

# PRIMARY DIVERGENCE INSUFFICIENCY

BY *G. Victor Simpson*, MD

PRIMARY DIVERGENCE INSUFFICIENCY MAY BE DEFINED AS AN IRREGULAR OR anomalous departure from the established control of the ocular muscles, as the eyes change position from near to far vision. The result of this unstable control, is a failure of divergence of the eyes. Gradual and precise divergence is required if fusion is to be maintained, as the eyes assume new positions in changing from near to far. In divergence insufficiency the eyes do not diverge properly and the result is an esotropia with homonymous diplopia. Primary divergence insufficiency therefore is an eye muscle imbalance with symptoms and abnormal findings limited to distant vision.<sup>1</sup>

## ETIOLOGY

It is very important, when considering the etiology, that a clear separation be made between primary divergence insufficiency, divergence paralysis, and unilateral or bilateral sixth cranial nerve palsies. Divergence paralysis and sixth nerve palsies are the result of brain damage or disease.<sup>2, 3, 4, 5</sup> Primary divergence insufficiency acts more like a functional disorder. The history will reveal any one of a number of etiologic possibilities for divergence paralysis or sixth cranial nerve palsies. Recent trauma such as an automobile accident or fall, respiratory infection with meningitis or encephalitis, vascular lesions, tumors, multiple sclerosis, and syphilis have been known to cause divergence paralysis and sixth cranial nerve palsy. The etiology of primary divergence insufficiency is not so evident. It is probable that the fault involves the change from convergence to divergence in addition to a weakness of fusion.

## AGE, SEX, REFRACTIVE ERROR

Primary divergence insufficiency may have its onset at almost any age. The age of the patients described by Moore and associates<sup>6</sup> ranged from  
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twelve to fifty-six years. The ages of the patients discussed in this paper range from thirty-three to eighty-four years. It is unlikely that sex is important in this muscle imbalance. However, Moore and associate's group of patients consisted of ten females and six males. Ten of this present series were female and four were male.

It is unlikely that the refractive error is important in the development of divergence insufficiency. Moore and associate's study included five hyperopes and eleven myopes, all of moderate severity. Three of my patients were wearing cataract lenses and the remainder had moderate or insignificant refractive errors.

#### SYMPTOMS AND COURSE

The chief complaint of all the patients was either confused vision or double vision at distance. Reading vision was not disturbed. In the younger patients the confused vision was especially troublesome while driving a car. The patients complained that the center white line on the highway moved about and was well defined and clear only at very near distances. The older group of patients, who had less reason to be looking far away, complained that the television screen was mixed up or the candles in church were double.

The diplopia always has a subtle onset in divergence insufficiency. It may be intermittent, is seldom an emergency, and is not usually accompanied by nausea or headache. Patients have noted that blinking the eyes tends to correct the confusion momentarily and some patients will volunteer that closing one eye corrects the confusion.

The course of the muscle problem is not always consistent and is not by any means always progressive. It is possible that in the young patient, properly and vigorously treated, the progress of the imbalance can be slowed and eventually the prisms can be discarded. Some patients however will continue to need prisms for distant vision but with very little change. In other patients the required prism will have to be increased in power from time to time and eventually surgery may be necessary.

If the usual course of the imbalance were to be inferred from cases 1 and 2 of my report, the prognosis would not seem very favorable. In each of these patients, prisms base out of increasing strength had to be prescribed for comfortable distant vision and eventually surgery was required.

Primary divergence insufficiency beginning in later life is not serious. It may be more difficult to recognize but properly treated the patient can immediately be given comfortable distant vision. The increase in the

imbalance will not be excessive and will not require too much attention. Most of these patients are wearing bifocal glasses and the only problem involves prescribing the needed amount of prism in the distance correction and removing it from the reading segments.

#### MEASUREMENTS

In divergence insufficiency the homonymous diplopia should measure the same in every field of gaze. Likewise there should be no limitation of abduction to the right or left. In recently developed divergence insufficiency the fusion is not impaired. If however, the imbalance increases as in case 2 of the case reports, the esophoria will become an esotropia and suppression becomes apparent. When the normal balance was restored normal fusion quickly reappeared.

