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Facial asymmetry in ocular torticollis

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Abstract

Torticollis can arise from nonocular (usually musculoskeletal) and ocular conditions. Some facial asymmetries are correlated with a history of early onset ocular torticollis supported by the presence of torticollis on reviewing childhood photographs. When present in an adult, this type of facial asymmetry with an origin of ocular torticollis should help to confirm the chronicity of the defect and prevent unnecessary neurologic evaluation in patients with an uncertain history. Assessment of facial asymmetry consists of a patient history, physical examination, and medical imaging. Medical imaging and facial morphometry are helpful for objective diagnosis and measurement of the facial asymmetry, as well as for treatment planning. The facial asymmetry in congenital superior oblique palsy is typically manifested by midfacial hemihypoplasia on the side opposite the palsied muscle, with deviation of the nose and mouth toward the hypoplastic side. Correcting torticollis through strabismus surgery before a critical developmental age may prevent the development of irreversible facial asymmetry. Mild facial asymmetry associated with congenital torticollis has been reported to resolve with continued growth after early surgery, but if asymmetry is severe or is not treated in the appropriate time, it might remain even with continued growth after surgery.

Keywords: Facial asymmetry; Ocular torticollis; Superior oblique palsy

Introduction

Facial asymmetry is a condition in which the two sides of the face are not completely alike and similar.[1] Facial asymmetry is not necessarily an abnormality, as different degrees of asymmetry can be recognized in a normal population. There are different causes for facial asymmetry including trauma, facial muscles palsy, facial microsomia, craniosynostosis, phakomatosis, and progressive facial atrophy.[2] During the developmental stages of children, congenital muscular torticollis, with a prevalence of 0.3–2%, is the most important cause of the development and progression of facial asymmetry.[3,4] The importance of this type of torticollis is that it is the most common cause of torticollis in children,[5] and its effect on the development and progression of facial asymmetry in children is very similar to ocular torticollis.[6,7] Therefore, it is necessary to be familiar with the nature and causes of congenital muscular torticollis to differentiate it from facial asymmetry due to ocular torticollis. Congenital torticollis is a condition in which the baby draws his or her head to the side of the involved and damaged muscle with the chin pointing in the opposite direction. In most cases, congenital torticollis is developed following trauma to one of the sternocleidomastoid muscles. It is one of the most important muscles in torticollis with an ocular origin and is majorly responsible for head tilt or turn Fig. 1.[8]

The sternocleidomastoid muscle is a paired large muscle in the front of the neck. It is attached to the sternum from one end and to the mastoid process from the other end, with no attachment to facial muscles. Neck traumas during labor are

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Fig. 1. Torticollis to the Right side.

the most common causes of SCM abnormality with a prevalence of 1 in 300 babies. In this condition, the baby shows some degrees of congenital torticollis. About 50–70% of the abnormalities of SCM resolve within the first year of life without requiring any special treatment; therefore, the best age for surgical treatment is between 1 and 4 years of age.[9]

The presence of torticollis during sleep or despite closing one eye is the most important finding used for the detection of non-ocular origins of torticollis since in torticollis, with an ocular origin, there is no preference to sleep on one side, and on the other hand, the head returns to its natural position upon closing one eye. In addition, in congenital muscular torticollis, some limitations in the neck movement and loosening of the neck on the affected side are noted while neck and muscular movements are perfectly normal in ocular torticollis.[10]

In the absence of appropriate and timely treatment, congenital muscular torticollis results in the development and progression of facial asymmetry in the children. The signs of facial asymmetry in this type of torticollis are identical to ocular torticollis and limit the face on the torticollis side vertically. Unilateral contractions of the SCM result in the rotation of the head and its bilateral contractions results in the flexion of the head and neck. The extent of head tilt or turn is related to the activity of this muscle. Bone abnormalities, plagiocephalic syndromes, and unilateral hearing loss are other causes of facial asymmetry.[11,12]

