EXTENDED REPORT

The use of the Newcastle Control Score in the management of intermittent exotropia

Deborah Buck, Sarah R Hatt, Helen Haggerty, Susan Hrisos, Nicholas P Strong, Nicholas I Steen, Michael P Clarke

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See end of article for authors' affiliations

Correspondence to:
Mr M P Clarke, Claremont
Wing Eye Department,
Royal Victoria Infirmary,
Newcastle upon Tyne NE1
4LP, UK;
m.p.clarke@ncl.ac.uk

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Aim: To evaluate the use of the Newcastle Control Score (NCS) in the management of intermittent exotropia (X(T)).
Participants and methods: Children aged <11 years with X(T) had an assessment of NCS as part of routine management. Other data collected included visual acuity, near and distance alignment with alternating prism cover test and near (Frisby test) and distance stereoacuity (Frisby Davis Distance Stereotest (FD2TM)). Analysis involved correlation between baseline NCS, angle and stereoacuity, examination of change over time and logistic regression to determine predictors of surgery.

Results: Baseline data were obtained on 272 children and follow-up data on 157. Mean (SD) age was 4 (1.9) years. Complete NCSs were obtained for all except one child at baseline, and all children at follow-up. At baseline, total NCS and the home control component were correlated with near stereo ($r = -0.22$, $p < 0.01$ and $r = -0.19$, $p < 0.02$, respectively), near alignment ($r = 0.34$, $p < 0.001$ and $r = 0.19$, $p < 0.02$) and distance alignment ($r = 0.30$, $p < 0.001$ and $r = 0.26$, $p < 0.001$). The clinic near control component was correlated with near alignment ($r = 0.39$, $p < 0.001$), but not near stereoacuity, and the clinic distance control with near alignment ($r = 0.16$, $p < 0.02$), distance alignment ($r = 0.27$, $p < 0.001$) and distance stereoacuity ($r = -0.25$, $p < 0.03$). A high (poor) NCS (≥ 4) at the latest follow-up predicted surgery ($p < 0.001$, OR 29.3, 95% CI 6.2 to 138.7).

Conclusion: The NCS is a useful measure of the clinical severity of X(T), can be used to serially assess improvement or deterioration and is a useful tool for the management of these patients.

Intermittent exotropia (X(T)), is a common form of childhood strabismus, which is exacerbated by distance fixation, tiredness or inattentiveness.^{1,2} It may be accompanied by monocular eye closure in bright sunlight.³ Affected children are typically not aware of diplopia when the deviation occurs and show normal binocular single vision (BSV) when it is controlled. Alignment at near fixation is better controlled than at distance fixation, and the presence of near stereopsis is usual, but the deviation may progress such that the control of alignment at near deteriorates, with the development of a constant strabismus and loss of stereopsis.

The options for management of X(T) include observation, orthoptic exercises, occlusion, minus lenses and surgery.⁴ Some authors recommend early surgery to prevent the development of constant exotropia with loss of BSV.⁵ However, surgery, particularly early surgery, is associated with a risk of over-correction causing diplopia or loss of BSV and amblyopia in patients under 5 years of age.⁶

The indications for surgery have been suggested to be a deviation, which is present >50% of the time (home control) and which is poorly controlled on cover testing (office control).⁷ These indications have been quantified into a score—the Newcastle Control Score (NCS) for intermittent exotropia.⁸ The NCS has good interobserver correlation and has been useful in the longitudinal follow-up of children with X(T) being treated with minus lenses.⁹

The purpose of this study was to evaluate the NCS in the initial assessment and follow-up of a cohort of children with X(T).

METHODS

Participants

Children with X(T) aged <11 years, with no history of treatment for strabismus or amblyopia, and with X(T) of ≥ 20

prism dioptres on distance fixation and ≤ 20 prism dioptres at near fixation were eligible for inclusion in the study. Carers of such children were provided with written information about the nature of the study and recruited once signed consent had been obtained. The study was granted approval from the UK North West Multi Centre Research and Ethics Committee and was conducted in accordance with the tenets of the Declaration of Helsinki.

Clinical assessment

At baseline, the visual acuity, NCS, alignment at near and distance with simultaneous prism cover test and alternating prism cover test, convergence, stereoacuity at near (Frisby test; <http://www.frisbystereotest.co.uk/index.htm>) and distance (Frisby Davis Distance Stereotest (FD2TM); <http://www.frisbystereotest.co.uk/index.htm>)¹⁰ were measured. Cycloplegic refraction and fundus examination were undertaken if they had not recently been performed. The NCS was recorded, as table 1 shows.