The abnormal muscle balance in divergence insufficiency is limited to far vision. At twenty feet an esophoria varying in amount from five to eight prism diopters will be found. There may be a small vertical component. The ability of a patient with primary divergence insufficiency to overcome prisms base out should be greater than normal and the ability to overcome prisms base in should be reduced. In uncomplicated divergence insufficiency the muscle balance at near will be normal.

#### DIFFERENTIAL DIAGNOSIS

Divergence insufficiency must be distinguished from divergence paralysis and unilateral or bilateral sixth nerve palsy. Suddenly developing confused distant vision with anxiety, headache, nausea, and dizziness ushers in divergence paralysis or sixth nerve palsies. The history of trauma or an illness tends to confirm the paralytic nature of the imbalance. If any doubt remains a neurological examination is indicated.

#### NON-SURGICAL MANAGEMENT

Once it has been established that the imbalance is primary divergence insufficiency the management is simple and effective. It should be easy to determine how much prism base out will restore binocular single vision. The amount of prism that is to be prescribed should be somewhat less than the measurement found with the red glass and Maddox rod.

If the patient has not previously worn glasses a careful refraction should be done. The necessary amount of prism is then equally divided between the two lenses and the glasses prescribed to be worn mainly for distance

If the patient is young the glasses may be worn constantly as the small amount of prism base out should not interfere with comfortable reading.

Wearing the glasses will overcome the diplopia and restore binocular vision. There is no justification for delaying the prescribing of base out prisms while other forms of treatment are given a trial. When the diplopia has been relieved and the patient is comfortable, orthoptics certainly should be encouraged. The aim will be to strengthen stereoscopic vision and build up prism divergence power. This means of course to increase the ability of the patient's eyes to overcome prism base in with the instrument fixed for distant vision. The progress of the imbalance should be followed carefully and if the prism divergence power improves satisfactorily the patient should be given a trial with reduced base out prism or with no prism at all. Careful reevaluation of the situation is required if diplopia returns.

If the patient is older and already wearing bifocal glasses the management requires somewhat more attention. A careful refraction must be performed and the necessary correction for distant and near vision determined. A choice now has to be made on how to take care of the esophoria which is present only at distant gaze.

The following summarizes the available management methods:

A. Prescribing separate distance and reading glasses. The distance glasses ground with the necessary base out prisms and the reading glasses without prisms.

B. Prescribing bifocal glasses with the necessary base out prism in the upper areas. A cemented wafer provides the reading power and sufficient base in prism to neutralize the base out in the upper areas.

C. Prescribing fused bifocal glasses, available only on special order which are expensive and require some weeks in preparation.

D. Prescribing Fresnel press-on base out prisms of required dioptric power on the upper area of each lens of the patient's present glasses or on his new glasses. The press-on prism is shaped with scissors to cover only the upper portion of the lens, leaving the reading area without a prism. If a vertical prism is required the horizontal prism may be rotated so as to achieve correct horizontal and vertical prism power.

Any one of these methods of neutralizing the esophoria will be successful and the patient should have comfortable distant vision.

Orthoptic training planned to strengthen stereoscopic vision and to increase divergence power should now be useful.

## SURGICAL MANAGEMENT

Surgical treatment becomes necessary when the imbalance can no longer be satisfactorily corrected with prisms. The maximum base out prism that can be comfortably worn, especially in bifocal glasses, is about seven diopters in each lens. This would mean that when the esophoria for distance has increased to fifteen prism diopters, surgery should be considered. It is possible that the new Fresnel press-on prisms will delay the need for surgery.

There is no argument as to the operation of choice. It has been repeated over and over again for years, that an operation on the medial rectus muscle to correct primary divergence insufficiency would be a disaster. Therefore, the lateral rectus muscle of the non-fixing eye should be strengthened by resection, advancement, or tucking.

## CASE REPORTS

The following patients were chosen from the patients that have been followed for many years with primary divergence insufficiency. Five of the patients were young when first seen and all of them continued a moderately progressive course. Three of the patients required surgery.

## CASE 1

A 33 year old male was first seen January 1955 complaining of constant diplopia at distance.

## Present glasses:

R.E.  $-4.25S = -.25 \text{ ax } 90 = 20/20$

L.E.  $-4.25S = -1.00 \text{ ax } 135 = 20/20$

no prisms being worn.