Facial asymmetry and ocular torticollis

In ocular sciences, asymmetry is defined as any lack of symmetry and uniformity of the two sides of the face as a result of an abnormal head position caused by the palsy of cyclovertical muscles. It should be noted that although the highest amount of facial asymmetry is observed in torticollis due to cyclovertical muscles palsy, it does not necessarily mean that other causes of ocular torticollis like nystagmus, DVD, uncorrected astigmatism, sixth nerve palsy, Duane syndrome, etc. cannot cause facial asymmetry.[13] The highest amount of cyclovertical muscle palsy is observed in congenital palsy of the superior oblique muscle and forth cranial nerve palsy, which is one of the reasons for more reports of facial asymmetry in superior oblique muscle palsy. On the other hand, the lower the age is at the onset of torticollis, the higher the odds of development and progression of facial asymmetry. Therefore, the higher prevalence of the congenital palsy of the superior oblique muscle versus the sixth cranial nerve palsy, DVD after two years of age, the low prevalence of torticollis following non correction of astigmatism when compared to torticollis in the superior oblique muscle palsy, etc. all indicate the higher importance of facial asymmetry in patients with superior oblique palsy.[7]

When evaluating ocular asymmetry following ocular torticollis, it should be kept in mind that every congenital torticollis cannot cause facial asymmetry. For example, patients who only have chin up and down (without head tilt or turn) should be excluded in the evaluation of facial asymmetry since this type of torticollis has a similar effect on the left and right side of the face.[13]

Facial asymmetry in the normal population

The presence of facial asymmetry does not necessarily indicate an abnormality, as different levels of facial asymmetry are observed in the normal population.[6]

In an evaluation performed by Huang et al on Chinese individuals with a negative history of torticollis, plagiocephaly syndromes, and trauma, some degrees of asymmetry were noted in the normal population. The highest amount of asymmetry was seen in mouth angles followed by the sides of the nostrils.[14] Some studies have even reported that some degrees of asymmetry are quite normal and help the face to look more attractive.[15]

Ocular plagiocephaly

Plagiocephaly is a general term for facial and skull asymmetry. It originates from the Greek word *plagios*, meaning oblique, and *kephale*, meaning the head.[6]

The concept of ocular plagiocephaly, which is caused by imbalance in one of the ocular muscles, can be defined through careful evaluation of ocular torticollis. Other forms of plagiocephaly include deformation and craniosynostosis plagiocephaly, in which bone abnormalities and muscular changes are accompanied by a compensatory torticollis early after birth, like primary musculoskeletal abnormalities that can cause plagiocephaly, torticollis, or both. In ``ocular plagiocephaly", although bones and muscles are normal at birth, the presence of tilt or turn is the main sensory neural cause for an ocular plagiocephaly, indicating the effect of a long-term torticollis on the growth of facial muscles.[16,17]

In deformation plagiocephaly, the occipital bone, forehead, and whole face are deformed due to the conditions of one side of the head in the uterus or after birth. Some researchers claim

that the deformity of the skull during the neonatal period or childhood that results from the baby's preference to sleep in a certain position has a mechanism similar to facial asymmetry.[18]

Superior oblique palsy

Superior oblique palsy is the most common paretic form of strabismus in children. The results of one study showed that fourth nerve palsy comprised 36% of all palsies related to extraocular muscles and had the highest prevalence in congenital anomalies.[19]

This muscle is innervated by the fourth cranial nerve, and the anatomic location of this nerve makes it very susceptible to trauma when compared to other nerves related to extraocular muscles. In a study by Gunderson, 70% of the samples with superior oblique palsy aged less than 10 years and 51% of the samples aged 21–40 years had congenital palsy, indicating an increase in traumatic superior oblique palsy in this age group when compared to childhood.[20] Considering the actions of this muscle (inversion, depression, and abduction), if a problem occurs in the actions of this muscle in one eye, the head moves in the opposite direction of the action of the defective muscle. This abnormal position of the head, in addition to its effects on the basal tonicity of the face and neck muscles, can cause changes in the visual habits of the person. For example, a child who has left torticollis following right superior oblique palsy prefers to fixate on and see the environment on the right side of his visual field. The tilt and turn that occurs following superior oblique palsy in one eye is in the opposite direction to the affected eye and sometimes, in addition to the tilt and turn, the position of the head moves downward a little as well. In very few cases, ocular torticollis is not observed despite superior oblique palsy while in most of the cases, the person escapes the functional field of affected muscle with a head tilt without any head turn or downward movement. Apart from the type of the abnormal position of the head, researchers have found that early surgical treatment in these patients increases the odds of resolving the abnormal head position and the subsequent torticollis while if the corrective surgery for superior oblique palsy is performed with a delay, due to the changes in the facial and neck muscles and bones that may result from the abnormal position of the head for a long time, the abnormal position of the head will be maintained even after correcting the primary cause.[16]

