

# Results of Surgical Treatment of Intermittent Divergent Strabismus

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## ABSTRACT

Inasmuch as surgery is often suggested as the primary treatment for intermittent exotropia, we undertook an extensive literature search to ascertain the outcome of this treatment. Surprisingly, only 22 papers were located which gave presurgical and postsurgical results for intermittent exotropia using reasonably clear success criteria. Many other papers were located but were excluded because they either failed to state the criteria used, lumped exotropia and esotropia together in their reported successes, or used orthoptics along with surgery. The total number of cases reported in the 22 acceptable papers was analyzed in terms of four levels of success to permit comparison across studies. These four levels were: functional success, motor alignment, cosmetically acceptable, and unsuccessful (no change or worse). The data are tabulated and summarized.

**Key Words:** intermittent exotropia, strabismus surgery results, binocular function

About one-fifth of all strabismics have intermittent exotropias,<sup>1-3</sup> a condition affecting 1% of the population.<sup>4</sup> Intermittent exotropia is usually classified as basic exotropia, convergence insufficiency, or divergence excess based upon Duane's classification.<sup>5</sup> The last category, divergence excess, is further subdivided into "true" and "simulated," a distinction which may influence the particular surgical approach used.<sup>6</sup> This report does not distinguish among the various categories of intermittent exotropia, but rather analyzes the reported results of surgery

for all types of intermittent exotropia taken together.

## METHODS

To accomplish our purpose of analyzing the results of surgery for intermittent exotropia, an extensive literature search was undertaken using *Medlars II* (1967-1980), *Excerpta Medica Ophthalmologica* (1950-1981), *Ophthalmic Literature* (1953-1981), the bibliographies of standard ophthalmological textbooks,<sup>7,8</sup> and 10 current ophthalmic journals (see Appendix), thus making our search current to December 1982. We sought all papers with presurgical and postsurgical results. Papers without clear or adequate descriptions of the success criteria used could not be analyzed and were therefore excluded. Because our interest was in the effectiveness of surgery, we did not use studies in which orthoptics was included in the treatment along with surgery. Inasmuch as the presence of amblyopia, which is not usual in intermittent strabismus, would tend to reduce functional success and thus bias the results against a good clinical outcome, we omitted all amblyopic subjects from our analysis. For similar reasons we excluded any patient who had had extraocular muscle surgery before becoming part of the studied clinical population, although patients who began as intermittent exotropes and then received multiple surgeries were included. This avoided contamination with patients who had previously had surgery for another condition which then resulted in intermittent exotropia. A total of only 22 papers<sup>3,6,9-28</sup> were located which met the minimum scientific standard of giving presurgical and postsurgical results using clearly stated success criteria.

Most of the literature search citations that dealt with the results of surgery could not be analyzed due to one or more of the following reasons: (1) No criteria were used (i.e., the results were reported as "80% were successful" with no statement of what constituted success).

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(2) Esotropia and exotropia were not separated. (3) Results were stated as averages of all deviations (i.e., average preoperative angle 40  $\Delta$  and average postoperative angle 10  $\Delta$  with no statement of the results on individual cases). (4) Exophorias were not differentiated from exotropias.

In several papers, where the purpose was the comparison of orthoptics vs. surgery, only the surgically treated cases were considered. This left a total of 1490 patients described in 22 different studies. Insofar as we can determine, we have included every credible paper in the ophthalmic literature over the past 30 years that has reported on the outcome of purely surgical treatment of intermittent exotropia.

### Criteria for Analysis of Data

To permit aggregating data across studies, we have adopted four criteria. These are functional success, motor alignment, cosmetically acceptable, and unsuccessful. The descriptions of these categories are:

1. Functional success requires that the postsurgical patient demonstrates no tropia at any distance by cover test, motor fusion ranges at distance and near as tested by prisms or in an amblyoscope, and sensory fusion. It should be mentioned that the functional success criteria we had to adopt in order to permit any useful analysis was far less stringent than the functional success criteria used in the reporting of orthoptic results.<sup>29</sup>

2. Motor alignment requires that the postsurgical patient demonstrates no acceptable tropia at any distance by cover test, with no demonstration of sensory improvement.

