

The Heritability of Liability to Congenital Dislocation of the Hip*

Metin Atasü, D.V.M.** / Ümit Akkoyunlu, M.D.*** /
Nejat Tokgözoğlu, M.D.**** / Burhan Say, M.D.*****

It has been claimed that both the genetic and environmental factors have a place in the etiology of congenital dislocation of the hip.¹⁻⁵ Those who claim that genetic factors have greater effect in the respect are in the majority. It has been pointed out that congenital dislocation of the hip (CDH) in German Shepherd dogs shows a dominant transmission.⁶ In addition, it is reported that the incidence of CDH in relatives of the proband is higher than that in the general population. If hereditary factors were involved, an increased incidence of the abnormality among the relatives of the affected might be expected. This has been the case in previous studies, however, the genetic mechanism of CDH can not be explained as simple Mendelian inheritance. In recent years those who studied this subject have shown that CDH has been determined by more than one allele genes. Meanwhile, the studies on the heritability of liability of CDH were performed and significant scores were estimated.

It is important to study again how genetic factors affect this abnormality which has been discussed with the different observations in the etiology. In this paper CDH will be discussed on the basis of those considerations. It should also be noted that in Turkey the incidence of CDH is higher than it is in the other countries.

* From the Department of Pediatrics, Orthopedic Surgery and Division of Clinical Genetics, Hacettepe University, Ankara, Turkey.

** Instructor in Clinical Genetics and Statistics.

*** Instructor in Orthopedic Surgery.

**** Associate Professor of Orthopedics.

***** Professor of Pediatrics.

Materials and Methods

At the Orthopedic Surgery Department, Hacettepe University, one hundred cases of CDH were studied, as a control group 8344 cases from the same department were taken.⁷ The pedigrees of the affected cases were obtained and observed incidence of CDH in relatives were recorded. The heritability of liability was estimated according to Falconer's method.⁸

Application and Results

Thirteen of the patients and one of the parents were affected. The others were normal. Although this observation has made us think a simple Mendelian inheritance responsible for CDH, the analysis shows us that this idea is doubtful.

Since the incidence is high among the relatives when compared with that in the control group, the heritability of liability to CDH has been estimated by paying attention to the sex characteristics. For example, the heritability of liability to CDH in male sibs of male cases has been estimated by the following equations.

$$b = \frac{p_c(x_c - x_r)}{a_c} = \frac{0.9922 (2.418 - 1.4652)}{2.748} = 0.347$$

and

$$h^2 = 2b = 0.694$$

Thus the standard error of h^2 is found as:

$$\begin{aligned} V_b &= \left[\frac{p}{a} - b \left(\left| a \times \frac{p-q}{P} \right| - x \right) \right]_c^2 \times \left(\frac{p}{a^2 \times A} \right)_c + \left(\frac{p}{a} \right)_c^2 \times \left(\frac{p}{a^2 \times A} \right)_r \\ &= \left[\frac{0.9922}{2.748} - \left(0.347 \left| \frac{2.748 \times 0.9844}{0.9922} \right| - 2.418 \right) \right]_c^2 \times \frac{0.9922}{2.748^2 \times 33} + \\ &\quad \left(\frac{0.9922}{2.748} \right)_c^2 \times \frac{0.9286}{1.8096^2 \times 2} = 0.0188 \end{aligned}$$

and

$$SE(h^2) = 2 \times \sqrt{V_b} = 2 \times \sqrt{0.0188} = 0.02742$$

This and other scores are summarized in Table I. The weighted mean of these estimates is 49.2 ± 2.401 per cent.

TABLE I
VALUES CONNECTED WITH THE HERITABILITY OF LIABILITY TO CDH

	A	N	q	x	a	b	$V_b \times 10^4$	$h^2 \pm SE$
Relatives of								
Controls								
Male	33	4211	0.0078	2.4180	2.7480	—	—	—
Female	110	4134	0.0259	1.9447	2.3245	—	—	—
Relatives of								
Propositi								
Propositi Sibs								
Male Male	2	28	0.0714	1.4652	1.8096	0.347	1.88	69.4 ± 2.742
Male Female	1	20	0.0500	1.6450	2.0630	0.279	2.91	55.8 ± 3.412
Female Male	5	88	0.0586	1.5818	2.0086	0.152	0.84	30.4 ± 1.834
Female Female	7	99	0.0721	1.4603	1.9053	0.207	0.64	41.4 ± 1.6
Weighted Mean								49.2 ± 2.401

A: Observed number of abnormals in the sample.

N: Number of individuals in the sample.

q: Indidence of affected individuals.

p: 1-q

x: Normal deviate corresponding to q.

a: Mean deviation of affected individuals.

c: Controls

r: Relatives

b: Regression coefficient of relation on propositi

V_b : Sampling variance of b

h^2 : The heritability of liability to CDH

SE: Standart error

Discussion

The heritability of liability to CDH was estimated by Woolf and Coleman. These authors determined the heritability of liability to CDH with laxity of the joints and capsules was 100 per cent and with acetabular displasia was 80 per cent. On the other hand, they pointed out that there is a transmission related with a single allele of dominant genes in cases with the laxity of the joints.⁵ The results which we have observed differ from the results of these writers. However, the heritability of liability to CDH is significant and this characteristic does not show a recessive transmission.

Summary

The heritability of liability to congenital dislocation of the hip was estimated by analysing one hundred index families. It was found as 49.2 ± 1.6 per cent.

REFERENCES

1. Carter, C. D. and Wilkinson, J. A.: Genetic and environmental factors in the etiology of congenital dislocation of the hip, Clin. Orthop. 33: 119, 1964.
2. Carter, C. D. and Wilkinson, J. A.: Persistent joint laxity and congenital dislocation of the hip, J. Bone & Joint Surg. 46 B: 40, 1964.
3. Record, R. G. and Edwards, J. H.: Environmental influences related to the etiology of congenital dislocation of the hip, Brit. J. Prev. Soc. Med. 12: 8, 1958.
4. Wilkinson, J. A.: Prime factors in etiology of congenital dislocation of the hip, J. Bone & Joint Surg. 45: 269, 1963.
5. Woolf, C. M. and Coleman, S. S.: The influence of genetic and non-genetic factors, Am. J. Hum. Genet. 20: 430, 1968.
6. Bornfors, S., Palson, K. and Skude, G.: Hereditary aspects of hip displasia in German Shepherd dogs, J. Am. Vet. As. 145: 15, 1964.
7. Akkoyunlu, Ü. A.: Doğuştan kalça çıkığı etiyolojisinde genetik ve çevresel faktörlerin incelenmesi, Ph. D. Dissertation, 1971.
8. Falconer, D. S.: The inheritance of liability to certain diseases, estimated from the incidence among relatives, Ann. Hum. Genet. (Lond.) 29: 51, 1965.