Figure 1 Components of the head tilt response in DVD. Left: head tilt toward the side of the fixing eye (group 1). A human dorsal light reflex induces a tilt of the subjective vertical (SV) towards the side of the fixing eye and a vertical divergence of the eyes. A head tilt to align the head with the tilted subjective vertical would be necessary to maintain vertical orientation. Right: compensatory head tilt in DVD. A patient with DVD and a hyperdeviation of the left eye (left figure) can use a compensatory head tilt to the left to recruit otolithic innervation to neutralise the DVD innervation and nullify the existing vertical divergence and restore binocular alignment (BA) of the eyes.

Figure 2 Clinical algorithm depicting postural mechanisms for head tilting in congenital esotropia.

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oblique and left inferior oblique muscles. Conversely, a head tilt to the left would recruit otolithic innervation predominantly to the right inferior oblique and left superior oblique muscles, which serve to neutralise a left DVD associated hyperdeviation and improve vertical alignment (fig 1, right). Thus, by tilting the head towards the side of the more hyperdeviating eye, children in group 2 could calibrate their head position to modulate DVD in the two eyes and thereby stabilise binocular fusion. Both patients who underwent strabismus surgery in an attempt to equalise the hyperdeviations showed reduction in the size of the head tilt and displayed some residual asymmetry in the hyperdeviations between the two eyes.

According to Jampolsky, DVD can eventually lead to secondary superior rectus contracture in the hyperdeviating eye. Superior rectus contracture can reverse the head tilt response in DVD, causing a hyperdeviation in the affected eye to increase with ipsilateral head tilt and decrease with contralateral head tilt. In this setting, a compensatory head tilt to the side of the fixing eye may be used to minimise otolithic innervation to the tight superior rectus muscle, while a head tilt towards the side of the higher eye will augment the hyperdeviation. When a superior rectus contracture develops, surgical recession of the tight superior rectus muscle can reduce or eliminate the compensatory head tilt.

Only one of our patients in group 1 developed evidence of a superior rectus contracture (case 5), as evidenced by a head tilt away from the hyperdeviating eye and an induced hypotropia of the fixing eye when it was patched. Although three of our patients in group 2 had a superimposed hypertropia, they manifested a head tilt towards the side of the hyperdeviating eye, which is inconsistent with superior rectus muscle contracture. It therefore appears that a superimposed hypertropia can develop in some patients with asymmetrical DVD without other clinical signs of superior rectus contracture. It is also possible that these patients had a small coexistent hypertropia that was unrelated to the DVD (perhaps caused by unequal vertical positioning of the medial rectus muscles during surgery or by undetected unilateral inferior oblique muscle overaction). In a young child, a bilateral symmetrical DVD could mask a small hypertropia to produce a clinical appearance that simulates asymmetrical DVD. Figure 2 summarises the probable mechanisms by which DVD can manifest with head tilting in children with surgically treated congenital esotropia.

The dichotomy in the direction of head tilt relative to the fixing eye in this study suggests asymmetrical DVD induces a schizophrenic situation in which the need for vertical orientation and the need for vertical ocular alignment create conflicting postural drives. One the one hand, a head tilt towards the side of the fixing eye that is necessary to re-establish vertical orientation will increase the hyperdeviation of the contralateral eye (fig 1, left). On the other hand, a head tilt towards the side of the hyperdeviating eye that is necessary to minimise the DVD associated hyperdeviation will disrupt vertical orientation (fig 1, right). The neutral head position maintained by many patients with DVD may therefore represent a compromise position. To the extent that there is little binocular vision and an asymmetric DVD, however, one might expect the drive for vertical orientation to override, resulting in a head tilt towards the side of the fixing eye (that is, one that is driven by a human dorsal light reflex and non-compensatory for binocular vision).