Dept. of Human Genetics, Ophthalmological Clinic of the University, Ghent
(Director: Prof. J. François)

Short Arm Enlargement in a G Chromosome

J. François, M. Th. Matton-Van Leuven, R. Coppieters

Enlargement in length of the short arm and/or satellite region of a G chromosome has been reported in different connections, i.e. in normal persons, in patients with concomitant chromosomal and phenotypic abnormalities, in patients with developmental disorders and otherwise normal karyotype and also in the normal relatives of diseased or retarded patients.

Although no constant relationship has yet been established between this short arm enlargement and a particular pathologic clinical entity, association with the following conditions either in the proband or the relatives is known: Marfan's syndrome (Tjio *et al.*, 1960), mental retardation with dysarthria (Moorhead *et al.*, 1961), mental retardation associated with multiple congenital malformations (Van Wijck *et al.*, 1961), mongoloid features (Cooper and Hirschhorn, 1962), repeated abortions (Schmid, 1962; Carr, 1963), abnormalities of the central nervous system (de la Chapelle *et al.*, 1963), muscular dystrophy (Ruffie *et al.*, 1965).

It is the purpose of this paper to describe short arm enlargement of a G chromosome in two retarded children and in the mother of one of them. The first patient (D.J.M.) had a diploid chromosome-number, $2n = 46$, and congenital glaucoma; the second (G.G.) was a typical mongoloid child with $2n = 47$ and trisomy 21.

The chromosomal evaluation was obtained from venous blood cultured following a modification of Lejeune's micromethod.

Case reports

Case I

D.J.M. was referred to us by Dr. Nelis with the diagnosis of congenital glaucoma.

Clinical data – The child was 2 years old (Fig. 1). There was pronounced psychomotoric retardation, relative nanism and articular hyperlaxity. The child produced monotone plaints in a low voice and stereotypic movements such as rolling of the head and slapping with the hands. There was microcephaly, flat facies, flat occiput and cranial asymmetry. The mouth was large, the lips dry and fissured, the teeth irregularly implanted, the tongue thick, the palate flat.

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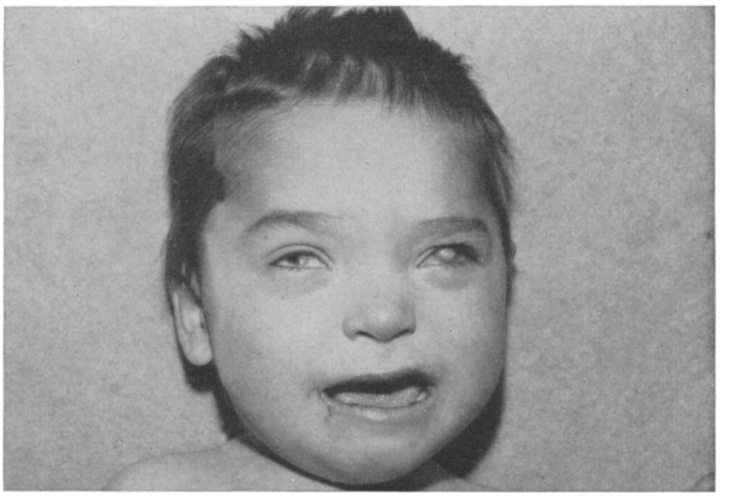
Fig. 1. D.J.M.: facies



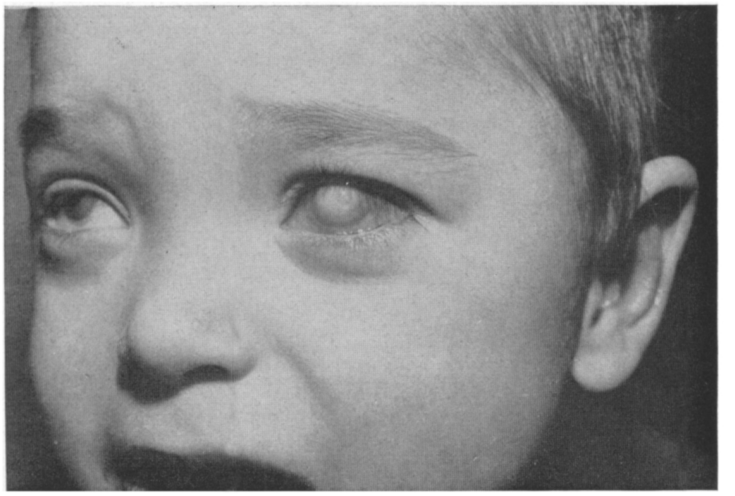


Fig. 2. D.J.M.: corneae

The ears were implanted low, the eardrums blue and there was an important degree of deafness. EEG and tendon reflexes were normal. There was no Babinsky nor hypertony.

X-rays showed retarded bone age and a mongoloid pelvis.

There was horizontal bilateral nystagmus. The right eye (Fig. 2) was normal in size, with a corneal diameter of 11 mm; the inferior half of the cornea was hazy. The posterior pole of the fundus showed irregular dusty pigmentation with several pigmentary spots; the periphery was albinoid with visibility of the choroidal vessels; the optic nerve and retinal vessels were normal. Ocular tension was 31.6 mm Hg. There was light perception. The