## Measurements:

In primary position with correction

S 14 L.H.'2

S'2 L.H.'2

No increase in esophoria to right or left.

February 1955. 8 mm resection lateral rectus R.E.

March 1955 new glasses prescribed:

R.E.  $-3.75S = -.50 \text{ ax } 105 \text{ 2 out}$

1 up

L.E.  $-4.00S = -.75 \text{ ax } 135 \text{ 2 out}$

1 down

With this correction, there was no diplopia for distance and the patient was comfortable while reading. A recheck in 1959 and 1962 showed no diplopia and good vision. In October 1967 at age 45, there was no diplopia but he complained of difficulty with close work. New Rx:

R.E.  $-5.00S = -.50 \text{ ax } 90 \begin{matrix} 3\frac{1}{2} \text{ out} \\ 2 \text{ up} \end{matrix}$   
 L.E.  $-5.00S = -.75 \text{ ax } 120 \begin{matrix} 3\frac{1}{2} \text{ out} \\ 2 \text{ down} \end{matrix}$

New bifocal Rx:

Cement segment  $+1.00S$  add  $3\frac{1}{2}$  diopter prism base in each wafer.

In June of 1972 he complained of intermittent diplopia.

Measurements:

In primary position with correction  
 S 12 L.H. 6  
 S' 2 L.H. 6

New Rx:

R.E.  $-4.75S = -1.00 \text{ ax } 30 \begin{matrix} 5 \text{ out} \\ 3 \text{ up} \end{matrix}$   
 L.E.  $-4.50S = -1.00 \text{ ax } 135 \begin{matrix} 5 \text{ out} \\ +2.00S \text{ add} \\ 3 \text{ down} \end{matrix}$

Lenses were Unis D with vertical prisms in distance and near correction. Fresnel press-on prisms 5 out in distance area of each lens.

Result: Patient comfortable, no diplopia but conscious of some haziness of distant vision and may decide to have further surgery.

CASE 2

A 58 year old male was first seen in December 1967 complaining of eye fatigue and intermittent diplopia at distance vision.

Measurements:

In primary position  
 S 10 L.H. 2  
 X'2 L.H.'2

Refraction:

R.E.  $-.50S = +1.50 \text{ ax } 5 = 20/20$   
 L.E.  $\text{plano} = +1.25 \text{ ax } 180 = 20/20$   
 $+2.25 \text{ S add}$

Patient had been wearing bifocal glasses without prisms.

New correction:

R.E.  $-.50S = +1.50 \text{ ax } 5 \begin{matrix} 3 \text{ out} \\ 1 \text{ up} \end{matrix}$   
 L.E.  $-.25S = +1.25 \text{ ax } 180 \begin{matrix} 3 \text{ out} \\ 1 \text{ down} \end{matrix}$

$+2.25S$  add cement segments 3 base in prism each wafer.

Patient was improved but continued to have intermittent diplopia.

September 20, 1972 no change in refraction.

In primary position with correction:

ST 15 L.H. 3  
 S' 4 L.H. 3

Advised to have surgery.

October 26, 1972 8 mm resection lateral rectus L.E.

November 2, 1972

New glasses:

R.E.  $-.50S = +1.50$  ax 5 1 up

L.E.  $-.25S = +1.25$  ax 180 1 down  
+2.50S add.

No horizontal imbalance for distance, x'3 for near.

#### CASE 3

A 67 year old female was first seen 1957 and had no diplopia.

In 1966 no complaints of diplopia.

Measurements:

With correction in primary position

S 4 no hyper.

Orth' no hyper.

In 1969 complained of diplopia at distance.

Measurements:

With correction in primary position

S 8 no hyper

X' 1 no hyper

New glasses:

R.E.  $+1.75S = +1.00$  ax 180 2½ out

L.E.  $+2.00S = +.75$  ax 180 2½ out

Cement segment +2.50S add 2½ diopter prism base in each wafer.

In 1970 recurrence of diplopia at distance.

New Rx:

R.E.  $+1.75S = +1.00$  ax 180 4 out

L.E.  $+2.00S = +.75$  ax 180 4 out

Cement segment +2.50S add 4 diopter prism base in each wafer. No diplopia for distance vision and comfortable reading. Complains however of the weight of the glasses.

