Evaluating Torsion with the Torsionometer, Synoptophore, Double Maddox Rod Test and Maddox Wing: A Reliability Study

Zoran Georgievski BAppSc(Orth)Hons
School of Orthoptics
La Trobe University
Bundoora
Lionel Kowal MBBS FRACS FRACO
Ocular Motility Clinic
Royal Victorian Eye & Ear Hospital
Melbourne.

Address for correspondence:
Zoran Georgievski
School of Orthoptics
Faculty of Health Sciences
La Trobe University, Bundoora 3083
Email: ortzg@lure.latrobe.edu.au

This paper was in part published in: Lennerstrand G. (ed.) Update on Strabismus and Pediatric Ophthalomology. Proceedings of the Joint ISA and AAPO&s Meeting, Vancouver, Canada, June 19 to 23, 1994. Boca Raton: CRC Press, 1995.

Submitted: February 1996.
Accepted for publication: May 1996.

Abstract

This paper reports a reliablity study which compared a new test for the measurement of torsion, the Torsionometer, and three standard clinical methods: the synoptophore, double Maddox rod test and Maddox wing. Measurements on the four tests correlated well, however there were significant discrepencies between different tests on several occasions. Such variation is clinically important and it is therefore recommended that clinicians evaluate torsion with more than one test.

Key Words:
torsion, ocular torsion, cyclotropia, strabismus, Torsionometer, synoptophore, double Maddox rod test, Maddox wing.

Introduction

In his 1984 Costenbader lecture, Gunter von Noorden asked " Why has cyclotropia been a stepchild of clinical investigation for so long?"[1]. Without doubt, part of the neglect in this field of strabismology has been due to the complexity of the measurement procedure of some tests. This is probably compounded by the fact that surgery for torsion has only been widely practiced for a relatively short time. Little over twenty years ago, in fact, orthoptists were taught never to mention torsional diplopia to patients as there was nothing that could be done about it! Today, the measurement of torsion is recognised as a intergral part of the ocular motility examination, since its presence and extent are important factors in planning treatment.

Various instruments and tests can be employed to assess torsion in cyclovertical deviations. These 'measurement' methods can be inexact and often need to be supplemented by a second or even third test. They are subjective and, unlike measuring horizontal and vertical deviations, challenge the patient to align two lines parallel to each other. The concept of parallelism is difficult which complicates the measurement of torsion. This paper reports the results of a reliability study which statistically compared four methods of measuring torsion [2], one of which is a new test from Clement Clarke International Ltd., called the Torsionometer [3].

The Torsionometer

The Torsionometer (Figure 1) offers the advantages of portability, speed and ease of use for both patient and examiner. The device consists of a red plate with a vertical line beside a green one, which the patient rotates using a dial (Figure 2). The patient's view of the test has been designed so that there are minimal cues about objective parallelism. On the back of the test plate is a measurement scale corresponding to the orientation of the green line relative to the red line. This enables the examiner alone to read the amount of torsion present. The test is carried out in free-space with the patient wearing a pair of reversible complementary red and green goggles, so each eye is presented with a different line image. However, the test plate and its surrounds are visible to both eyes so that sensory cyclofusion, a most effective compensatory mechanism in cyclodeviations,[4] is not precluded.

Measurement is relatively quick and uncomplicated (Figure 3). The test plate is positioned at a 40cm viewing distance, perpendicular to the patient's line of sight. To begin testing, the green line is rotated maximally in one direction and the patient attempts to make it subjectively parallel with the red line. Up to 25° of excyclo– or incylcotorsion can be read off the scale. Torsion can also be measured in other positions of gaze, for example in downgaze, where it is often greater and causes most problems in cases such as bilateral fourth nerve palsy [5,6]. The goggles that come with the Torsionometer enable unrestricted measurement in the reading position or extreme downgaze.

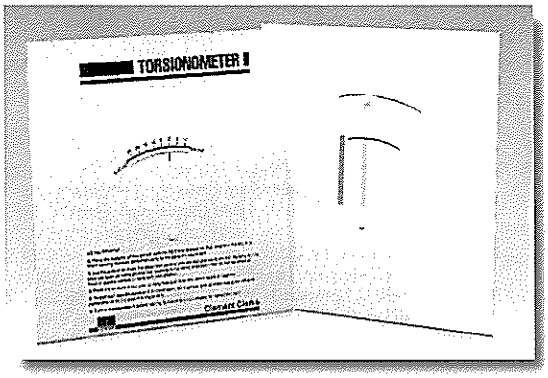

Figure 1

The Torsionometer: Front and Rear Views.