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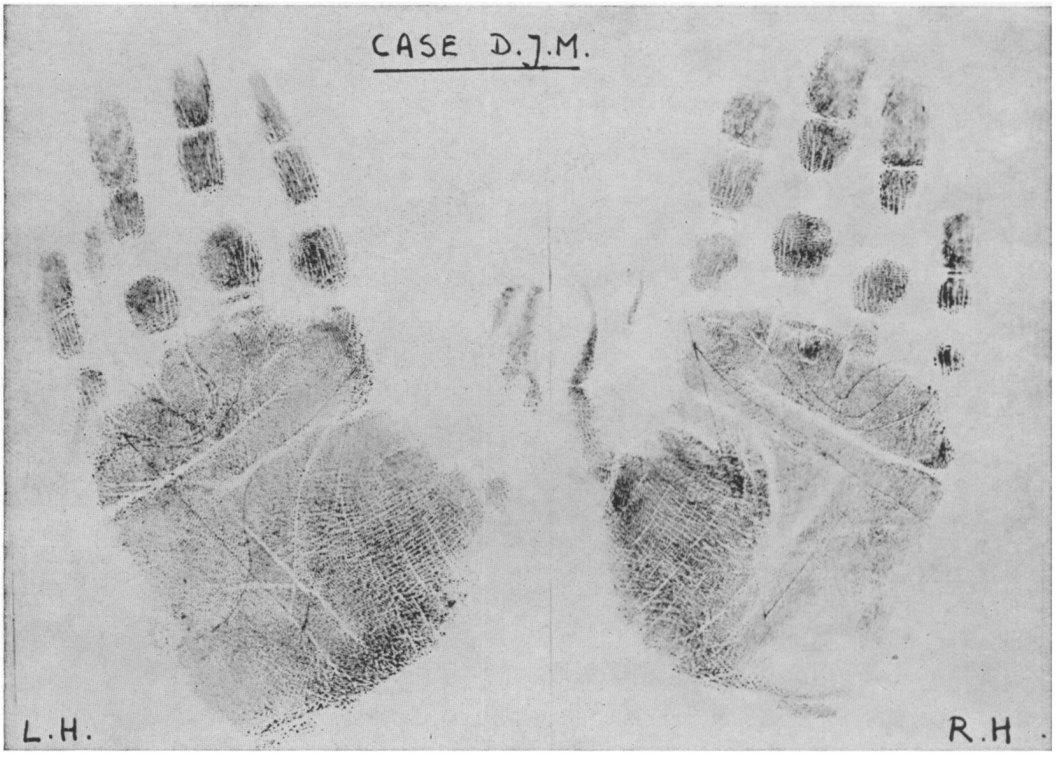

Fig. 3. D.J.M.: dermatoglyphics

pupillary reflexes were normal. The left eye (Fig. 2) was manifestly glaucomatous with buphthalmia, central corneal leukoma and vascularization. The intraocular tension was 80 mm Hg, the corneal diameter 16 mm.

The electroretinogram was strongly subnormal in both eyes.

The *dermatoglyphics*, evaluated by Lic. S. De Bie and taken at the age of 4 years (Fig. 3) were as follows: normal palm-fissures, axial triradius in position t′ (right atd = 51°, left atd = 55°), bilateral distal loop in the fourth interdigital area. The palmar formula is as follows: right: 11-7-9-5′-t′-0-0-0-0-L; left: 9-7-5′-3-t′-0-0-0-0-L. The only abnormality in this dermatoglyphic pattern is the slightly displaced axial triradius.

Cytogenetic evaluation. – *Sexchromatin* was male: 3% Barr bodies in buccal smears, drumsticks in polymorphonuclear neutrophiles absent.

Numerical chromosomal analysis of 38 metaphases revealed 2n = 46 in 96% of the cells, 4% of the cells having lost one or more chromosomes during the technical manipulations.

Structural analysis was done in 16 photographic karyotypes (Fig. 4). They were technically excellent, which allowed easy pairing of the chromosomes and precise length measurements.

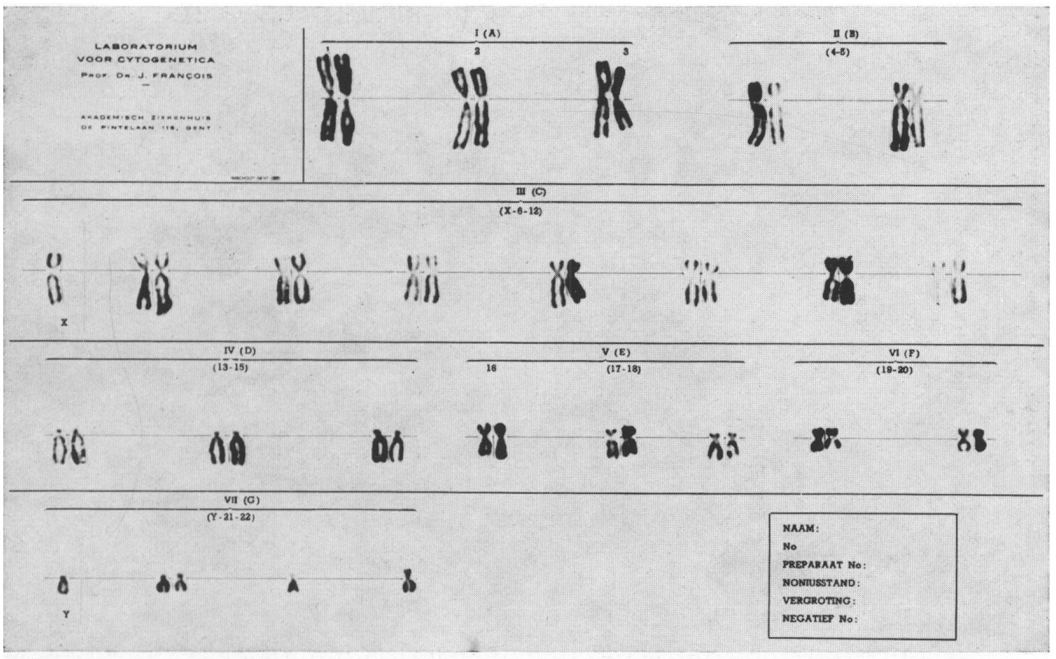

Fig. 4. D.J.M.: karyotype

There were only three normal small acrocentrics (Fig. 5). There was an odd submetacentric chromosome which could not be paired with any other chromosome. It was tentatively put in the G group. All the chromosomes of the other groups were structurally normal. Particularly no excess of secondary constrictions was noted in any of them. The total length of the odd chromosome approximated the length of an F chromosome (Tab. 1). Its long arm had the size of a long arm of a small acrocentric; its short arm was of the same length order as the short arm of chromosomes 17-18 (Tab. 2). In most karyotypes were the chromatides of this short arm parallel with each other; their extremities did not diverge and did not carry satellites. In only one karyotype (no. 9) the odd chromosome seemed to be dicentric and carrier of satellites.

