ORIGINAL ARTICLE

ATLANTOAXIAL INSTABILITY AND LIGAMENTOUS HYPERLAXITY IN DOWN SYNDROME

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SUMMARY

Atlantoaxial instability (AAI) is characterized by hypermobility of C1-C2 joint due to laxity of alar ligament, being common in Down syndrome patients. The aim of this study is to verify AAI incidence and its association with generalized ligamentous laxity in Down syndrome. Eighty children were selected, 34 (42.5%) males and 46 (57.5%) females, aged from 5.6 to 15 years old (average = 9). Patients were evaluated by questionaire and X-ray imaging of cervical spine in a flexed lateral view. Clinical features amount to 58%, most expressed as weakness of lower limbs. 77,5% of atlanto-odontoid spaces were as small as 4.5mm; 15% were between 4.5 to 6mm; and 7.5% were greater than 6mm. Patients presenting generalized ligamentous laxity (group 1) did not show a greater incidence of AAI compared to those not presenting that condition (group 2). The authors concluded that AAI is a common disorder in Down syndrome, having no direct association to generalized ligamentous laxity.

Keywords: Down syndrome; Pathology; Cervical spine.

INTRODUCTION

Sports practice in Down syndrome patients has been established as an important method of therapy, integration and socialization[1]. However, the presence of atlantoaxial instability (AAI) in those children deserves a special concern, because it exposes their carriers to high risks of acute medullary injuries with sudden death, in case a forced cervical flexion occurs during sports activity, dislocating or sub-dislocating vertebrae and compressing spinal cord[1] .

Spitzer et al.[2] published the first report on atlantoaxial instability in Down syndrome patients. Since then, many authors have reported this association at rates ranging from 9% to 40%, with only 10 to 15% of those individuals being symptomatic[1,3,4,5,6]. Thus, the identification of AAI and its risk factors in those children is very important before indicating a sport practice. The odontoid hypoplasia and the degenerative changes on cervical spine have already been reported as predisposing factors; however, the generalized ligamentous hyperlaxity, which is also found in high rates in those individuals, has been considered by some authors as the major entity related to AAI.

It is known that the atlantoaxial instability (AAI) is an affection characterized by the increased mobility of the joint formed by the first and second cervical vertebrae (atlantoaxial joint) due to the laxity of the alar ligament at this level[7]. However, the association between alar ligamentous laxity and generalized ligamentous laxity, as well as its real meaning, remain poorly defined in literature.

Based on this controversy, a transverse-sectioned study was conducted aiming to check the incidence of AAI in Down syndrome patients and its potential correlation with generalized ligamentous hyperlaxity.

MATERIALS AND METHODS

A transverse-sectioned study was conducted in a population formed by Down syndrome patients assisted at APAE (Association of Handicapped Children's Parents and Friends) in the city of Salvador, and at the Pediatric Orthopaedics Service of the Bahiana Medical School (Hospital Santa Izabel).

The study was approved by the Committee on Ethics in Research at the Bahiana Medical School. Children's parents or legal representatives were contacted and informed about the objective of the research and about which kind of tests would be made for diagnostic purposes. After the informed consent was signed by parents or legal representatives, dates and times for applying the questionnaire and performing x-ray assessment were scheduled.

Eighty patients were selected; 34 (42.5%) were males, and 46 (57.5%) were females, whose ages ranged from 5.6 to 15 years old, with an average of 9 years old. The distribution of individuals is summarized by gender and age in Table 1.

All sorts of important symptoms, health general status, presence or absence of discomfort or any kind of pain and its corresponding site, as well as details about the motor development were recorded. After the questionnaire was applied, patients were submitted to x-ray tests with flexed cervical spine in lateral plane, according to the method by Kobori and Takahashi[8].

X-ray tests assessment was personally made by the author, considering the measurement of the distance between posteroinferior view of the Atlas anterior arch (C1) and the anterior surface adjacent to the odontoid process – atlanto-odontoid distance (AOD) – according to criteria standardized by Pueschel et al.[9]. AOD was regarded as within normal standards when it was as small as 4.5mm (type I), AOD between 4.5 and 6 mm was considered as suggestive of AAI (type II) and, finally, AAI was considered established in those patients with measures above 6mm (type III).