Stereoacuity was recorded as absent if the child showed an understanding of the principle of the test, but was unable to obtain a stereoacuity value at the standard testing distance. Measurements were repeated at each subsequent follow-up visit, scheduled at 3-month intervals. Only patients with a minimum of 6 months follow-up (before surgery if performed) were included in the analysis. The decision to operate was based on conventional indications of estimated frequency, control and size of deviation, and/or parental concerns.

Data analysis

Data were entered on to a database (SPSS V.11) for primary analysis to be performed in the following fields: NCS and

Abbreviations: BSV, binocular single vision; X(T), intermittent exotropia; NCS, Newcastle Control Score

Table 1 The Newcastle Control Score

Home control	Score
X(T) or monocular eye closure seen	
Never	0
<50% of time fixing in distance	1
>50% of time fixing in distance	2
>50% of time fixing in distance+seen at near	3
Clinic control	
Distance	
Immediate realignment after CT	0
Realignment after blink or refixation	1
No realignment/manifest spontaneously	2
Near	
Immediate realignment after CT	0
Realignment after blink or refixation	1
No realignment/manifest spontaneously	2
Total NCS = (home+near+distance)	

CT, cover test; NCS, Newcastle Control Score; X(T), intermittent exotropia.

components; near and distance angle of deviation with alternating prism cover test; stereopsis at near using the Frisby test; and stereopsis at distance using the FD2TM. To include those cases in which stereoacuity was absent—that is, was worse than the highest (poorest) measurable score—reciprocal transformation was undertaken on stereoacuity values, with absent values being assigned a value of zero (J Frisby, personal communication, 2006). These reciprocal values were used only in analysing change in stereo over time, although this longitudinal analysis was repeated using the original values. Analysis was performed on baseline and last follow-up measurements (or last follow-up before surgery). Differences over time were tested using Wilcoxon's tests, and Spearman's correlation coefficients were used to explore relationships between baseline measurements. Univariate logistic regression was performed to examine whether demographic and baseline measurements were significantly associated with subsequent surgery (age, sex, baseline NCS, near and distance angle, and near and distance stereoacuity). A dichotomous variable indicating a high NCS (≥ 4) at the latest follow-up was computed and included in the regression analysis. Variables with a univariate significance of $p < 0.05$ were included in a multivariate logistic regression model to determine which of these best predicted subsequent surgery. Postoperative findings will be reported separately.

Figure 1 Total Newcastle Control Score (NCS) at baseline.

RESULTS

Baseline data were obtained from 272 children recruited to the study from centres in Newcastle, Hull, Sunderland, London (Moorfields Eye Hospital), Durham, Norwich, Torbay and York, UK. Mean age at recruitment was 4 years (SD 1.9, range 1–10 years). Six months or longer follow-up data were available on 157 (58%) children before any strabismus surgery (median follow-up 12 months, range 6–27 months). A total of 27 (17%) went on to have strabismus surgery (median follow-up 12 months, range 6–27 months). Complete NCSs were obtained for 271 children at baseline. Figure 1 shows the distribution of the NCS at baseline: the median score at this time point was 3. Other baseline and follow-up data were incomplete for some children, owing to immaturity or non-cooperation, and the lack of an FD2TM in some centres. Table 2 illustrates median baseline and follow-up values, significance of changes over time, and proportions improving, stable or deteriorating over time for NCS, angle of deviation and stereoacuity.

We found no clinically significant changes in near or distance angle of deviation, but on the basis of both the original (table 2) and the reciprocal values, there were significant improvements over time in both near and distance stereoacuity ($z = -5.72$, $p < 0.001$ and $z = -3.26$, $p < 0.01$, respectively).

Table 3 displays the correlations between NCS, stereoacuity and angle of deviation at baseline.