The most important sign for a diagnosis of superior oblique palsy is hypertropia in the affected eye, an abnormal head position, excyclotorsion, and a positive Parks three step test. In a study by Tollefson in 2006, the reason for 71% of all hypertropia was superior oblique palsy, Brown's syndrome, or vertical deviation with CNS abnormalities.[21]

A child with superior oblique palsy has the highest amount of vertical deviation in the functional gaze of the affected muscle and the amount of deviation decreases in opposite gaze.[22]

In addition to objective examinations, evaluation of the patients' symptoms is very important to differentiate the acquired type of superior oblique palsy from its congenital type. A person with acquired superior oblique palsy suffers from diplopia and asthenopia while these signs are absent in the congenital form due to long-term coping mechanisms. On the other hand, in the acquired form, a person has a history of trauma or recent torticollis while there is no history of trauma in the congenital form although the patient suffers from torticollis for a long time.[7]

Facial asymmetry and differential diagnosis of the nature of superior oblique palsy

It has been well-documented that patients with superior oblique palsy tilt their head to prevent diplopia.[7,23] Therefore, there is a chance of developing facial asymmetry in a long term torticollis while no facial asymmetry is detected in acquired torticollis. Hence, the presence of facial asymmetry is an important factor in differentiating acquired torticollis from its congenital form, and congenital torticollis in the context of superior oblique palsy affects facial growth and development. To support this hypothesis, Wilson and Hoxie[7] studied some patients with superior oblique palsy. They evaluated the facial angle (the angle between the line that pass from eyelids and line that pass from lips) and found that 9 out of 11 persons with congenital superior oblique palsy and none of the patients with acquired superior oblique palsy had hemifacial microsomia.[7] Goodman et al[24] also found similar results. They evaluated torticollis with different ocular origins and found that only congenital SOP caused facial asymmetry.[22]

However, some researchers have found that all individuals with congenital torticollis do not necessarily develop facial asymmetry. For example, Paysee et al[25] studied a number of patients with congenital and acquired SOP. They clinically detected SOP and confirmed it through traction testing. The results were obtained through qualitative assessment by the three independent researchers. The patients' photographs were compared with the photographs of ten normal individuals. In this study, 82% and 76% of the patients with SOP had torticollis and facial asymmetry, respectively. The results showed that all patients with congenital torticollis do not necessarily develop facial asymmetry.[26]

Some researchers have even reported some degrees of facial asymmetry in patients with acquired SOP. For example, Helveston et al evaluated 125 patients with SOP and found that 55% of the patients with congenital SOP and 9% of the patients with acquired SOP had facial asymmetry.[27]

Therefore, since clinical examinations can only confirm the presence of SOP, facial asymmetry can be used to distinguish congenital SOP from the acquired form. Hence, as for the differentiating acquired and congenital SOP, the only important objective finding is facial asymmetry which strongly indicates the congenital nature of SOP. The facial asymmetry following a long-term congenital torticollis results in changes in the appearance of the face, cheeks, nostrils, nasal septum, and the height of the forehead in both sides, which eventually causes asymmetry. One of the most important aspects of detecting facial asymmetry is to differentiate between acquired

and congenital SOP in legal medicine and in malingering patients since the superior oblique muscle is the most frequently injured muscle in accidents due to the sensitive anatomical location of the fourth nerve. On the other hand, the frequency of congenital SOP is higher when compared to other extraocular muscles.