For checking the generalized ligamentous hyperlaxity, the criteria by Wynne-Davies and Gormley[10] were used, which consider 5 items correlated to joint motion: 1) Elbow extension > 180°; 2) Thumb

Study conducted by Bahiana Medical School and Santa Casa de Misericórdia of Bahia – Hospital Santa Izabel, Salvador - Bahia

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reaching the forearm with flexed wrist; 3) Hand fingers parallel to the forearm with maximum wrist and metacarpophalangeals extension; 4) Ankle dorsiflexion ≥ 45°; 5) Knee extension > 180° . Whenever 3 pairs of any of the joints above presented these patterns, generalized ligamentous hyperlaxity was considered as present.

Descriptive statistics was used to present data and the chi-square test was used for evaluating the significance among non-parametric data in Tables 1, 2, and 3, always determining $\alpha = 0,05$ as significance level.

RESULTS

Among the 80 Down syndrome patients evaluated, we found 6 (7.5%) children with AOD greater than 6mm (type III), 12 (15%) with an AOD between 6mm and 4.5mm (type II) and 62 (77.5%) with AOD smaller than 4.5 (type I). Mean AOD in the population studied was 4.13mm and the atlantoaxial instability (types II and III) was present in 22.5% of the children.

There was generalized ligamentous hyperlaxity in 61.2% of the individuals. Other orthopaedic problems were present in 77% of the individuals, with 97% having flatfeet, 50% having kyphosis, 40% genuvalgum, 20% genuvarum, 20% scoliosis, 15% lordosis, 10% lower limbs inward rotation.

Regarding tonus, 46% of the children had normal tonus and 54% presented with hypotonia. The decrease on muscular strength was a symptom found in 27% of the children. All children practiced one or more sports activities, more than three times a week.

Regarding symptoms that could be correlated to AAI, 58% of the children presented with lower limbs weakness, while only 12% reported occasional unconsciousness. Cervical motion restraint was found in 27%, with no pain symptoms. Pain in the lower limbs was present in 23% of the individuals, and only in 2% of the cases pain was related to cervical spine or irradiated to shoulders. Non-specific paresthesia was noticed in 39% of the cases.

A delay was found in the motor development of all children. Eighty five percent achieved cervical control within more than 4 months; seated position was achieved after 8 months of age in 58% of the individuals; 57% of the individuals did not crawl, and those who crawled after one year of life totaled 31%, that is, delayed in comparison to children considered as with normal motor development. The most significant value found was regarding ambulation, because 81% of the children with Down syndrome walked only after one year and four months.

Age	Male	Female	General
Up to 8 years old	8	15	23
8-12 years old	18	21	39
12-15 years old	8	10	18
Total	34	46	80

X^2 calculated= 0.801, P = 0.670

Table 1 - *Distribution of patients according to gender and age.*

Gender	AOD < 4,5mm	AOD > 4,5mm	General
Female	34	12	46
Male	28	6	34
Total	62	18	80

X^2 calculated = 0.388, P = 0.533

Table 2 - *Correlation of gender and atlanto-odontoid distance (AOD).*

AOD	No hyperlaxity	With hyperlaxity	General
< 4,5mm	25	37	62
> 4,5mm	6	12	18
Total	31	49	80

X^2 calculated = 0.068, P = 0.794

Table 3 - *Correlation of generalized ligamentous hyperlaxity and atlanto-odontoid distance (AOD).*

For the effects of analysis of the correlation between generalized ligamentous hyperlaxity and AAI, type-II and type-III AOD carriers were considered as a single group and compared to the individuals of type I, who were considered as not having AAI. The results are distributed in Tables 2 and 3.

DISCUSSION

Patients with Down syndrome may present with many orthopaedic problems, such as patelllofemoral instabilities, valgus flatfeet, knee recurvation and juvenile bunion. Most of those problems are related to the generalized ligamentous hyperlaxity they have. However, the most severe orthopaedic problems related to this syndrome are those located on the cervical spine[1,3,6].

The odontoid hypoplasia, the low cervical arthrosis, and the C1-C2 instability affect 10-20% of the patients, although only 1-2% of them are symptomatic[1,9]. The presence of atlantoaxial instability (AAI) deserves, however, a special concern because it exposes its carriers to high risks of acute medullary injury, particularly during sports practice, which has become increasingly common as a therapeutic and socializing approach for those children.

The atlantoaxial instability (AAI) may also present with chronic manifestations, such as rapid fatigue, difficulties in walking, gait abnormalities, cervical pain, cervical motion restraint, wryneck or head tilt, lack of coordination, sensitive deficit, spasticity, hyper-reflex, clonus, Babinsky and other symptoms of the upper motor neuron. Those signs sometimes remain stable for months or years; they occasionally progress and, more rarely, may lead to paraplegia, hemiplegia, quadriplegia, or death[1].