3. Cosmetically acceptable requires that the postsurgical patient demonstrates a strabismus which measures less than 15  $\Delta$ . No functional binocularity need be present. (A number of patients were converted from intermittent strabismics to low-angle constant strabismics. Although these are considered to be cosmetic successes for the purposes of this study, in these

instances the benefits to the patients may be questionable.)

4. Unsuccessful cases did not meet any of the three prior category criteria or were unchanged or worse after surgery. It was not always possible to differentiate between nonimprovement and worsening of the condition because of the method of data presentation.

### Data Analysis

Five studies<sup>13-15,20,24</sup> reported data in a manner permitting analysis of functional success. (The others did not give functional results after surgery.) This combined group of 571 patients is summarized in Table 1. In this group 34.3% were functionally successful, 27.5% were motorically aligned, and 16.3% were cosmetically acceptable. An aggregate percentage of 78.1% were cosmetically acceptable or better, with less than one-half of these patients showing good binocular function postsurgically. The remainder were either left with a postsurgical deviation greater than 15  $\Delta$ , unimproved, or were worse after surgery.

The remaining 17 studies could be analyzed on the basis of the motor alignment of the eyes, but not function, because they did not provide postoperative fusion measurements. These studies, which involved a total of 919 patients, are summarized in Table 2. Of this group, 42.0% achieved elimination of the strabismus, 15.8% were cosmetically acceptable, and the remaining 42.2% were not cosmetically acceptable.

Combining the results shown in Tables 1 and 2 discloses that 977 of 1490 (65.6%) patients operated on for intermittent divergence excess achieved a cosmetically acceptable end result. Of these, it seems probable that approximately one-half were no longer strabismic on cover test after surgery. The remaining one-third of the entire sample did not achieve even the minimum benefit of being left with a cosmetically acceptable deviation.

Most authors did not present their data in a way which permitted differentiation between patients who were improved cosmetically (al-

TABLE 1. Functional results of surgical treatment of intermittent exotropia.

Author	No. of Cases	Functional*	Motorically Aligned*	Cosmetically Acceptable*	Unsuccessful*
Cooper and Leyman <sup>13</sup>	264	110	109	—	45
Dunlap and Gaffney <sup>14</sup>	100	12	21	24	43
Folk <sup>15</sup>	50	14	27	—	9
Moore <sup>20</sup>	57	19	—	29	9
Pratt-Johnson et al. <sup>24</sup>	100	41	—	40	19
Total	571	196 (34.3%)	157 (27.5%)	93 (16.3%)	125 (21.9%)

\* See text for specific definitions of criteria.

TABLE 2. Nonfunctional results of surgical treatment of intermittent exotropia.

Author	No. of Cases	Motorically Aligned <sup>a</sup>	Cosmetically Acceptable <sup>a</sup>	Unsuccessful <sup>a</sup>
Ballen <sup>9</sup>	16	12	—	4
Bedrossian <sup>10</sup>	35	24	—	11
Burian and Spivey <sup>11</sup>	98	54	—	44
Clarke and Noel <sup>12</sup>	78	33	—	45
Fletcher and Silverman <sup>3</sup>	60	45	—	15
Gillies <sup>16</sup>	92	24	—	68
Hamtil and Place <sup>17</sup>	9	7	2	0
Hardesty et al. <sup>18</sup>	50	39	4	7
Johnson <sup>19</sup>	51	25	20	6
Mulberger and McDonald <sup>21</sup>	25	8	7	10
Mumma <sup>22</sup>	95	30	23	42
Newman and Mazow <sup>23</sup>	30	—	20	10
Raab and Parks <sup>25</sup>	93	—	51	42
Swan <sup>26</sup>	25	6	9	10
Velez <sup>27</sup>	34	14	9	11
von Noorden <sup>6</sup>	91	48	—	43
Windsor <sup>28</sup>	37	17	—	20
Total	919	386 (42.0%)	145 (15.8%)	388 (42.2%)

<sup>a</sup> See text for specific definitions of criteria.