Evaluation of facial asymmetry

Removal of the primary cause of torticollis is the first step in the treatment of asymmetry. As mentioned earlier, most of the causes of torticollis are nonocular, and even if an ocular cause of torticollis is definite, the possibility of a coexisting nonocular abnormality should be investigated. If ocular and nonocular causes point to one direction, they aggravate torticollis and result in more severe facial asymmetry. For example, the presence of a plagiocephaly deformation on the right side along with the SOP in the left eye causes severe torticollis on the right side, but if the plagiocephaly deformation on the right side is concurrent with type I Duane syndrome in the left eye, depending on the severity of these abnormalities, the head will assume an abnormal position to the side of the more severe abnormality. If the two abnormalities have a similar severity, an ocular torticollis may not develop at all.[6]

A careful history is crucial when evaluating asymmetry. Birth injuries to neck muscles can cause torticollis and eventually asymmetry. A positive history of trauma in these patients is in favor of congenital SOP. Investigation of the possibility of congenital syndromes and musculoskeletal abnormalities can help to better understand the nature of torticollis. Physical examination is also a very important aspect of evaluation. It is important to detect the cause of torticollis since treatment is different in different types of torticollis.[10]

The examinations should start with palpation and evaluation of the tone of the SCM on both sides of the neck. Detecting any difference in the muscle tone suggests muscular torticollis. In this condition, if one tries to change the position of the child's head from the affected side to the opposite direction, a mechanical limitation is observed due to the shorter size of the SCM in the affected side, and the child prefers on the side of torticollis, which causes deformation in the long term[16,28] while in ocular torticollis, there is no difference in the tone of the SCM on both sides and no limitation in neck movements.

On the physical examination of the patients with torticollis, in addition to the amount of deviation in the far and near in the primary position, the amount of deviation in the upward and downward gaze and in the left and right tilt and turn should be measured for a definite diagnosis of SOP. If the torticollis is developed following nystagmus, the type of the nystagmus should be investigated so that its frequency and amplitude in different directions reach the null point. Then the effect of a yoked prism to resolve torticollis should be evaluated with the apex toward the null point. If the torticollis is resolved, its ocular origin is the nystagmus, and if not, either another factor is associated with the development of torticollis along with nystagmus or long-term torticollis has resulted in changes in the musculoskeletal system.[16] In patients with type I Duane syndrome, only a torticollis without a tilt to the side of the affected eye is observed.

Medical imaging and facial asymmetry

Medical imaging is a very important part of asymmetry evaluation. Some researchers[27] consider facial asymmetry a feature of congenital SOP; however, orbital imaging studies have shown that incomitant vertical strabismus that are rather similar to SOP can be due to heterotrophic rectus muscle pulley. These studies[23] suggest that the presence of facial asymmetry can predict an abnormal orbital anatomy rather than a secondary cause that results from ocular torticollis. Some orbital imaging studies have revealed that 50% of the cases that are clinically diagnosed as SOP have a muscle that is normal is size and can contract in the affected gaze. One example for the unreliability of the clinical diagnosis of SOP is that heterotopy (malpositioning) of the rectus pulleys heterotopy may have features similar to SOP. These orbital imaging studies have raised questions on the relationship of SOP with torticollis and facial asymmetry.[2]

Measurement of facial asymmetry

Quantitative measurements and careful qualitative observations are necessary to follow the changes that occur in facial asymmetry in the process of torticollis treatment.

The facial morphometric characteristics are registered in the following ways:

The orbits slope angle

To calculate this angle, the angle between the line that connects the external canthi of both eyes and the line that connects the internal and external canthus of each eye is measured. A positive counterclockwise angle for the right eye and a positive clockwise angle for the left eye have been defined. Facial changes in Down's syndrome result in a positive orbits slope angle in both eyes. Complete asymmetry is present when the slope in both orbits is similar.[27]

Relative facial size

To calculate this index, first the distance between the external canthi of both eyes and the mouth angle is measured (the facial size of the two sides of the face). There is asymmetry if these two distances are different, but what is more important is their ratio. To calculate this ratio, the larger distance is divided by the smaller one. A facial relative size equal to 1 indicates complete asymmetry.[27]

It should be noted that if the aim of morphometric measurements of the face is to evaluate the extent of the improvement of facial asymmetry following active or passive torticollis treatment plans in a certain patient, it is better to use the facial size and the difference between the external canthus and the mouth angle, but if morphometric measurements are performed to compare different patients in terms of the amount

and severity of asymmetry (mainly for research purposes), the relative facial size or the ratio of the distance of the external canthus and the mouth angle is a better option.

