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Parents with Translocation & the Outcome in their off springs

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Abstract: ***Introduction:*** *Depending on the chromosomal morphology translocations are of two types; reciprocal (rcpt) and Robertosonian (robt). Based on the exchange of material it could be balanced and unbalanced. The incidence of the translocation is one in 16,000. The individuals with balanced translocation may give rise to offsprings with anomalies. In individuals with rcpt the risk is 6.1% and robt 3.7%. The present study reports the occurrence of the rcpt & robt in the parents and its association to the chief complaints in their live birth off springs*

Material and Method: *The data was available on 42 parents (27 mothers, 15 fathers) and their age ranged from 20 to 45 years*

Results: *The observations have shown robt in 16 (38%) (12 mothers, 4 fathers) and rcpt in 26 (62%) (15 mothers, 11 fathers) parents. The commonly seen karyotypes in robt were (13;14) in six; (14;21) in nine and in rcpt: 1;15/ 1;21/ 5;8 in two each (n6). Mental retardation (MR), multiple congenital anomaly (MCA), Down syndrome (DS), primary amenorrhea (PA) and bad obstetric history (BOH) were the clinical conditions in robt and in rcpt they were DS, MR, MCA, BOH and fertility failure (FF). Mothers as carriers were of more percentage (27/42, 64.3%) than fathers. The risk to get the following offsprings was: MCA 28.5%, DS 28.5%, BOH 24%, MR/MCA 10%, MR 5%, PA 2% and FF 2%.*

Conclusion: *The percentage of translocations was observed to be higher in rcpts, mothers and in clinical conditions in female offsprings.*

Keywords: *Robertsonian translocation, reciprocal translocation, translocation carrier parents, offsprings, meiotic segregation*

I. Introduction

Translocation is an abnormality caused by the rearrangement of chromosome segments between non-homologous chromosomes. When translocations occur during gametogenesis, chromosomal abnormality is seen in the offspring; but if the translocation occurs during somatic cell divisions of the zygote, then, chromosomal abnormality occurs only in the affected cell line. Based on the morphology of the chromosomes two main types of translocations are observed: reciprocal (rcpt) and Robertsonian (robt). Moreover, based on the exchange of material, it is classified as balanced (no extra or missing genetic material; normal phenotype) and unbalanced (genetic material extra or missing; abnormal phenotype) translocation. The carriers with balanced translocation may give rise to offsprings with unbalanced translocation (20%), spontaneous abortions (50%), which might be due to sequence rearrangements of the functional genes and incidence being one in 16,000. The risk for a serious congenital anomaly is 6.1% when rcpt is found, 3.7% for robt and 9.4% for inversions, which is 2-3% in general population.[1,2,3,4]

In robt, the exchange involves two long arms of the acrocentric chromosomes with loss of the short arms leaving behind a total of 45 chromosomes. The incidence is around 0.97 in 1000 new livebirths. The acrocentrics commonly involved in translocations are 13 and 14. Males with robt have normal phenotype but may have infertility associated with oligozoospermia.[5]

In rcpt, exchange of genetic material occurs between two non-homologous chromosomes. The incidence varies from one in 500 to 650 live births. The individuals with balanced rcpt are normal, healthy individuals because of the normal complement of genetic material. The carrier individuals may give rise to normal offsprings with normal chromosomal complement or with balanced translocation status as in the parents or to abnormality in the offffsprings because of the unbalanced chromosomal offsprings such as mental retardation(MR), multiple congenital anomalies(MCA), Down syndrome(DS), bad obstetric history(BOH), primary amenorrhea(PA), fertility failure(FF). [6,7,8] About 6% of balanced reciprocal translocation individuals may have symptoms of autism, intellectual disability of congenital anomalies due to disruption of the genes at the breakpoints.

There are very few articles on carrier parents, mode of segregation and the clinical correlation in offsprings. The present study reports the occurrence of the rcpt & robt in the parents and its association to the chief complaints and the karyotypes in their live birth offsprings.

II. Material and Method

Cytogenetically confirmed data was available on 42 parents (42 mothers and 42 fathers) and their age ranged from 20 to 45 years. Karyotypes were determined with peripheral leucocyte cultures and photomicroscopy. The percentage analysis was calculated.

III. Results

The data was tabulated for the robt and rcpt and translocation status and given in tables one to three.