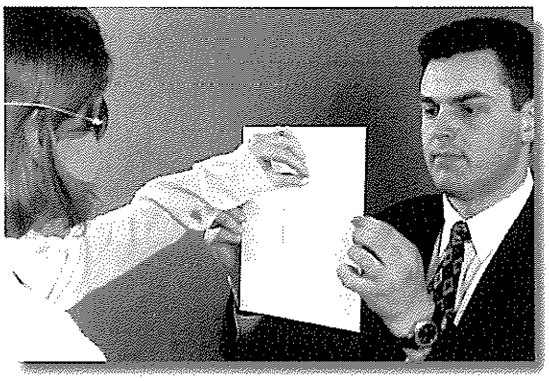

Figure 2

The Torsionometer: Alignment by the patient.

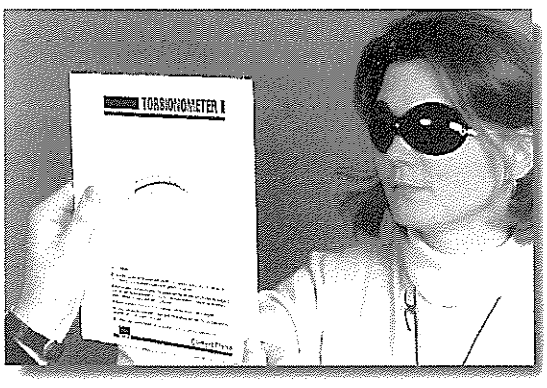

Figure 3

The Torsionometer: Measurement Scale.

Method

Patients

Patients were obtained from the Ocular Motility Clinic, Royal Victorian Eye and Ear Hospital, Melbourne. Thirty-three (n=33) adult patients who were aware of a torsional component to their diplopia underwent torsional measurement.

Apparatus

Torsion was measured with the following: the Torsiononmeter, synoptophore (Major Synoptophore Model 2053, Clement Clarke International Ltd.), double Maddox rod test (DMR) and Maddox wing (MW). To improve precision, the synoptophore slides (simultaneous perception, G35 & 36) were modified with horizontal straight lines. Also, the Maddox rods were marked to indicate the axis in the trial frames (Oculus).

Procedure

The four tests were performed in a conventional manner and presented in random order. In certain situations, measurements could not be obtained with all tests, for example, the MW could not be used with large amounts of torsion. All patients had their torsion measured in the primary position, some also in the secondary position, usually depression, and many were assessed on review visits when the torsion may have changed either spontaneously or following treatment. Comparisons were made between measurements obtained at the same visit and in the same position of gaze.

Statistical Analysis

In total, 68 sets of measurements were analysed using the one–way ANOVA intraclass correlation coefficient, or ICC [7,8]. This is a statistic used in clinical reliability studies and test relationships similar to Pearson's r test, except that it takes into consideration variance components due to error or absolute differences in the data [7]. The level of significance, alpha, was set at 0.05.

Results

As evident in the correlation matrix (Table 1), there were moderately high to very high correlations between measurements of the four tests, the strongest correlation being between the Torsionometer and DMR test (ICC: R=0.93). This is also shown in Figure 4.

The overall correlation between all four tests was moderately high(R=0.74) and strengthened only when the MW data were excluded from the analysis (R=0.90). It would seem that the highest correlation was between the Torsionometer, Synoptophore and DMR test. On closer inspection, however, it was found that this is related to the larger measurement range of these three tests. Repeat analysis that was confined to measurements of 10° and less on all tests showed that when the MW data was excluded, the correlation actually dropped slightly (from R=0.74, as above, to R=0.70).

It was found that the DMR test generally revealed greater amounts of torsion than the other tests. This was statistically significant against the Torsionometer (ANOVA:$F1$, 56 = 5.76, p=0.020) and synoptophore ($F1$, 56=9.66, p=0.003), except when the analysis was confined to 10° and less when all four tests were included ($F3$, 102=1.24, p=0.298). In other words, the DMR test revealed significantly greater amounts of torsion, but only when the amount of torsion exceeded 10°. Furthermore, it was determined that the tests in order of decreasing dissociation tendency after the DMR test were the Torsionometer, synoptophore and MW, although there were no statistically significant differences between the measurements obtained with the latter three tests ($F2$, 74=0.09, p=0.912.)

Despite the strong agreement between the four tests, the mean difference between the highest and lowest torsion value for each measurement set was only 2.4° (sd= 1.7°, mode =2°).

However, the difference between the two extreme values was at least 5° for 7 (10.3%) of the 68 measurement sets, the maximum being 8° for one patient. These differences were encountered in measurements obtained from six patients and across different tests, so that no particular test was consistently responsible for the variation.

Discussion

The results demonstrate that the Torsionometer is a valid test for the measurements of torsion. They also confirm the validity of the standard testing methods when they are modified as described. The MW is an equally reliable device, but is limited in application by its small measurement scale.