Assessment of the facial lines and angles is another quantitative morphometric method for the evaluation of facial asymmetry. Two lines are used in this method: the first line connects the external canthi, and the second line connects the corners of the mouth. These two lines are parallel in a face with complete symmetry while they approach each other on the affected side in facial asymmetry Fig. 2.[27]

Researchers use different methods for the evaluation of facial asymmetry. Some investigators like Wilson and Hoxie have only utilized quantitative data for describing facial asymmetry. They drew some lines on facial photographs that connected the centers of the eyes and the corners of the mouth and investigated facial asymmetry through comparison of the distances and angles.[7]

The best method for the measurement of facial asymmetry is to not merely rely on subjective findings but to compare the results with quantitative data as well. The quantitative data help us to better evaluate patients with similar asymmetries. On the other hand, some asymmetries are not obvious through the evaluation of ocular lines and angles, and it is therefore better to use the qualitative observation method from different directions to detect them, just like dissociated deviations that cannot be clinically evaluated through photographs. Moreover, researchers have reported that many patients with SOP have marked facial asymmetry and facial bulk and mass reduction on one side of the face on qualitative observation while asymmetry is not obvious when the facial lines and angles are evaluated quantitatively.[7]

What is more acceptable when evaluating facial asymmetry is the simultaneous use of post photography measurement methods (two dimensional) and evaluation of the bulk and mass of the two sides of the face through observation (three dimensional) for better and more careful investigation of facial asymmetries.[6]

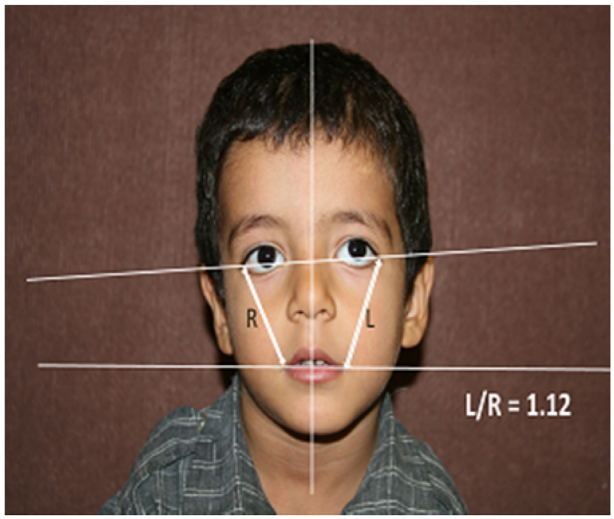

Fig. 2. Morphometric calculation of facial asymmetry.

Facial asymmetry in ocular torticollis

Three facial regions should be evaluated: 1) the frontal region above eye level, 2) the maxillary region below eye level and above mouth level, 3) the mandibular region below mouth level

Facial compression

Most researchers have reported facial compression or decreased facial mass on the side of head tilt or turn while there are also reports of facial compression on the opposite side, as well. For example, Greenberg[6] evaluated 10 types of torticollis with ocular causes. He reported that 41 out of 43 patients with facial asymmetry had facial compression and decreased facial mass on the side of the head tilt or turn while 2 patients showed facial compression on the opposite side.