On the whole, the karyotypes suggested that the enlarged short arm represented an enlargement of the short arm itself and not an enlargement of the satellites.

The short arm of the odd chromosome was shorter than the long arm of even the smallest of the other G chromosomes. The difference in length amounted usually to much more than 15%, percentage which has to be allowed for technically unavoidable inaccurate measuring of the small acrocentrics (Tab. 3).

The centromeric index of the odd chromosome was smaller than 0.5 and also smaller than the mean centromeric index of the F chromosomes (Tab. 4), except in karyotype no. 9 where the odd chromosome had a dicentric aspect.

No special association with the satellite regions of other small or large acrocentrics was detected.

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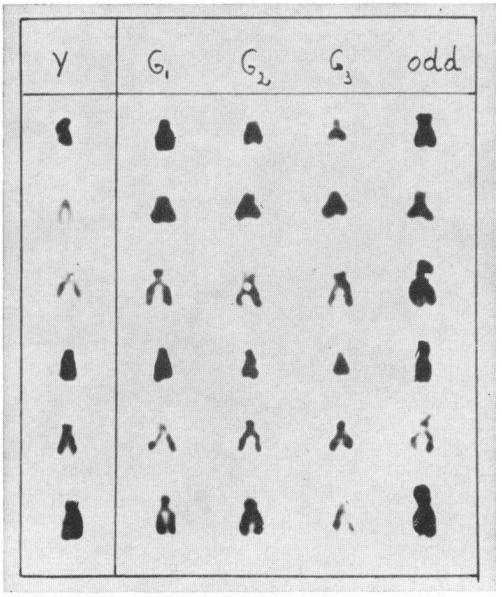

Fig. 5. D.J.M.: G groups cut out from six different karyotypes

Case II

G.G. was referred to us by Dr. C. Bossuyt with the diagnosis of " mongolism ".

Clinical data. – The patient was 2½ years old. He had one older brother (12 years of age), one older sister (10 years of age) and one younger brother (1 year of age), all normal and healthy. No other cases of trisomy 21 were known in the family.

The patient had a mongoloid appearance (Fig. 6). There was slanting of the palpebral fissures, slight hypertelorism, prominent ears, flat nose. The mouth was open and small, the lips thick and fissured, the teeth irregularly implanted, the tongue thick, protruding and fissured, the voice hoarse and with a low tone, the neck large and short. There was pectus excavatum and a slight dorsolumbal kyphosis. The skin of the arms had a marbrated aspect. There was articular laxity and muscular hypotony. The hands were short, broad and flabby. The fingers were also short, especially the fifth. The hair was straw-like.

The *dermatoglyphic pattern* (Fig. 7), evaluated by Lic. S. De Bie, showed bilaterally a unique simian crease, two flexion creases in the fifth finger, a triradius in position t''' (atd = 98° and 95° resp.), absence or triradius c in the left hand and most probably also in the right hand, a cubital loop in the hypothenar region of the right hand, a bilateral distal loop in the third interdigital area and a proximal loop in the thenar region of the left hand. The formula was as follows: right: 11-0-7-5'-t'''-Lc-0-0-L-0; left: 11-0-7-2-t'''-V-D-O-L-O, which corresponded with trisomy 21.

Cytogenetic evaluation. – *Sexchromatin* was male: 2% Barr bodies in buccal smears.

Numerical chromosomal analysis of 38 metaphases revealed 2n = 47 in 72% of the cells, 28% of the cells having lost one or a few chromosomes during the technical manipulations.

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Tab. 1. Total length expressed in mm of the odd chromosome and mean total length of the F chromosomes in 10 karyotypes of patients D. J. M., G. G., M. G.

Karyotype N.	Patient					
	D.J.M.		G.G.		M.G.	
	odd chromosome total length	F chromosome mean total length	odd chromosome total length	F chromosome mean total length	odd chromosome total length	F chromosome mean total length
1	14	15.1	12.5	13.1	15	17.6
2	14.5	15.3	11	13	13.5	14.5
3	13	13.1	12	12.2	16.5	14.7
4	12	11.6	9.5	14	11.5	11.1
5	16	17	12.5	13.5	17	18.1
6	13	13.4	11.5	13.7	12	14.2
7	14.5	16.4	14.5	15.3	13.5	14.8
8	14	13.5	14	13.5	?	14.8
9	16	16.5	10.5	13.7	19.5	18.3
10	17	16.5	12	13.7	—	—

Tab. 2. Patient D. J. M., 2n = 46: length expressed in mm of the long arm of the G chromosomes and the odd chromosome and of the short arm of the 17-18 chromosomes and the odd chromosome

Karyotype N.	G chromosomes – long arms				Odd chromosome		Mean short arm	
	Y	G_1	G_2	G_3	long arm	short arm	17_1-17_2	18_1-18_2
1	7.5	7.5	7	6.5	8	6	6	5.5
2	10	8	8	6.5	8	6.5	6.25	4.5
3	8	8	7.5	6	8	5	5.5	4.5
4	6	7	6.5	5.5	7.5	4.5	5	4.5
5	6.5	10	10	9	9.5	6.5	8	5.5
6	9	8	8	7.5	8	5	6.25	5.5
7	11	10	8.5	8.5	9	5.5	7.25	5.75
8	8.5	8.5	8	8	9	5	5.5	4.5
9	10	9	9	8	8.5	7.5	7	6.25
10	10	9	9	8	10	7	7	5.75

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Tab. 3. Difference in length between long arm of smallest G chromosome and short arm of odd chromosome expressed in %

Karyotype N.	Patient		
	D.J.M. %	G.G. %	M.G. %
1	7.7	15.3	47.3
2	0	25.0	21.4
3	16.7	23.0	0
4	18.1	38.4	0
5	27.8	9.0	42.1
6	33.3	16.6	30.7
7	35.3	20.0	26.6
8	37.5	14.2	?
9	6.2	33.3	20
10	12.5	25	—