Table1: Robertsonian (robt) and reciprocal (rcpt) translocation:Carrier Parents and their male and female children

-	Robt (n16)	Rcpt (n26)	Total
t carrier mother (n27)			
Male children	05	07	12
Female children	07	08	15
Total	12	15	27
t carrier father (n15)			
Male children	02	08	10
Female children	02	03	05
Total	04	11	15
Total male children	22	Total female children	20

Table 1: Observations:

- Forty two mothers' and 42 fathers' karyotyping has revealed that 27 mothers (64.3%) and 15 fathers (35.7%) were translocation carriers. 15 mothers (46,XX) and 27 fathers (46,XY) had normal karyotype.
- robt was detected in 16 (38%) and rcpt in 26 (62%) parents.
- Sixteen robt was present in 12 mothers (75%) and four fathers (25%) and the 26 rcpt in 15 mothers (57.7%) and 11 (42.3%) fathers.
- In the 27 mothers, robt was seen in 12 (44.4%) and rcpt in 15 (55.6%); whereas in the 15 fathers, robt was seen in four (26.7%) and rcpt in 11(73.3%).
- Male offsprings born to the 27 translocation carrier mothers were 12 (44.4%) and the female offsprings born were 15 (55.6%). Male children born to the 15 carrier fathers were ten (66.7%) and the female children were five (33.3%).
- As per the types of translocation, male children born to the 12 robt carrier mothers were five (41.7%) and the female children were seven (58.3%) and it is two and two for the four robt carrier father (50% each). In rcpt, male and female children born to the 15 rcpt carrier mothers were seven (46.7%) and eight (53.3%) and it is eight (72.7%) and three (27.3%) to the 11 rcpt carrier father.

Table 2: Robertsonian Translocation (Robt) in Carrier Parents & the Genotype and Outcome in the Offsprings

Serial Nos	Mother carrier for robt: Karyotypes	Chief complaints & karyotypes in the offsprings	Serial Nos	Father carrier for robt: Karyotypes	Chief complaints & karyotypes in the offsprings
1.	45,XX, t(13;14)	MR; 45,XX,t(13;14)	13.	45,XY, t(14;21)	t DS 46,XY,t(14;21)+21
2.	45,XX,t(13;14)	MCA; 46,XX, t(13;14)+13 t trisomy 13	14.	45,XY, t(14;21)	t DS; 46,XY,t(14;21)+21
3.	45,XX,t(13;14)	DS; 46,XX, t(13;14)+21	15.	45,XY, t(14;21)/46,XY (1 in 20 spreads)	t DS 46,XX,t(14;21)+21
4.	45,XX,t(14;21)	t DS 46,XY,t(14;21)+21	16.	45,XY,t(21;21)	t DS 46,XX,t(21;21)+21
5.	45,XX,t(14;21)	t DS; 46,XY,t(14;21)+21	-	-	-
6.	45,XX,t(14;21)	t DS 46,XY,t(14;21)+21	-	-	-
7.	45,XX,t(14;21)	t DS 46,XY,t(14;21)+21	-	-	-
8.	45,XX,t(14;21)	t DS 46,XY,t(14;21)+21	-	-	-
9.	45,XX,t(14;21)	t DS 46,XX,t(14;21)+21	-	-	-
10.	45,XX,t(13;14)	PA; 45,XX,t(13;14)	-	-	-
11.	45,XX,t(13;14)	BOH; 45,XX,t(13;14)	-	-	-
12.	45,XX,t(13;14)	BOH; 45,XX,t(13;14)	-	-	-

* MR: mental retardation; MCA: multiple congenital anomaly; DS: Down syndrome; PA: primary amenorrhea; BOH: bad obstetric history; t DS: translocation Down syndrome

Table 2: Observations:

- The observed robt in 16 carrier parents were (13;14) in six; (14;21) in nine and (21;21) in one in a mosaicism status.
- robt (13;14) was seen only in six mothers. The nine t(14;21) were present in six mothers and three fathers and t(21;21) in one father.
- Six mothers with t(13;14) had six female offsprings. The chief complaints in the six children were MR, MCA, DS and PA in one each respectively and BOH in two. The offsprings with MR, PA and BOH had robt(13;14) in balanced status as in the mothers. The child with DS had robt(13;14) along with three free 21s resulting in DS. The child with MCA had t(13;14) and the other two 13s in 'free status' resulting in translocation trisomy 13 (Patau syndrome).
- Six mothers with t(14;21) had five male and one female children. Three fathers with t(14;21) had two male and one female children and one father with t(21;21) had one female child. All the ten offsprings were DS.
- It is to be noted that one of the male proband with double t(14;21) had both his mother and father as carriers for robt (14;21).