Table 2 Baseline and latest follow-up data

	Median (range) at baseline*	Median (range) at baseline†	Median (range) at follow-up‡	Significance of change between baseline and follow-up‡	n (%) improved	n (%) stable	n (%) deteriorated
NCS	3 (1–7) n = 271	3 (1–7) n = 157	3 (1–7) n = 157	$z = -1.56$ $p = 0.11$	63 (41)	51 (32)	42 (27)
APCT 1/3 m (prism dioptres)	14 (0–40) n = 246	14 (0–40) n = 134	14 (0–55) n = 134	$z = -1.47$ $p = 0.14$	17 (13)	82 (61)	35 (26)
APCT 6 m (prism dioptres)	30 (6–50) n = 252	35 (6–50) n = 140	30 (14–55) n = 140	$z = -2.88$ $p < 0.01$	34 (24)	87 (62)	19 (14)
Frisby (near stereoacuity)	150 (30–600) n = 157	110 (30–600) n = 92	75 (20–600) n = 92	$z = -4.54$ $p < 0.001§$	60 (61)	25 (25)	14 (14)
FD2TM (distance stereoacuity)	30 (5–60) n = 45	34 (13–60) n = 15	23 (5–34) n = 15	$Z = -2.76$ $p < 0.01§$	27 (71)	6 (16)	5 (13)

APCT, alternating prism cover test.

*For whole group.

†Those with both baseline and follow-up data for this variable.

‡Wilcoxon signed ranks test.

§Based on original stereoacuity values, therefore excludes absent values.

Table 3 Correlations between baseline NCS, baseline stereoacuity and baseline angle of deviation (Spearman's rho, p value)

	Frisby stereo (n = 171)	FD2TM stereo (n = 45)	APCT 1/3 m (n = 245–246)	APCT 6 m (n = 251–252)
Total NCS	-0.22, p<0.01	-0.14, p=0.23	0.34, p<0.001	0.3, p<0.001
Home control	-0.19, p<0.02	-0.05, p=0.7	0.19, p<0.02	0.26, p<0.001
Clinic near	-0.14, p=0.07	-0.06, p=0.6	0.39, p<0.001	0.1, p=0.1
Clinic distance	-0.12, p=0.11	-0.25, p<0.03	0.16, p<0.02	0.27, p<0.001

APCT, Alternating Prism Cover Test; FD2TM, Frisby Daris Distance Stereotest; NCS, newcastle control score.

Total NCS and the home control component were weakly correlated with near stereo, and both near and distance angle. The clinic near control component was moderately correlated with near angle (but not near stereoacuity) and the clinic distance control was weakly correlated with distance angle and distance stereoacuity. Complete NCSs were obtained for all 157 children at follow-up (mean age 4.8 years; (SD 1.7), range 1–10 years). Figure 2 shows the distribution of NCS at follow-up the median score at follow-up was unchanged at 3.

Univariate logistic regression showed that three variables were significantly associated with undergoing surgery (baseline NCS, baseline distance angle and a high NCS at the latest follow-up). Multivariate logistic regression showed that one of these (high NCS at follow-up) predicted surgery (p<0.001, odds ratio (OR) 29.3, 95% confidence interval (CI) 6.2 to 138.7). Table 4 illustrates the relationship between high NCS at the latest follow-up and surgery.

No child developed a constant exotropia with loss of near stereoacuity over the study duration, although surgery may have prevented this occurring.

DISCUSSION

The aim of management of X(T) is to prevent or reverse any functional or cosmetic consequence of the ocular misalignment seen in the condition.⁴ To this end, a variety of parameters may be measured, which indicate these consequences or progression towards them. There is no consensus about which of these parameters are the most important, although most authors include measures of "control" and stereoacuity as end points.¹¹ The size of the deviation when the strabismus is manifest is generally considered to be of lesser importance than the frequency with which it is manifest.⁷

Control generally refers to the observed frequency with which the squint is manifest, together with a measure of the speed or ease of realignment after dissociation.² These two measures may not always correlate—for example, in the case of

a squint, there may be inaccurate parental observations, but it generally follows that an X(T) which is often manifest in everyday life will not recover immediately after dissociation. Measurement of recovery after dissociation should be used to confirm the accuracy of parental observation rather than these observations being ascribed independent credibility.

Assigning a numerical value to control becomes useful if serial comparisons are to be made for an individual patient, and for comparison between patients. The NCS is one method of assigning a numerical value to control and was measurable in all except one of the children in this study. This is in contrast with other parameters, such as the measurement of convergence or simultaneous prism cover test, which were not readily performed, particularly in younger children with the condition.

Does the measurement of control as a score contribute to the management of X(T)? The main concern of the parents of a child with X(T) is usually the appearance of the strabismus, measured clinically by the frequency and size of the strabismus: the NCS measures the frequency with which ocular misalignment occurs, and has been shown in this study to correlate with the size of the deviation once it is manifest. In terms of the functional consequences of X(T), the total NCS correlates with near stereoacuity and clinic control to a distant target correlates with distance stereoacuity (albeit weakly)—indicating that either the frequency with which the deviation is manifest or the speed of recovery after dissociation, or both, has a consequence for stereoacuity (or vice versa).