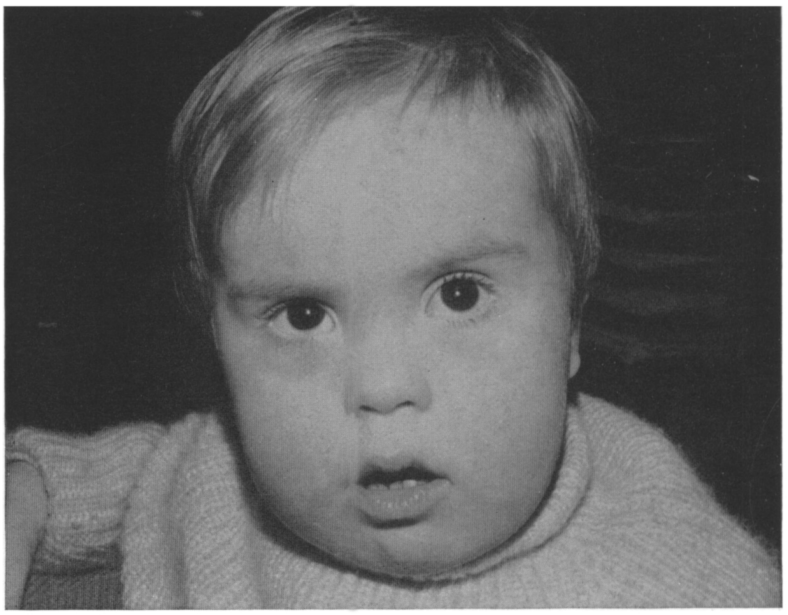

Fig. 6. G.G.: facies

Structural analysis was done in 10 photographic karyotypes (Fig. 8). There were 44 normal autosomes, an X chromosome and a Y chromosome and in addition to this an odd submetacentric chromosome which could not be paired with any other chromosome. It was tentatively put with the small acrocentrics (Fig. 9). The other chromosomes were all structurally normal and no excess in length or number of secundary constrictions was noted. The total

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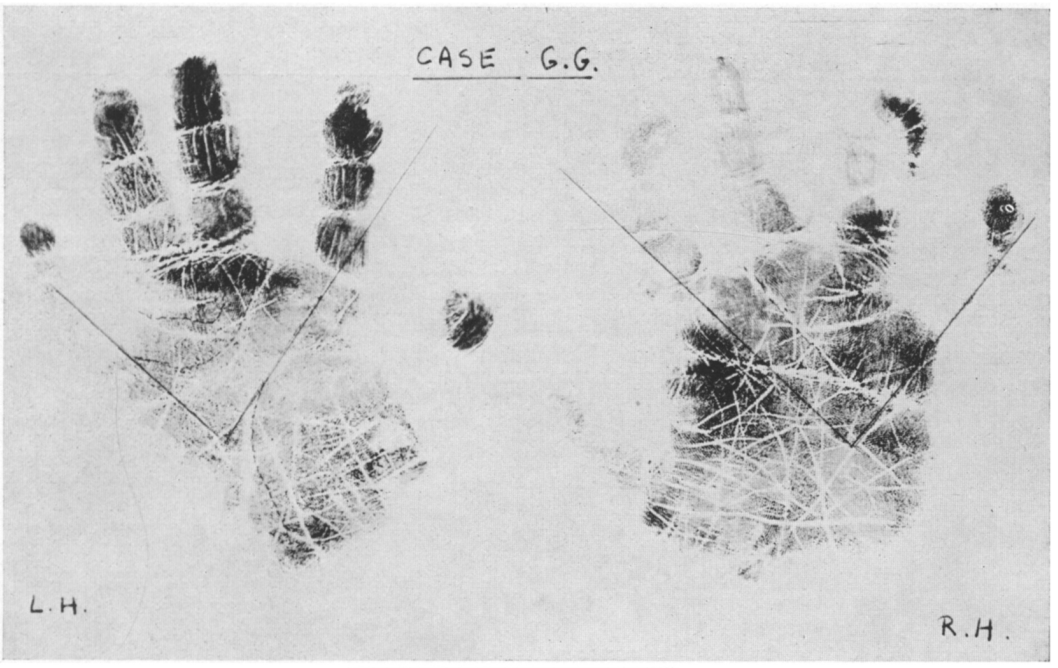

Fig. 7. G.G.: dermatoglyphics

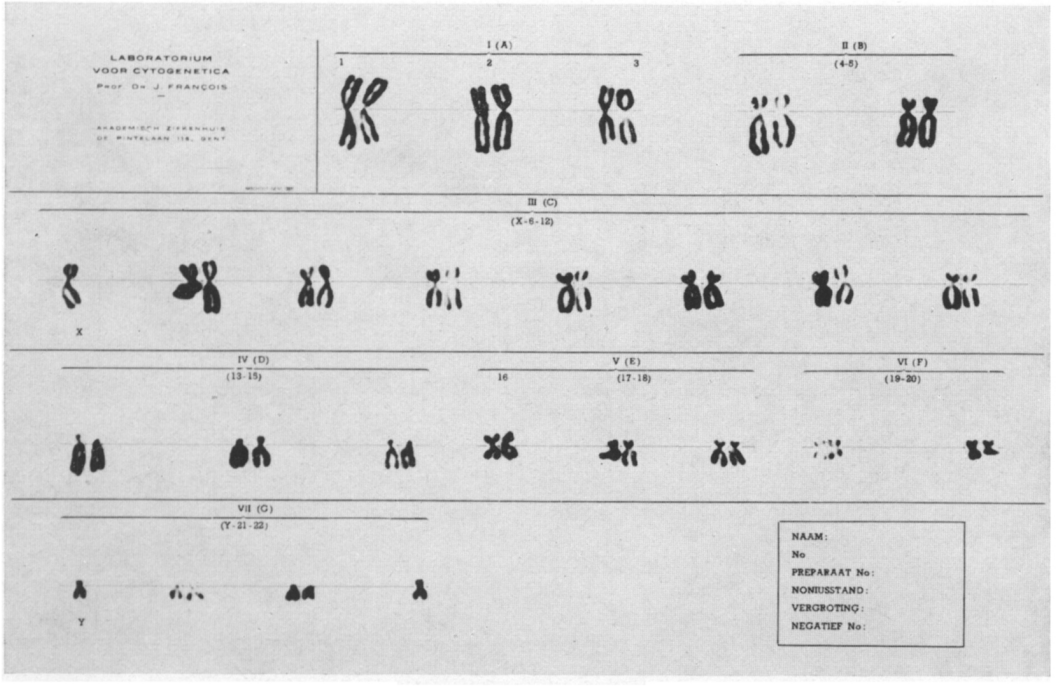

Fig. 8. G.G.: karyotype

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length of the odd chromosome was about the size of an F chromosome, although perhaps a little bit smaller (Tab. 1).