Researchers who have studied different types of ocular torticollis have reported facial compression and decreased facial mass on the side of head tilt or turn. It seems that the reason for the decreased facial mass and facial compression in different types of ocular torticollis is similar. To put it in simple terms, these facial asymmetries in different types of torticollis result from head tilt or turn.[6]

In patients with more severe torticollis, for example in patients with SOP or type I Duane syndrome, the amount and severity of asymmetry is far more when compared to patients with less severe torticollis, like patients with DVD and nystagmus.[29] Kim et al also described that the cranial base volume increased on the non-deviated side in patients with facial asymmetry and mandibular prognathism.[30]

Nasal septum deviation and changes of the size of the nostrils

Columella is part of the nose that separates the nostrils and has no skin. It is one of the parts of the nose that is very much affected by torticollis. Most researchers have reported septal deviation opposite to the direction of head tilt or turn. The size of the nostrils can also be affected in ocular torticollis, but they are more affected by the head tilt because in the presence of the head tilt, gravity has the greatest effect on changing the pressure on the nostrils, enlarging the nostril on the side of the tilt, and reducing its size on the opposite side Fig. 3.[6,7,27]

In the study by Greenberg,[6] a nasal tip deviation to the side of the head tilt was observed in 6 out of 8 patients with no SOP. All 17 patients who did not have SOP and exhibited a nasal tip deviation to the opposite side of the torticollis only had a head turn. In patients with SOP, 8 patients had a nasal tip deviation to the side of torticollis while the nasal tip deviation was to the opposite side of the torticollis in 9 patients. However, statistical analysis was not performed due to the small sample size. Finally, it was concluded that the nasal tip deviates to the side of the head tilt or to the opposite side of the head turn Fig. 4.[6]

Wilson and Hoxie also found that the nasal tip deviated towards the side of the head tilt in SOP as a result of the effect of gravity. In these patients with a head tilt, the nasal tip

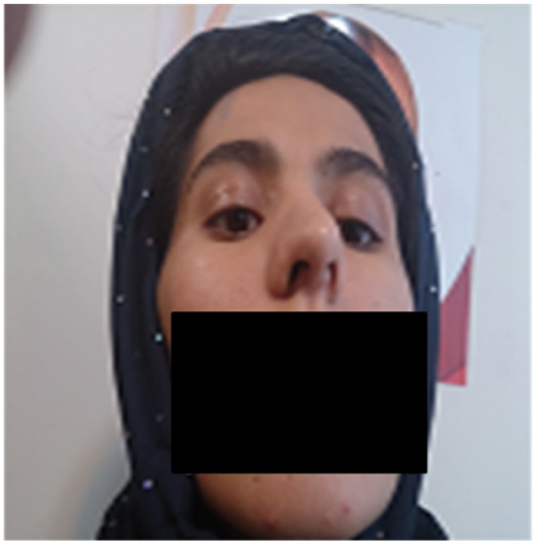

Fig. 3. Nostril size change and nasal septum deviation following a congenital tilt to the right.

usually points to the ground directly. Previous photographs of these patients also show nasal tip deviation to the side of the head tilt.[7]

The nasal tip and columella deviate to the opposite side of the head turn in patients who only have a head turn, like patients with Duane syndrome or lateral rectus palsy. In patients with only a face turn, their normal genetic pattern determines their nasal tip position, and their nasal tip is aligned with their body position rather than the side of the head turn. In this regard, the frontal, maxillary, and mandibular bones should be affected opposite to the side of the head turn Fig. 5.[6,27]

Considering the above-mentioned, the nasal tip deviates to the side of the head tilt and away from the side of the head turn in ocular torticollis, and since the head tilt and turn is usually to the same direction in patients with lateral rectus palsy, the nasal tip and columella may deviate to or away from the side of the head tilt and turn or may not exhibit any deviation at all. However, some investigations have shown that in lateral rectus palsy, the effect of the head turn on nasal deviation is more notable when compared to head tilt.[6,27]

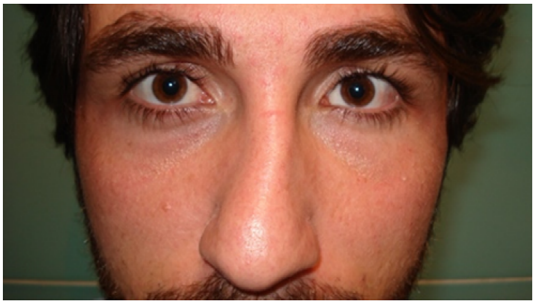

Fig. 4. Nasal septum deviation following the congenital SOP of the left eye and a tilt to the right.

