5%	64.5%
r=0.65	r=0.74	r=0.77
p=1.60	p=1.36	p=1.46

It is worth noting the fact that the horizontal incomitance in the inferior component of the "V" anisotropy in exotropic patients was larger than the superior component (16.76 ± 12.48 and 13.11 ± 4.9), an unexpected fact because it is known that the inferior oblique muscles exert their action mainly in upgaze. The probable explanation of this fact is that, once eliminated the inferior oblique overaction, with probable contracture, the superior oblique becomes released to exert its normal function.

Table 2. Mean correction, in prism diopters, of "V" anisotropia in 17 exotropic patients who underwent bilateral weakening surgery of the inferior oblique muscles, with especial reference of the correction in its superior and inferior components

		
X=31.88 ± 9.4	X=13.11 ± 4.9	X=18.76 ± 10.10
Y=20.94 ± 15.0	Y= 6.82 ± 8.0	Y=14.11 ± 12.48
65.7% (0 to 50)	52.0%	75.3%
r=0.92	r=0.63	r=0.92
p=1.32	p=1.37	p=1.44

CONCLUSION

The conclusions of these data are:

1) There is no difference between the relative magnitude of correction of the "V" anisotropy, by inferior oblique weakening, in esotropic and exotropic patients, although in absolute numbers the correction is larger in the exotropic patients.

2) The mean reduction of the "V" anisotropy by inferior oblique weakening is between 65 and 70% of the initial incomitance.

3) The bilateral inferior oblique muscles weakening corrects similar amounts of "V" anisotropy in its superior (eso shift) and inferior (exo shift) components, except in the exotropic patients, in whom the correction in the inferior component was larger (superior = $6.82^{\Delta} \pm 8.0^{\Delta}$ and inferior = $14.11^{\Delta} \pm 12.48^{\Delta}$).

Regarding the influence of the isolated bilateral superior oblique muscle weakening on the horizontal alignment in the primary position, the results observed in those 12 patients show that the classic concept of the "eso shift" is not true. Though in 3 patients there was such effect (patients 3, 9 and 10), in 5 patients the alignment in primary position did not change (patients 1, 2, 4, 7, 8) and in 4 patients there was an "exo shift" (patients 5, 6, 11 and 12). Diamond and Parks had already shown that in 1981[6]. Our result shows that the mean effect of this operation on the horizontal alignment in

Table 3. Amount of correction, in prism diopters, of the "A" anisotropia in 12 patients who underwent isolated weakening surgery of the superior oblique muscles, with especial reference of its influence on the alignment in the primary position (bold-face)

Nº	Age	Preoperative	Surgery	Immed. postop.	Late postop.	Follow-up
1	29	0 **XT 20** XT 30	Tenectomy at insertion	XT 15 **XT 20** XT 25	XT 10 **XT 20 + 10** XT 30 + 7	24 m
2	11	XT 15 **XT 25 - 4** XT 40	Tenectomy at insertion	XT 22 - 3 **XT 27 - 3** XT 32	XT 25 **XT 25 - 2** XT 35 - 6	1 m
3	7	XT 6 **XT 25 + 10** XT > 80	Berke´s tenotomy	XT 2 **XT 18 - 7** XT 20 - 10	XT 12 - 3 **XT 20 - 8** XT 22 – 10	22 m
4	25	ET 30 **ET 15** XT 20	Berke´s tenotomy	ET 7 **0** XT 7	ET 10 + 5 **ET 15 + 10** XT 15 + 15	24 m
5	4	XT 15 **XT 20** XT 40	Ressection	XT 15 **XT 15** XT 15	XT 40 **XT 35** XT 40	12 m
6	10	XT 20 **XT 25** XT 50	Elongation	XT 25 **XT 15** XT 20	XT 35 **XT 40** XT 35	36 m
7	2	ET 25 **ET 20** 0	Disinsertion		ET 20 **ET 20** ET 20 - 4	8 m
8	10	ET 2 + 1 **+ 3** + 8	Tenectomy at insertion		-15 **0** ET 4 – 3	2 m
9	19	XT 4 + 2 **XT 12 + 4** XT 22 + 2	Disinsertion		XT 6 **XT 6 + 2** XT 10 + 2	7 m
10	8	XT 8 **XT 22 – 2** XT 40 + 4	Berke´s tenotomy	XT 12 - 4 **XT 20 - 4** XT 35 - 4	XT 8 - 4 **XT 20 - 6** XT 35 - 8	6 m
11	5	ET 2 **ET 2** XT 30	Tenectomy at insertion		0 **0** XT 4	7 m
12	8	ET 30 + 3 **ET 25 + 5** ET 13+ 5	Elongation	ET 20 + 4 **ET 12 + 4** ET 3 + 4	ET 25 **ET 15 + 10** ET 2 + 4	24 m