The long arm of the odd chromosome had the size of the long arm of a small acrocentric. Its short arm was of the same length order as the short arm of chromosomes 18 (Tab. 5).

In almost all karyotypes the chromatides of the odd chromosome's short arm were clung together or lay parallel and did not diverge nor carried satellites. The short arm of the odd chromosome was always shorter than the long arm of the smallest G chromosome. This difference in length amounted in several karyotypes to well over 15% (Tab. 3). The centromeric index of the odd chromosome was smaller than 0.5 and also smaller than the mean centromeric index of the F chromosomes (Tab. 4).

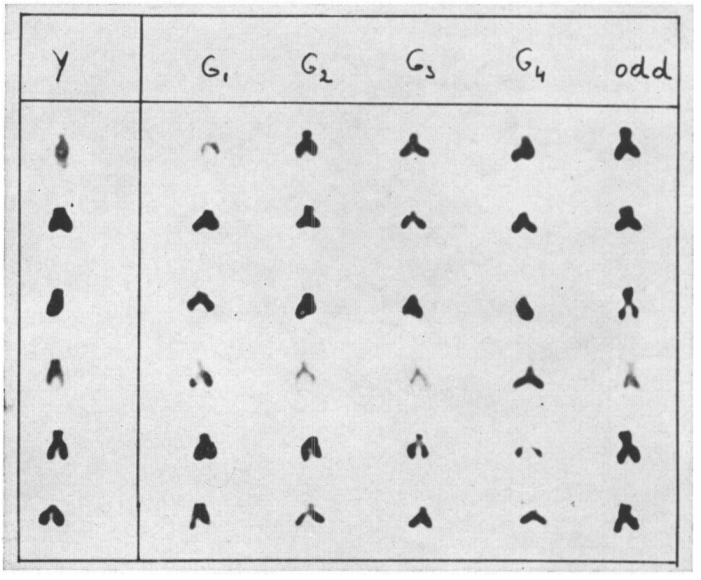

Fig. 9. G.G.: G groups cut out from six different karyotypes

Case III

M.G. was the mother of G.G.

Clinical data. – The patient was 36 years old, healthy and mother of proband G.G. and of 3 more healthy children.

Cytogenetic evaluation. – *Numerical chromosomal analysis* revealed 2n = 46 in 85% of the cells.

Structural analysis of 10 karyotypes showed in 8 karyotypes the presence in the G group of a submetacentric chromosome with the same length characteristics as were found in the son (Tab. I) (Figs. 10-11). In karyotype no. 8 the G group was of less quality so that the presence of the odd chromosome could only be suspected, but no accurate measurements could be made, and in karyotype no. 10 the enlargement was not present. In several karyotypes multiple secondary constrictions, heterochromatic gaps and chromatide breaks were present.

Tab. 4. Centromeric index (Ic) of the odd chromosome and mean Ic of the F chromosomes

Karyotype N.	Patient					
	D.J.M.		G.G.		M.G.	
	Ic odd chromos.	Mean Ic F chromos.	Ic odd chromos.	Mean Ic F chromos.	Ic odd chromos.	Mean Ic F chromos.
1	0.428	0.492	0.440	0.483	0.333	0.448
2	0.448	0.458	0.409	0.489	0.407	0.447
3	0.384	0.466	0.416	0.458	0.454	0.439
4	0.375	0.469	0.421	0.455	0.434	0.414
5	0.406	0.455	0.400	0.471	0.323	0.454
6	0.384	0.477	0.434	0.452	0.375	0.438
7	0.379	0.496	0.413	0.455	0.407	0.445
8	0.357	0.453	0.428	0.490	?	0.419
9	0.468	0.463	0.380	0.444	0.410	0.455
10	0.411	0.462	0.375	0.463	—	—

Tab. 5. Patient G. G.: 2n = 47: length expressed in mm of the long arm of the G chromosomes, the long and short arm of the odd chromosome and the mean short arm of chromosomes 18

Karyotype N.	Long arm G chromosomes					Odd chromosome		18_1-18_2
	Y	G_1	G_2	G_3	G_4	long arm	short arm	mean short arm
1	10.5	8	7.5	7.5	6.5	7	5.5	5
2	7.5	6.5	6.5	6.5	6	6.5	4.5	4.75
3	8	7	6.5	6.5	6.5	7	5	4.5
4	8	8	7.5	6.5	6.5	5.5	4	5.5
5	8	7.5	6.5	6	5.5	7.5	5	4.75
6	8	7.5	6.5	6	6	6.5	5	4.25
7	8.5	8.5	8.5	8	7.5	8.5	6	4.25
8	8.5	8	8	7.5	7	8	6	5.75
9	9	7	7	7	6	6.5	4	4.75
10	7	8	8	6.5	6	7.5	4.5	4.75

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The long arm of the odd chromosome was of the same size as the long arm of a normal G chromosome. Its short arm was of the same length order as the short arm of chromosomes 18 (Tab. 9). In many karyotypes the chromatids of the odd chromosome stuck together. Satellites could be seen or their presence suspected in 3 of the 10 karyotypes.

The short arm of the odd chromosome was always shorter than the long arm of the smallest G chromosome, the difference amounting to more than 15% in most karyotypes (Tab. 3).

The centromeric index of the odd chromosome was smaller than 0.5 and mostly also smaller than the mean centromeric index of the F chromosomes (Tab. 4).

Case IV

F.G. – The patient was 40 years old, in good health and father of G.G.and of the 3 more healthy children.