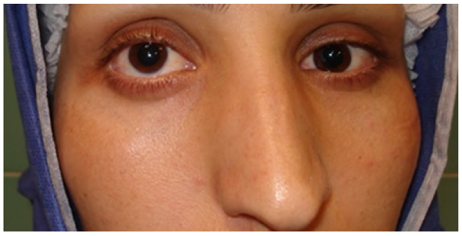

Fig. 5. Nasal septum deviation to the left.

The mechanism of the development of facial asymmetry

Facial asymmetry in ocular torticollis may result from different models of head posture. The bone, muscle, fat, and skin are all live tissues that change completely throughout life. It has been estimated that the skeleton of an adult replaces more than 20% of its mass with new tissue annually, or in other words, the bone tissue renews every five years. The natural growth in children and atrophy in adults may accelerate this process in this age group.[6]

Other known examples of re-structuring of tissues in the long term may include reshaping of the extraocular muscles sarcomeres in shape of mechanism of contracture of this muscles in ocular deviations and elongation of the arm that is used to play in tennis players. Evidence suggests that the development of the face is controlled by genes and these active genes in young people during development are effective in adulthood, as well. This control should be affected by head tilt and turn. Some researchers believe that torticollis can cause facial asymmetry through continuous tissue remodeling process, resulting in ocular plagiocephaly. The presence of facial asymmetry in strabismus is an important clinical finding to learn about the duration of development of an imbalance in the muscles.[6]

In 1995, Goodman et al[22] introduced plagiocephaly deformation as the cause of facial asymmetry. Some researchers have claimed that the deformity of the skull in the neonatal period and childhood that results from the baby's preference to sleep on the side has a mechanism similar to facial asymmetry.[22]

Therefore, the main reason for facial asymmetry in ocular torticollis is not clear. Certain strabismic syndromes like craniosynostosis, Goldenhar syndrome (hemifacial microsomia), and Duane syndrome may have skull and facial asymmetry as their distinctive features. However, most causes of ocular torticollis have no relationship with plagiocephaly syndromes.[6]

The mechanisms through which head tilt and turn can affect the facial shape are not clearly understood. Continuous muscular pressure or changes in the muscular innervation can play a role in this regard. The muscle that is responsible for the amount of head tilt or turn is the SCM muscle that is attached to the back of the ear, has a distance from the face and forehead, and has no attachment to the mandible. Therefore, in head turn, this muscle acts against the side of the turn and

facial compression. Gravity can play a role as well since in patients with inferior oblique palsy whose head turn and head tilt are towards opposite directions, facial atrophy is observed on the side of the head tilt, not the side of the head turn. Wilson and Hoxie found that the nasal tip pointed towards the side of the head tilt in SOP, and gravity could play the main role in this process as well. In patients with a head tilt, the nasal tip usually points directly to the ground. Previous photographs also demonstrated the deviation of the nasal tip toward the side of the head tilt.[6]

Treatment options for facial asymmetry

Since the highest prevalence of facial asymmetry is observed in congenital or long-term torticollis and the possibility of facial asymmetry is much higher in head and neck musculoskeletal abnormalities than other types of torticollis in older ages, primary treatments in younger ages are very important and effective. However, the best age for the correction of torticollis to prevent facial asymmetry is not still clear although it is well documented that primary operations of strabismus can improve torticollis and astigmatic changes.[6,27]

It should be noted that some researchers like Goodman et al[22] believe that the facial asymmetry following SOP results from the deformation plagiocephaly secondary to the abnormal head position during the sleep. They suggested that early primary surgery of strabismus before the closure of skull sutures prevented this complication.[22] Vilmmeren et al also recommended physical therapy and early surgery for the prevention of asymmetry during the neonatal period and childhood.[30]