Table 4. Mean correction, in prism diopters, of "A" anisotropia in 12 patients who underwent isolated superior oblique weakening surgery, with especial reference to its horizontal influence on the alignment in the primary position

	Preoperative	Postoperative	Correction
Supraversion	ET 1.75 ± 17.48	XT 6.75 ± 19.94	Exo shift 8.5
Primary position	**XT 7.42±18.81**	**XT 9.67±20.03**	**Exo shift 2.25**
Infraversion	XT 30.42 ± 22.26	XT 16.67 ± 19.27	Eso shift 13.75

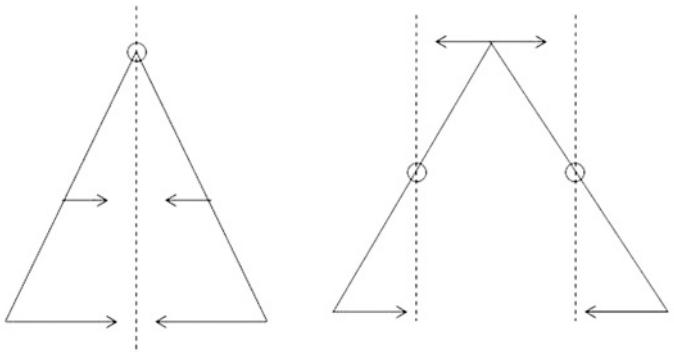

Figure 1. Shematic representation of the effect of the surgical weakening of the superior oblique muscles on the correction of the "A" anisotropia.

the primary position was an "exo shift" of 2.25$^{\Delta}$ a clinically negligible amount. This datum shows that the *fulcrum* of the correction of the "A" anisotropy by superior oblique muscle weakening is the primary position, i.e., there was an "eso-shift" in downgaze, an "exo-shift" in upgaze and practically no horizontal effect in primary position (Figure 1). The conclusion is that one does not have to include this factor when planning the surgery for the horizontal deviation in primary position.

As to the effect of the isolated bilateral superior oblique muscle weakening surgery on the "A" anisotropy in those 12 patients, the result shows that the decrease of the incomitance was similar to the decrease of the "V" anisotropy by weakening the inferior oblique muscles (22.25$^{\Delta}$ and 20.94$^{\Delta}$ respectively).

REFERENCES

1. White JW, Brown HW. Occurrence of vertical anomalies associated with convergent and divergent anomalies. Arch Ophthalmol. 1939;21:999-1009.
2. Urrets-Zavalia A. Inducción en la elevación. Arch Oftalmol B Aires. 1948;22:125.
3. Knapp P. Vertically incomitant horizontal strabismus: the so-called "A" & "V" syndromes. Trans Am Ophthalmol Soc. 1959;57:688-99.
4. Guyton D, Weingarten P. Sensory torsion as the cause of primary oblique muscle overaction/underaction and A- and V- pattern strabismus. Binocular Vis Eye Muscle Surg Q. 1994;9:209-36.
5. Demer JL. The orbital pulley system: a revolution in concepts of orbital anatomy. Ann N Y Acad Sci. 2002;956:17-32.
6. Diamond GR, Parks MM. The effect of superior oblique weakening procedure on primary position horizontal alignment. J Ped Ophthalmol Strabismus. 1981;18(1):35-8.
7. Gobin M. Desinsertion of the superior oblique in A- patterns. Doc Ophthalmol. 1977;44(1): 193-202.
8. Prieto-Díaz J. Disinsertion of the superior oblique for A-pattern anisotropies. Binocul Vis. 1987;2:7.
9. Souza-Dias C. Full tenectomy of the superior oblique muscle close to the scleral insertion for the correction of "A" anisotropy. In: 5th Proceedings of the International Strabismological Association (ISA). Meeting. Rome: Campos; 1986. p.429-36.
10. Prieto-Díaz J, Souza-Dias C. Estrabismo. 5ª ed. Buenos Aires: Ediciones Científicas Argentinas; 2005. p.541.
11. Berke RN. Tenotomy of the superior oblique for hypertropia. Trans Am Ohthalmol Soc. 1946;44:304-42.
12. Crawford JS. Surgical treatment of true Brown syndrome. Am J Ophthalmol. 1976;81(3): 286-95.