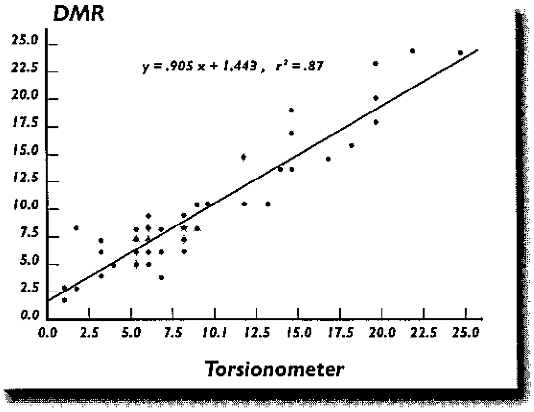

Figure 4

Strongest Correlation seen between Torsionometer and DMR

Table 1

Correlation Matrix

	Tor	Syn	DMR	MW
Torsionometer	1.00	0.90	0.93	0.81
Synoptophore	0.90	1.00	0.87	0.76
Dbl Maddox Rod	0.93	0.87	1.00	0.76
Maddox Wing	0.81	0.76	0.76	1.00

It is generally believed that different tests reveal varying amounts of torsion depending on the level of dissociation provided. For example, measurement with the Bagolini striated glasses would be expected to show less torsion than the DMR test because the former allows cyclofusion [4,9]. In the present study, it was also found that the DMR test generally revealed greater amounts of torsion than the other methods, but this was only statistically significant when the amount of torsion exceeded 10°.

It is difficult to explain why the synoptophore and MW revealed lesser amounts of torsion than the DMR test as all three are haploscopic tests. The Torsionometer, on the other hand, uses complementary colour dissociation, is performed in free space and does not preclude sensory cyclofusion, yet ranked second after the DMR test in dissociation tendency.

In a subsequent statistical analysis of tabular data published by Pratt–Johnson and Tillson in 1987 [10], it was found that there was no signifcant difference between the torsion measurements obtained by DMR and Bagolini striated glasses testing in 10 patients with bilateral fourth nerve palsy (ANOVA: $F1$,9=1.91, p=0.164), which is contrary to the conclusion made by these authors.

In light of these findings, it is probable that a torsion test's dissociation tendency is not particularly important when cyclotropia is associated with vertical and horizontal strabismus, as it usually is, and fusion is not possible even peripherally. This is supported by a further analysis of Pratt–Johnson and Tillson's [10] data. In their small series, torsion was measured on the synoptophore using simultaneous perception and fusion slides, although these were not modified for the purposes of measuring torsion specifically. The measurements obtained with the simultaneous perception slides were significantly greater (ANOVA: $F1,9=7.22$, $p=0.002$), presumably because fusion was suspended.

In the present study, a small but significant number of patients demonstrated quite a variation between the highest and lowest torsion value in a measurement set. There are important clinical implications if different testing methods elicit such different torsion measurements in one patient, in one position of gaze, and in one measurement sitting. Indeed how much torsion does the patient have? One implication is that it becomes more difficult to determine if the patient's symptoms are attributable to the torsion. Also, using the amount of torsion as an indicator of bilateral involvement in fourth nerve palsy becomes even more problematic.

It is therefore important that torsion be measured with more than one test, particularly when the patient is aware of it and describes it as a component of the diplopia. The author routinely uses at least two methods to evaluate torsion in such cases and recommends that each test be repeated to verify the measurement. This proccedure adds negligible time to the ocular motility examination and is therefore more than worthwhile.

References

1. von Noorden GK. Clinical and theorectical aspects of cyclotropia. J Pediatr Ophthal Strab 1984; 21: 126–132.

2. Georgievski Z. Comparison of three standard clinical tests and a new test for the measurement of torsional diplopia. Chapter III.15 in Lennerstrand G. (ed.) Update on Strabismus and Pediatric Ophthalmology. Proceedings of the joint ISA and AAPO&S Meeting, Vancouver, Canada, June 19 to 23, 1994. Boca Raton: CRC Press, 1995: 171–174.

3. Georgievski Z. A new test for the measurement of torsion. J Pediatr Ophthal Strab 1996; 33(1): 63–64.

4. von Noorden GK. Binocular Vision and Ocular Motility: Theory and Management of Strabismus. 5th ed. St Louis: Mosby CV, 1995: 189–191, 370–372.

5. Georgievski Z, Kowal L. A survey of symptomatic ocular torsion Strab 1995; 3(4): 169.

6. Kraft SP, O'Reilly C, Quigley PL, Allan K, Eustis HS. Cyclotorsion in unilateral and bilateral superior oblique paresis. J Pediatr Ophthal Strab 1993; 30: 361–367.

7. Portney L, Watkin M. Foundations of Clinical Research: Applications and Practice. Norwalk:Appleton and Lange 1993: 505–528.

8. Haas M. Statistical methodology for reliable studies. J Manip Physiol Ther 1991; 14: 119–132.

9. Ruttum M, von Noorden GK. The Bagolini striated glasses test for cyclotropia. Doc Ophthal 1984; 58: 131–139.

10. Pratt–Johnson J, Tillson G. The investigation and management of torsion preventing fusion in bilateral superior oblique palsies. J Pediatr Ophthal Strab1987; 24 (3): 145–150.