Cytogenetic evaluation: completely normal. *Numerical analysis* of 40 metaphases revealed $2n = 46$ in 96% of the cells. *Structural analysis* of 9 karyotypes did not reveal any structural abnormality or peculiarity.

Discussion

The characteristics common to the odd chromosome found in the 3 patients are: a total length approximating the length of an F chromosome, a short arm of the size of the short arm of chromosome 18, a long arm with the length of a long arm of a G chromosome and a centromeric index varying between 0.323 and 0.468.

The odd chromosome was found on the one hand in a child with a normal diploid chromosome number and on the other hand in a child with trisomy 21 and in his normal diploid mother. It belonged apparently to the G group chromosomes.

Theoretically such an odd chromosome can either be the result of a structural rearrangement or be a normal morphologic variant due to coiling alterations.

I. The following rearrangements can at once be excluded as being on the origin of the odd chromosome:

1. *Pericentric inversion* because of the normal length of the long arm.
2. *Isochromosome formation from the long arm of a G chromosome* because of the submetacentric value of the centromeric index.
3. *Classical G/G translocation* (21/22 *or* 21/21) as can be found in interchange trisomic children with $2n = 46$, whose karyotypes have only three small acrocentrics but an additional small metacentric element in the F group; this can be excluded here in view of the comparative measurements of the odd chromosome's short arm and the long arms of the G chromosomes (Tab. 3).

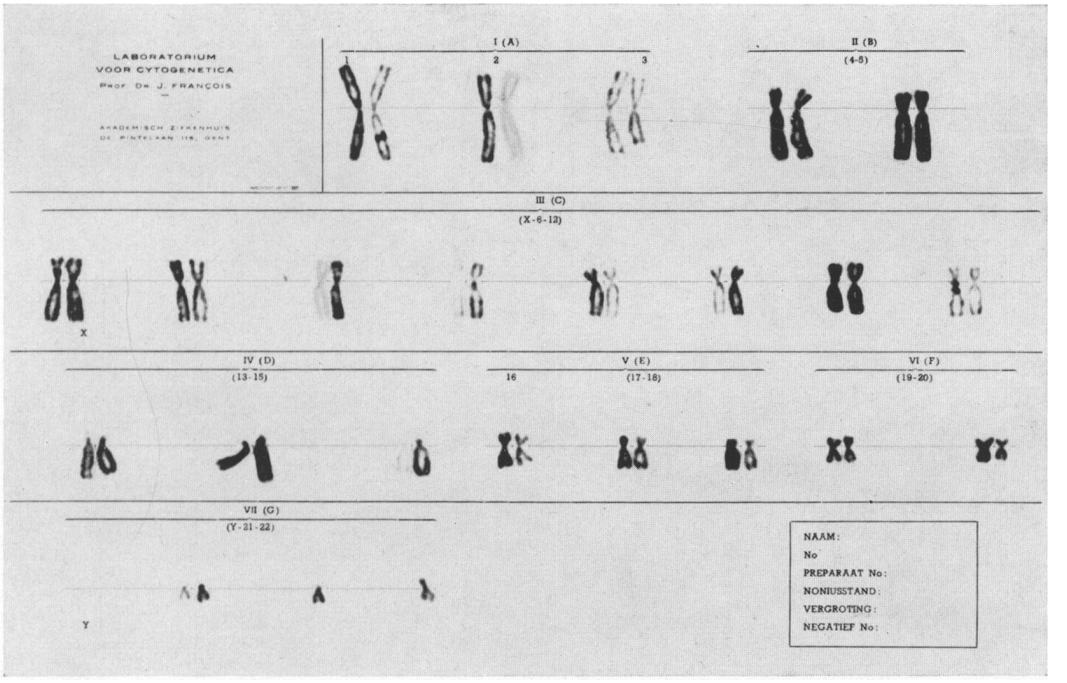

Fig. 10. M.G.: karyotype

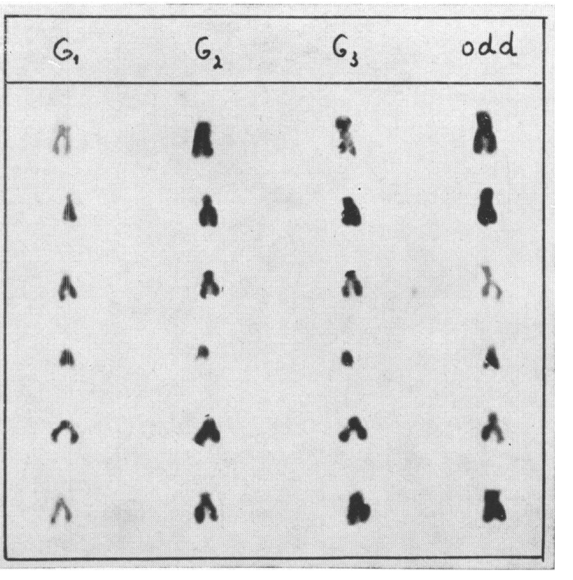

Fig. 11. M.G.: G groups cut out from six different karyotypes

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Tab. 6. Patient M. G., 2n = 46: length expressed in mm of the long arms of the G chromosomes, the long and short arms of the odd chromosome and the mean short arm of chromosomes 18

Karyotype N.	Long arm G chromosomes			Odd chromosome		18_1-18_2
	G_1	G_2	G_3	long arm	short arm	mean short arm
1	11.5	11.5	9.5	10	5	6.25
2	7.5	7.5	7	8	5.5	5
3	8.5	7.5	7.5	9	7.5	5.5
4	6	6	5	6.5	5	4
5	10.5	10	9.5	11.5	5.5	6.25
6	7.5	7.5	6.5	7.5	4.5	5.5
7	8.5	8.5	7.5	8	5.5	5.5
8	7.5	7.5	7	?	?	5.75
9	11	10	10	11.5	8	6
10	—	—	—	—	—	—

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II. The following rearrangements might possibly be responsible for the formation of the odd chromosome:

1. A *duplication* of a chromosomal segment in the short arm, possibly associated with loss of the satellites.

2. An *insertion* in the short arm of a fragment of which the origin remains unknown.

3. *A reciprocal translocation occurring de novo in the proband (possibly case D.J.M.) or inherited from one of the parents (case G.G.)*, the chromatine being translocated into this position from another unknown chromosome, which in its turn would have received in exchange the satellite region of the G chromosome. If the translocated segment derives from a long chromosome, it is very difficult to detect its origin.