Whereas stereoacuity tended to improve, and angle tended to remain the same over the follow-up period in this study, the change in NCS was evenly distributed between improvement, no change and deterioration, indicating that this may be a better marker of change or progression. (It should be noted that the sample size for distance stereo measurements was small and based on data from three of the eight centres, thus the finding should be met with some caution.) Some authorities suggest that deterioration of control and the development of a constant exotropia is a frequent consequence of X(T).⁷ However, our data would tend to confirm that of Chia *et al.*,¹² who found that control remained unchanged in 63% of their cases.

It is important to consider the issue of spontaneous improvement in this condition, although a recent publication suggests that this occurs in only 4% of cases.¹³

The NCS is based on standard criteria for surgical intervention, so it is not surprising that a high NCS predicts surgical

Figure 2 Total Newcastle Control Score (NCS) at latest follow-up.**Table 4** Relationship between high Newcastle Control Score at the latest follow-up and surgery

Underwent surgery	High NCS at latest follow-up*	
	No, n (%)	Yes, n (%)
No	96 (74)	34 (26)
Yes	2 (7)	25 (93)

NCS, Newcastle Control Score.

*Presurgery for those undergoing surgery.

treatment, and our findings indicate that the underlying criteria were being used in our clinical practice when decisions on surgical treatment were made. It should be noted that the NCS was not used as an absolute, nor as the only criterion for surgery—rather, the decision to operate was made as a result of consideration of parental observations and concerns allied with the clinical examination. Nonetheless, assigning a numerical value to control facilitates serial assessments of individual patients and comparisons between patients with X(T). In addition, it provides a means of standardising management of the condition. To quote Lord Kelvin: “When you can measure what you are speaking of and express it in numbers, you know that on which you are discoursing. But when you cannot measure it and express it in numbers, your knowledge is of a very meagre and unsatisfactory kind.”

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Authors' affiliations

Deborah Buck, Susan Hrisos, Nicholas I Steen, Michael P Clarke, Institute of Health and Society, Newcastle University, Newcastle upon Tyne, UK
Sarah R Hatt, Helen Haggerty, Nicholas P Strong, The Royal Victoria Infirmary, Newcastle upon Tyne, UK

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REFERENCES

- 1 **Noorden GKv, Campos E.** *Binocular vision and ocular motility*, 6th edn. St Louis: Mosby, 2002:358–72.
- 2 **Rosenbaum A, Santiago A.** *Clinical strabismus management*. Philadelphia: WB Saunders, 1999:163–75.
- 3 **Campos E, Cipolli C.** Binocularity and photophobia in intermittent exotropia. *Percept Mot Skills* 1992;**74**:1168–70.
- 4 **Gnanaraj L, Richardson SR.** Interventions for intermittent distance exotropia: review. *Eye* 2005;**19**:617–21.
- 5 **Abroms A, Mohny B, Rush D, et al.** Timely surgery in intermittent and constant exotropia for superior sensory outcome. *Am J Ophthalmol* 2001;**131**:111–16.
- 6 **Richard J, Parks M.** Intermittent exotropia. Surgical results in different age groups. *Ophthalmology* 1983;**90**:1172–7.
- 7 **Rosenbaum A, Stathocopoulos R.** Subjective and objective criteria for recommending surgery in intermittent exotropia. *Am Orthopt J* 1992;**42**:46–51.
- 8 **Haggerty H, Richardson S, Hrisos S, et al.** The Newcastle Control Score: a new method of grading the severity of intermittent exotropia. *Br J Ophthalmol* 2004;**88**:233–5.
- 9 **Watts P, Tippings E, Al-Madfaï H.** Intermittent exotropia, overcorrecting minus lenses, and the Newcastle scoring system. *J AAPOS* 2005;**9**:460–4.
- 10 **Davis H, Frisby J, Walters B.** *The Frisby Davis Distance Stereotest (FD2)*. Florence, Italy: European Strabismological Association, 2001.
- 11 **Pratt-Johnson J.** Intermittent exotropia: what constitutes a cure? *Am Orthopt J* 1992;**42**:72–3.
- 12 **Chia A, Seenyen L, Long QB.** A retrospective review of 287 consecutive children in Singapore presenting with intermittent exotropia. *J AAPOS* 2005;**9**:257–63.
- 13 **Nusz KJ, Mohny BG, Diehl NN.** The course of intermittent exotropia in a population-based cohort. *Ophthalmology* 2006;**113**:1154–8.