#### CASE 4

A 77 year old female was seen in January 1967, complaining of blurred distant vision but did not recognize diplopia.

Refraction:

R.E.  $-1.75S = -.75$  ax 105 = 20/30-

L.E.  $-.75S = -.75$  ax 90 = 20/30-  
+2.75S add

Measurements:

In primary position with correction.

S 8 L.H. 1

X'4 L. H.' 1

New Rx:

R.E. -1.25S = -.75 ax 105 3 out  
1 up

L.E. -.75S = -.75 ax 90 3 out

Cement segment +2.75S Add 3 diopters prism base in each wafer.

March 1972 age 82.

Recurrence of blurred vision.

New Rx:

R.E. -4.00S = -1.25 ax 110 5 out  
1 up

L.E. -4.25S = -1.50 ax 120 5 out  
1 down

+2.75S add.

Fresnel 5 diopters base out press-on prisms to upper areas. The vertical prisms were ground into the basic lens.

Patient complains of poor distant vision with new glasses because of Fresnel prisms and moderate bilateral lens haziness.

CASE 5

84 year old female had very satisfactory peripheral iridectomies in June 1970 for angle closure glaucoma. The pressure in each eye remained controlled but patient continued to have uncomfortable vision.

Refraction:

R.E. +3.50S = +1.50 ax 60 = 20/30-

L.E. +4.50S = 20/20-

Measurements:

In primary position with correction

S 10 L.H. 2

X' 2 L.H. 2

New Rx:

R.E. +3.50S = +1.50 ax 60 4 out  
1 up

L.E. +4.25S 4 out  
½ down

Vertical prisms ground in basic lenses along with base out prisms. Cement segment +2.50S add combined with 4 diopter base in prism in each wafer.

Vision perfectly comfortable for T.V. but tires for reading. Requires convergence exercises. New glasses are heavy and annoying pressure on nose and ears.

CASE 6

A 75 year old female had bilateral cataract extractions October 1967. Repair of prolapsed iris, right eye January 1968. Comfortable satisfactory visual result.

September 1972 complained of double vision for T.V.



## Refraction:

R.E. +10.00S = +.75 ax 15 = 20/30—

L.E. +6.50S = +4.25 ax 180 = 20/30

## Measurements:

In primary position with correction.

S 8 no hyper.

Orth' no hyper.

3 diopter Fresnel press-on prisms to upper areas of patient's present glasses.  
Very comfortable.

## CASE 7

74 year old female seen for first time in February 1970. Patient had had previous glaucoma surgery on each eye and cataract extraction R.E. November 1967 and L.E. September 1968. She complained of unsatisfactory distant vision and great fatigue for reading. No definite complaint of diplopia.

## New Rx:

R.E. +13.75S = +1.25 ax 30 = 20/40

L.E. +14.00S = +.75 ax 90 = 20/20  
+2.50 S add

New glasses were ordered and patient given loose prism exercises for convergence insufficiency. Convergence power improved satisfactorily but patient still had uncomfortable vision at distance.

In June 1972 a more careful study of muscle balance revealed in primary position with correction.

S 9 L.H. 1-2

X'2 L.H.' 1-2

With red filter over right eye binocular vision was obtained with 6 diopter prism base out and 2 diopter base up over right eye at 20 feet.

Fresnel press-on prisms 3 diopter base out over distance area of each lens with 1 diopter base up over distance area of right lens were ordered for patient's present glasses. The base up on right lens was obtained by rotating the press-on prism the required amount.

Distant vision was not impaired with press-on prisms and over all vision was more comfortable than at any time since glaucoma and cataract surgery.

## SUMMARY

Primary divergence insufficiency appears to be a functional disorder of eye muscle balance with symptoms and abnormal measurements limited to distant vision. It may develop at any age, is not especially related to sex or error of refraction, and it may not always be progressive.

The main symptom is confused or double vision at distance. The abnormal measurements will be an esophoria of moderate amount with an

abnormally high prism convergence power and a minimum prism divergence power. The onset of the diplopia is gradual, usually intermittent and never an emergency. Divergence insufficiency must be distinguished from divergence paralysis and unilateral or bilateral sixth cranial nerve palsies.