Aarskog (1966) remarked that a translocation between two chromosomes of greatly different size might increase the risk for failure of meiotic pairing or separation during gametogenesis. He described a child with the clinical features of trisomy 21, who had 47 chromosomes, but only 4 normal small acrocentrics and an odd, small and almost metacentric chromosome with the length of an F chromosome. One of the B chromosomes showed a deletion of the short arm. The findings were interpreted as a *B/G translocation* occurring *de novo* in the child, since both parents and two brothers had normal karyotypes.

4. *A deletion/translocation in one of the parents* who, being a balanced carrier of a ?/G translocation, could transmit an unbalanced chromosome complement to the child, resulting in *partial trisomy* for an unidentified chromosomal segment. This has been described by:

a) Van Wijck *et al.* (1961): A non-mongoloid but mentally subnormal and physically abnormal 20 years old patient had a karyotype with 2n = 46 in which there was an odd chromosome in the G group resembling the odd chromosome of our cases. The patient showed webbing of the neck, low set and malformed ears, small mandible, no fusion or absence of cervical vertebrae, pectus excavatum, malformed and small feet, limited movements of the ankle-joint, overlapping toes and mild epilepsy. Because the patient's anomalies evocated some clinical features of trisomy E the odd chromosome was interpreted as translocation of a fragment of a chromosome 17-18 on a G chromosome resulting in partial trisomy E.

b) Gustavson *et al.* (1964): a B/G translocation producing a small submetacentric chromosome and occurring in a balanced form in the normal mother but causing partial trisomy for the short arm of the B chromosome in the child who did not receive the deleted B chromosome and presented multiple malformations.

III. Short arm enlargement in a G chromosome is also seen in the familially occurring "marker" chromosomes. They have been described in:

1. *A small percentage of the normal population.* Court Brown *et al.* (1966) demonstrated that anomalous coiling of a G chromosome resulting in an unusually long short arm can occur as a heritable feature in a small proportion (i.e. 2.5%) of the popu-

lation and can be found in normal members of several families. Within these families the morphology of the odd chromosome could differ somewhat but remained without effect on the carrier of the odd chromosome, not only regarding his own development but also regarding the conception of abnormal children.

According to Court Brown *et al.* (1965) the criteria for interpretation of an odd chromosome as a normal variant are: its presence in most or all of the cells of more than one tissue, its familial character and its appearance in a chromosome group where secondary constrictions can be seen on the short arm, which is the case for the G chromosomes. These authors indicate that the morphologic change usually occurs in the vicinity of the constriction, where the chromatids tend to lie parallel and in apposition to each other. The finding in a malformed patient of a G chromosome, characterised by an increase in the length of the short arm, a change in its arm ratio and a change in its morphological appearance can thus be fortuitous and possibly be attributed to the normal range in variation of length occurring in the population.

2. *Relatives of patients with repeated abortions as described by*:

a) Schmid W. (1962): in the husband and father-in-law of the proband.

b) Carr D. H. (1963): in the child, husband and mother-in-law of the proband. The odd chromosome was here ascribed to an insertion, because the satellites were visible.

It remains an open question whether there exists a relationship between the odd chromosome and the abortions.

3. *Normal relatives of patients and in the patients themselves affected by pathologic conditions such as*:

a) Severe muscular dystrophy: the enlargement was found in the clinically affected proband, in his normal father, in one of his 3 normal brothers and in his normal sister (Ruffié *et al.*, 1965).

b) Mental retardation with mongoloid features and dysarthria: enlargement of the satellite region of a small acrocentric was found in the proband, his normal father and in 2 of his normal brothers and sisters (Cooper and Hirschhorn, 1962).

c) Abnormalities of the central nervous system: an identical enlargement of the short arm or satellite region was found in the grandmother, the father and in 3 of his 9 children. From the 5 subjects presenting the marker chromosome, 4 were clinically normal, but the fifth presented severe abnormalities of the central nervous system. A similar syndrome was found in one brother who was cytogenetically normal (De la Chapelle *et al.*, 1963).

4. Families in which besides the marker chromosome *additional cytogenetic abnormalities* occur in the proband and/or some relatives such as:

a) *Translocation* 13/22 with $2n = 45$ in a mother and 4 of her 6 children. The mother was normal. The 4 children with the translocation were mentally retarded and presented varying degrees of dysarthria. The father and the 5th child were normal. The 6th child had *trisomy* 21 and was mongoloid. The short arm enlargement of a G chromosome was present in the mother and some of the translocation bearing children (Moorhead *et al.*, 1961).

b) *Translocation* 2/13 in a mosaic cell line in the paternal grandmother of the proband, the short arm enlargement of a G chromosome being present in the proband and his father (Schmid, 1962).

c) *Additional small fragment* in proportion of cells in a proband with mongoloid traits: the enlargement was found in the proband and his normal mother (Gray *et al.*, 1962).

d) *Trisomy* 21 in the proband: the enlargement was present in the proband and in his normal mother and grandfather (Therkelsen, 1964).

e) *Turner syndrome*: the enlargement was present in the 2n = 45, XO patient, and in her normal sister and mother (De Grouchy *et al.*, 1964).

f) *Loss of Y and of one or more small acrocentrics and presence of Ph1* and of a 21-22 marker chromosome in a patient with chronic myeloid leukemia (De Grouchy *et al.*, 1966).

g) *Translocation 1/G* in the proband, a girl with psychomotor retardation and multiple congenital anomalies. In five relatives enlargement of the short arm of a small acrocentric was found (Maganias *et al.*, 1967).