though not sufficiently improved to be considered successful) and patients who were unchanged, or worse after surgery than they were before. In a number of studies the presence of cases damaged by surgery is evident. For instance, Moore<sup>20</sup> discussed patients who ended with "grossly over-corrected" esotropia; 43% of Dunlap and Gaffney's<sup>14</sup> patients ended up with one of the following: exotropia of greater than 20  $\Delta$  at distance, esotropia of greater than 10  $\Delta$  at distance and near, or esophoria of greater than 14  $\Delta$  at distance and near; Pratt-Johnson, et al.<sup>24</sup> created amblyopia in 4%, exotropia of 35  $\Delta$  in 2% and induced hypertropia in 18% of their patients; Burian and Spivey<sup>11</sup> reported an induced vertical deviation which was not present preoperatively in 10% of their total sample of 200 intermittent and constant exotropes; and von Noorden<sup>6</sup> (12%) and Velez<sup>27</sup> (32%) created constant strabismus despite the fact that all of their subjects were only intermittently strabismic before surgery. The surgical failures could be analyzed in eight studies<sup>8, 10, 15-17, 20, 26, 27</sup> involving 393 patients. These data are presented in Table 3. In this group at least 17.6% were not helped at all or were worse after surgery than before.

The paper by Burian and Spivey<sup>11</sup> is frequently cited and is one of the few which gave extensive presurgical functional data. This paper proved difficult to analyze due to the unusual way in which they present their results. By giving only combined group data, it was not possible to ascertain the changes in any single

patient. Their functional criteria was stereopsis of 50 to 100%, which 67% of their postoperative patients achieved. Inasmuch as 31% of this sample of intermittent exotropes showed this level of stereopsis before surgery, it would seem that only 36% of the patients improved. It is also possible that these "functional" cures included cases still exotropic but able to demonstrate stereopsis in an amblyoscope, or intermittent strabisms who could demonstrate stereopsis when aligned,<sup>30</sup> a phenomenon characteristic of intermittent exotropia. The peculiarity of their method of presenting the data is attested to by the fact that they report a higher number of functional successes than cosmetic successes. Similarly, we could not include their cosmetic results because their distance and near cover-test results are presented separately with no way for the reader to know whether a particular patient was cosmetically straight at all distances. Phorias and tropias were not separated in their cosmetic results. We were able to include this study in our motorically aligned group by extrapolating how many of their patients ended up with phorias postsurgically.

## SUMMARY

We have surveyed the literature reporting the outcome of surgery, including multiple operations, as treatment for intermittent exotropia. To permit comparison among studies we have defined a number of success criteria. Each study was analyzed according to these standards. If

TABLE 3. No change and/or worse after surgery for intermittent exotropia\*

Author	No. of Cases	Worse and/or No Change	Comments
Bedrossian <sup>10</sup>	35	1	No change
Folk <sup>15</sup>	50	0	—
Gillies <sup>16</sup>	92	31	No change
Hamtil and Place <sup>17</sup>	9	0	—
Moore <sup>20</sup>	57	9	No change or grossly overcorrected esotropia
Swan <sup>26</sup>	25	3	No change
Velez <sup>27</sup>	34	11	Now constant deviations greater than 15 Δ exotropia or 10 Δ esotropia
von Noorden <sup>6</sup>	91	14	No change
Total	393	69 (17.6%)	

\* See text for explanation.

there was ambiguity as to the appropriate classification, the case was assigned to the higher classification. Cases amblyopic before surgical treatment, secondary exotropes, or consecutive exotropes were not included. Any bias is in the direction of overstating the proportion of successful outcomes.

A surprising number of papers had to be omitted because they failed to meet certain rather basic requirements of scientific writing. They failed to state the criteria used; they used averaged data in a manner that made it impossible to determine the number of patients in each category; they failed to differentiate between phoria and tropia; or did not distinguish between esodeviation and exodeviation. Credible reports involving 1490 patients were located.

One-third of the reported cases did not achieve even the minimum benefit of being left with a low-angle deviation, with the indication that one in six derived absolutely no benefit at all or were harmed by the surgery. Two-thirds did achieve straight eyes, but only one-third attained normal binocular function along with alignment.

#### APPENDIX

The 10 current ophthalmic journals are as follows:

- Acta Ophthalmologica*
- American Journal of Ophthalmology*
- Archives of Ophthalmology*
- British Journal of Ophthalmology*
- Documenta Ophthalmologica*
- Investigative Ophthalmology and Visual Science*
- Journal of Pediatric Ophthalmology and Strabismus*
- Ophthalmic Surgery*
- Ophthalmology (American Academy of Ophthalmology)*
- Survey of Ophthalmology*

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