The radiographic measurement of the atlanto-odontoid distance (AOD) has been considered as the most reliable indicator for assessing the C1-C2 instability. According to Kobori and Takahashi[8], when the atlanto-odontoid distance (AOD) obtained through X-Ray in lateral view with flexed head is smaller than 3.5 mm, it means that the transverse ligament is intact; when this distance is 3.5 - 5.0 mm, the transverse ligament is insufficient; still, values above 5 mm may show transverse alar ligaments insufficiency or atlantoaxial sub-dislocation. Those authors report that people with AOD between 5 and 7 mm should avoid high-impact or flexing sports activities that may impose a pressure on the cervical spine. Distances between 7 and 9 mm imply in important instability and a periodic x-ray control must be performed for follow-up, cervical orthosis, and, most of all, to avoid contact sports. Surgical treatment is only prescribed in cases of significant instability, where neurological signs and symptoms are present

and with an AOD bigger than 10 mm. Newton[11] considered that children with AOD values below 4.5 mm may be considered as normal, and values above 4.5 mm are indicative of AAI.

Our series comprised 80 individuals with Down syndrome distributed by gender and age, according to Table 1. This is one of the greatest samples in literature related to this matter. There were no significant differences (p =0,05) regarding age and gender of the individuals (Tables 1 and 2). In our study, an AOD bigger than 4.5 mm was found in 22.5% of the individuals, while AODs bigger than 6 mm were only found in 7.5% of the total. Those data are in accordance to international and Brazilian literature regarding the matter.

It is believed that approximately 15% of the individuals within the pediatric group (younger than 21 years old) with Down syndrome are also AAI carriers, the majority of them being asymptomatic[1]. Since the first report of AAI in Down syndrome patients, in 1961, by Spitzer et al.[2], many authors have reported a very similar incidence, ranging from 9 to 13%, with Newton[11] finding the highest rate ever reported, with 40% of the Down syndrome population presenting AOD bigger than 4.5 mm in his study.

In Brazil, Nahas et al.[4] reported an AAI incidence of 11.76% among the 17 patients studied, while Minatel and Campos[3] found a rate of 15% (6 individuals) with AAI among 40 Down syndrome patients studied. There were no symptomatic AAI patients in any of those studies.

In our study, we found a general incidence of 61.2% of generalized ligamentous hyperlaxity among the Down syndrome population studied. This finding agrees with the study by Semine et al.[5] which reported the existence of a high prevalence of ligamentous laxity in Down syndrome children, obtaining an incidence of 76.5% in their work.

Burke et al.[12] believe that the AAI etiology in the Down syndrome is due to a failure on the collagen structure, manifested by the generalized ligamentous hyperlaxity. Burke et al.[12], Spitzer et al.[2] and Tishler and Martel[13] considered that the generalized ligamentous laxity reflects on the atlantal transverse ligament laxity. Nevertheless, Ohsawa et al.[14] in a study with 69 children with Down syndrome did not find this correlation, because, in some cases, even when the number of positive items on the Carter-Wilkson index reduced from 3 to 1, AOD remained unchanged during the period of study, suggesting that the atlantal transverse ligament hyperlaxity cannot be evaluated alone, based on generalized ligamentous hyperlaxity.

In our study, when we tried to assess the correlation between generalized ligamentous hyperlaxity and AAI (Table 3), one can notice that there is no significant statistic difference between the groups (p=0,05), meaning that there wasn't a higher prevalence of hyperlaxity in the AAI-carriers (types I and II) group. Evidences suggest that although generalized ligamentous hyperlaxity has a high prevalence in Down syndrome patients, this is not the root cause of AAI. It is possible that the general collagen failure providing the alar ligamentous failure is not a factor determining this event alone, being necessary the interference of other etiologic agents, such as osteogenic deformities on Atlas and Axis, or others that have not been fully explained yet.

CONCLUSION

The atlantoaxial instability had a prevalence of 22.5% in individuals with Down syndrome and the ligamentous hyperlaxity had a prevalence of 61.2%. The cause relationship of both conditions, however, was not explained. It is believed that further studies are required, trying to evidence genetic, anatomic, and biomechanical factors that could be considered as determinants of the AAI genesis in Down syndrome.

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