Some authors emitted the hypothesis that the marker chromosome might be responsible through chromosomal interaction for a gametic meiotic or mitotic misdivision (Lejeune, 1963; De Grouchy *et al.*, 1964; Hamerton *et al.*, 1965), because of the fact that simultaneous presence of several chromosomal abnormalities or peculiarities in the same person or the same family occurs more frequently than if it were due to chance. It might indeed be possible that small rearrangements would be passed on from generation to generation without any harmful phenotypic effect, because they are either small or balanced, until they cause another gross chromosomal abnormality which in its turn would have a pathologic effect.

Dekaban *et al.* (1963) found an " oversized " small acrocentric in three of 14 examined mongols.

Hamerton *et al.* (1965) found a variety of minor anomalies in 7 out of 208 families where " mongolism " occurred. They judged that this frequency of just under 3.5% might have a pathologic significance.

In a series of 73 " mongoloid " patients, Edgren *et al.* (1966) found short arm enlargement of a G chromosome in 4% of the patients.

In a series of 20 Caucasian and 20 Negro mongols, Starkman *et al.* (1967) also found morphologic abnormalities in the short arm or satellite region of the small acrocentrics in 2 Negroes and 2 Caucasians. In a control series of 20 Negroes and 20 Caucasians only 1 Negro showed similar peculiarities. The above mentioned percentages are all higher than the one of 2.5% found by Court Brown *et al.* (1966) in a normal control population.

In a series of 233 consecutive patients referred to us from different physicians for karyotyping we found satellite enlargement of a small acrocentric in 3 cases, i.e. in a normal father of a trisomy 21 patient, in a baby with a congenital heart anomaly and multiple malformations and in a patient with Stein-Leventhal syndrome.

In one patient, i.e. a child with congenital glaucoma, we found enlargement of

the short arm and/or satellite region, but it was impossible to tell whether the satellite or the short arm itself or both were involved in the enlargement.

Enlargement of the short arm itself was found in 7 cases, i.e. in a patient with Waardenburg-Klein syndrome, another with primary amenorrhoea, one with hypertelorism, one with otosclerosis and the three patients reported here.

In the total of 233 patients there were thus 11 patients with a peculiar small acrocentric of which in 7 (3%) an enlargement of the short arm itself could be ascertained. Except for the patient with trisomy 21 all the patients had a normal karyotype.

This series comprised 4 cases of congenital glaucoma. In two of them the chromosomes were perfectly normal. The third one is the child described in this paper. The fourth was the patient with short arm enlargement in a G chromosome, in whom it was impossible to tell whether the satellites or the arm itself were enlarged.

In evaluating the percentages of peculiar G chromosomes found by different authors, one has to take into account that the method of analysis and ascertainment of such chromosome is very subjective and prone to different interpretations and that comparison of the percentages between normal and abnormal patients can only be scrutinously analysed, when performed by the same investigators.

Conclusion

1. It is possible that in our patients the enlargement represents altered chromosomal behavior of *anomalous coiling*. Additional chromosome studies from skin or fascia will be done in order to investigate the presence of the odd chromosome in more than one tissue.

It is remarkable that some karyotypes of patient M.G. showed chromatide breaks and secondary constrictions. Perhaps is this a sign of a genetically determined despiralisation or abnormal coiling, in mother and son. Whether the odd chromosome in patient G.G. formed during gametogenesis in the mother's ancestors, has secondarily caused a failure of pairing or segregation of chromosomes 21, remains entirely speculative.

If the odd chromosome represents only an abnormal chromatine condensation, there would be no relationship between the phenotype with congenital glaucoma and the karyotype of patient D.J.M.

2. It is quite possible, however, that in the three patients the odd chromosome represents a *translocation chromosome*. This could occur under a balanced form in the mother, but cause additional trisomy 21 in the son and partial trisomy in the child with congenital glaucoma. The fact that in this latter patient no secondary constrictions were found in other chromosomes indicates perhaps that the odd chromosome in his case is not due to abnormal chromatine condensation but to a translocation or insertion of a chromosomal segment which would be the cause of his clinical condition.

As he was an institutionalized child of whom the parents were unknown, chro-

mosomal evaluation could not be performed in his relatives, which made the detection of a possible translocation carrier impossible.

More reports on normal and affected patients and families are needed in order to establish the exact importance of this karyotypic peculiarity.

Summary

The authors report three cases of enlargement in length of the short arm of a G chromosome: in a mother and her trisomy 21 son, and in a child with congenital glaucoma and systemic malformations. They discuss the nature of this odd chromosome. The latter can represent altered chromosomal behavior of anomalous coiling, but it is quite possible that it represents a translocation. The authors observed another case of congenital glaucoma with short arm enlargement in a G chromosome.

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RIASSUNTO

Gli AA. descrivono tre casi di allungamento del braccio corto di un cromosoma G, più precisamente in una madre e nel figlio mongoloide, e in un bambino affetto da glaucoma congenito e da altre malformazioni generali. Viene discussa la natura di questo allungamento, che può essere dovuto ad una spiralizzazione anormale o anche ad una traslocazione. Gli AA. hanno osservato un altro caso di glaucoma congenito con allungamento del braccio corto di un cromosoma G.

RÉSUMÉ

Les AA. rapportent trois cas d'allongement du bras court d'un chromosome G, à savoir chez une mère et son fils mongolien, ainsi que chez un enfant présentant un glaucome congénital et d'autres malformations générales. Ils discutent la nature de cet allongement. Celui-ci peut être dû à une spiralisation anormale, mais également à une translocation. Les AA. ont observé un autre cas de glaucome congénital avec allongement du bras court d'un chromosome G.

ZUSAMMENFASSUNG

Verf. beschreiben drei Fälle, bei denen der kurze Schenkel eines G-Chromosoms verlängert war: eine Mutter und ihr mongoloider Sohn sowie ein Kind mit angeborenem Glaukom und anderen generellen Missbildungen. Es wird erörtert, ob diese Verlängerung auf einer anormalen Anordnung der Chromosomspiralen oder auch auf einer Translokation beruhen könnte. Verf. fanden noch einen anderen Fall von angeborenem Glaukom mit Verlängerung des kurzen Schenkels eines G-Chromosoms.