Paysee et al[23] found that ocular torticollis is resolved during the sleep and in the sleeping position; therefore, this condition cannot cause deformation plagiocephaly. Greenberg et al,[6] who investigated facial asymmetry in neonates with DVD and adults with ocular torticollis, suggested that the neonatal skull deformation could not cause asymmetry. Although some researchers[7,27,28] agree that strabismus surgery can prevent long-term changes of facial asymmetry, the best way to achieve this goal is early detection and treatment of this condition. Researchers are not sure about the best time for surgery. The findings of facial asymmetry in adults with acquired ocular asymmetry have increased the hope for resolving this asymmetry at any age or at least decrease further facial asymmetry in the future after surgical correction of torticollis. It has been observed that a head tilt or turn in ocular torticollis may not resolve even after the correction of strabismus. Residual torticollis in these patients after corrective surgery of strabismus may result from the effects of facial asymmetry remodeling changes.[6]

What is known for a fact is that it is possible to decrease facial asymmetry through decreasing or correcting ocular torticollis. Some researchers have reported that following early torticollis surgery, the asymmetry will eventually resolve with an increase in the child's age.[5,31–33]

The point that should be noted in the process of the treatment of facial asymmetry is the objective of treatment. The surgeon should not wait for the development of facial asymmetry as a sign of the ideal timing of appropriate treatment because the facial asymmetry in children with ocular torticollis may be so subtle that it may not even be recognized by the parents, or a torticollis may be present without asymmetry in children. There are some reports that late surgical treatment of strabismus may not resolve torticollis due to its effect on the neck muscles and bones.[6] On the other hand, if a noticeable facial asymmetry is developed following torticollis, the prognosis of the resolution of asymmetry even with surgical correction of torticollis is poor.[34,35]

Some researchers believe that early surgery should be performed before six years of age for complete resolution of asymmetry[31] although this notion has been challenged by some other researchers.

If early surgery of strabismus cannot be performed for any reason, other non-active treatment options must be employed, one of which is training the parents to change the position of the head to the opposite side of the torticollis during the sleep. Some investigators have reported that the development and progression of this type of deformation results from abnormal head positions in the early months of life.[36]

Conclusion

Facial asymmetry or plagiocephaly may result from a head tilt following the superior oblique palsy. In this condition, the midface on the side of the tilt is smaller than the other side. On the other hand, the nasal tip and septum deviate to the side of the head tilt. However, in individuals with a head turn, the nose is deviated away from the side of the head turn. Enlargement of one of the nostrils is another asymmetry which may be seen on the side of the head tilt.[6,7,27,28]

Facial asymmetries that are developed in head tilts secondary to other congenital abnormalities, like congenital torticollis following the structural deformity of the SCM, are similar to the facial asymmetry in SOP.[10]

Knowledge about the manifestations of plagiocephaly is very useful for the detection of long-term torticollis. When strabismus results from a trauma, careful evaluation of the presence of a facial symmetry helps us to detect a long-term defect in the ocular muscles. In addition, in patients with extraocular muscle palsy, the presence of an asymmetry can help to exclude many evaluations like neurological evaluations. In patients with nystagmus who have a null point, the presence of asymmetry can justify the use of the Kestenbaum procedure. Moreover, it can be the only clinical manifestation to compare the findings and office-based examinations and confirm the results for a successful operation when the patient is under anesthesia.[6]

It should be noted that the presence of facial asymmetry in patients with an unknown cause of torticollis cannot be attributed to ocular causes due to the presence of a head tilt or turn since tilting and turning of the head can result from non-ocular torticollis as well, causing an asymmetry similar to that found in ocular torticollis. In addition, even if an ocular origin is confirmed for an asymmetry, it should be remembered

that the facial asymmetry may have originated from two or more factors. For example, if plagiocephaly deformation is developed on the opposite side of the face turn, the more severe condition will determine facial asymmetry and facial compression. In this condition, if deformation is more severe than the ocular torticollis, asymmetry will be observed on the opposite side of the head turn. Familial asymmetries may play a role in some other patients. For example, a facial asymmetry to the opposite side of the turn may be observed in Duane syndrome. Therefore, when investigating a facial asymmetry that is opposite to the side of the tilt or turn secondary to ocular torticollis, other factors that affect facial asymmetry may have dominance over ocular plagiocephaly factors.[6]

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