A patient with divergence insufficiency can easily be made comfortable with proper base out prisms to be worn for distance vision. Orthoptic training to strengthen fusion and build up divergence power should always be considered. Fresnel press-on prisms are valuable in the treatment of divergence insufficiency and provide an opportunity to increase the base out prism at much less expense.

Strengthening the power of the lateral rectus muscle should be considered if the esophoria increases to fifteen prism diopters or more. Such surgery is urgent if the esophoria becomes an esotropia for distant vision. Carefully performed resection of the lateral rectus muscle is an almost ideal operation.

#### REFERENCES

1. Duane A: A New Classification of the Motor Anomalies of the Eye. *Ann Ophthalmol Otolary* 5: 969-1008, 1918.
2. Oaks L: Divergence Insufficiency as a Practical Problem. *Arch Ophthalmol* 41: 562-569, 1949.
3. Deutsch A: Divergence Insufficiency. *Am J Ophthalmol* 33: 1297-1298, 1950.
4. Prangen AH, Koch FLP: Divergence Insufficiency: a clinical study. *Am J Ophthalmol* 21: 510-518, 1938.
5. Lyle J: Divergence Insufficiency. *Arch Ophthalmol* 52: 858-864, 1954.
6. Moore S, Harbison JW, Stockbridge L: *Am Orthop J* 21: 59-63, 1971.

#### DISCUSSION

DR PHILLIP KNAPP. The most interesting discussions occur when the discussor disagrees on several aspects of the subject and arrives at different answers. The essayist then rebuts the discussor and establishes the validity of his own findings. Unfortunately, as far as this discussion is concerned, I am in entire agreement with Dr Simpson.

I went over 21 cases of primary divergence insufficiency from the Orthoptic department and my own files. Their ages at onset varied from 10 to 84 years of age. Nine patients showed mild hyperopia, 11 had mild myopia, and one had anisometropia. The presenting complaint was diplopia in 19 patients, and confusion in two. Six patients did not receive any treatment for various reasons. Thirteen patients were treated with prisms, and two patients with resection of the lateral recti with satisfactory results.

Of the 13 patients treated with prisms, two patients improved so that they now have comfortable single binocular vision without prisms. Six patients are still wearing the prisms with evident satisfaction. One patient has worn prisms for 12 years and now wants surgery. The remaining four patients had a resection of each lateral rectus for esotropia of 18-22 prism diopters for distance. All still have an esophoria of between four and eight diopters remaining for distance and near. Thus, I can heartily support Dr Simpson's recommendation that the therapy of primary divergence insufficiency is base-out prisms, sufficient to allow fusion, and surgery for the larger deviations — either as a primary treatment or after a trial of prisms.

I would note that our only difference is our favoring the resection of both lateral recti, whereas the essayist succeeds with a single resection. I would also like to endorse his clear-cut separation of this benign problem from the acute condition of divergence paralysis which is frequently a sign of serious neurological disease.

In conclusion, I would like to congratulate Dr Simpson for bringing this interesting motility problem and its solution to our attention.

DR ROBERT W. HOLLENHORST. I think one word of caution is in order in patients of this type, particularly those in whom the onset of diplopia seems to have come on one day and disappear the next. I refer particularly to several cases of myasthenia gravis whose initial symptom was divergence insufficiency. It is my own practice to test with Tensilon every patient who presents with divergence insufficiency.

My second caution is illustrated by two teenagers who by Maddox rod tests had no sixth nerve palsy, and who had classical divergence insufficiency. One of these patients had had muscle surgery about a year before I saw him. Two or three years after we first saw these two teenagers there was unmistakable evidence of a pontine glioma in both patients, and they later developed bilateral sixth nerve palsies.

So, in the younger age group, I think one must bear in mind the possibility that you are dealing with a lateral rectus palsy or bilateral rectus palsy which presents as a divergence insufficiency.

DR G. VICTOR SIMPSON. May I thank Dr Knapp and Dr Hollenhorst. I think his word of caution is very well taken. We have had some experience with myasthenia gravis, but I have never seen an onset in such a benign fashion as divergence insufficiency.

The question of a single or double lateral rectus resection always has room for argument. Roughly, I believe a large resection, eight to ten mm under general anesthesia, will correct about 12 to 15 prism diopters of divergence insufficiency, and the small amount that may be left can be corrected with prisms.