Table 3: Reciprocal Translocation (rcpt) in Carrier Parents & the Outcome in their off springs

Serial Nos	Maternal origin of the rcpts	Chief complaints & the karyotypes in the offsprings	Nos	Paternal origin of the rcpts	Chief complaints & the karyotypes in the off springs
1.	46,XX,t (1;21) (p11;p11)	DS: 47,XX, t(1;21)+21 Male sib at conception was detected to be DS with prenatal diagnosis & was medically terminated.	16.	46,XY,t(2;9) (p22;p23)	MR/MCA: 46,XX,der(9) partial monosomy 9p21→9pter; partial trisomy 2p22 →2pter.
2.	46,XX,t(1; 21) (q32;q11)	MR/MCA: 47,XY, t(1; 21)+der 21; partial trisomy 1 & 21 (1q32→ 1qter; 21q11→ 21qter)	17.	46,XY,t(2;21) (p22;q22)	MR: 46,XY,der(2) partial monosomy 2p22→2pter; partial trisomy 21q22→21q ter
3.	46,XX, t(3;8) (p22;p21)	MR/MCA: 46,XY,der (8) partial monosomy 8p21→8pter partial trisomy 3p22→3pter.	18.	46,XY,t(3;14) (q25;p10)	MCA: 46,XX,der (14) partial monosomy; 14p10→ 14pter, partial trisomy; 3q25 →3qter. Female sib rcpt carrier
4.	46,XX,t(6; 20) (p21;q13)	MCA: 46,XX,der(20) partial monosomy 20q13→ 20qter; partial trisomy 6p21→6pter.	19.	46,XY,t(3;15) (p25;q22)	MR/MCA: 46,XY,(der3) partial monosomy 3p25→3pter; partial trisomy 15q22→15qter.
5.	46,XX, t(9;12) (p11;q24)	MCA: 46,XY,der(12) partial monosomy 12q24→ 12qter; partial trisomy 9p11→9pter	20.	46,XY,t(5;8) (p15;q22) Familial	MCA:46,XY, der (5)pat; der (22)mat partial monosomy 5p15→5pter; partial trisomy 8q22→8qter and partial monosomy 22q11→22qter; partial trisomy 11q23→11qter
6.	46,XX, t(9;15) (q22;p12)	MCA: 47,XX+der(9) partial trisomy (9q22→9qter; 15p12→ 15pter)	21.	46,XY,t(5;8) (p15;q22) Familial	MCA: 46,XY,der(5) partial monosomy 5p15 →5pter; partial trisomy 8q22→8qter Paternal cousin to the proband with serial no 5.

7.	46,XX, t(9;21) (q22;q22)	MCA: 46,XX,der(9); Partial monosomy 21q22→21qter; partial trisomy 9q22→9pter	22.	46,XY,t(7;18) (p21;q22)	MCA:46,XY, der(18) partial monosomy 18q22→18qter; partial trisomy 7p21→7pter
8.	46,XX,t(11;22) (q23;q11)	MCA:46,XY, der (5)pat; der (22)mat partial monosomy 5p15→5pter; partial trisomy 8q22→8qter and partial monosomy 22q11→ 22qter; partial trisomy 11q23→11qter	23.	11.46,XY,t(9;10) (p13;q24) Familial	MCA: 46,XY,der (9); partial monosomy 9p13→9pter; partial trisomy 10q24→10qter.
9.	46,XX,t(1; 15) (p35;q24)	BOH: 46,XX,t(1;15) (p35;q24)mat; pat	24.	46,XY,t(13; 18) (q14;q21)	MCA: 46,XY, der(18); partial monosomy 18q21→18qter; partial trisomy 13q14→13qter.
10.	46,XX,t(4; 12) (q31;q24)	BOH: 46,XX,t(4;12) (q31;q24)	25.	46,XY,t(1;15) (p35;q24)	BOH: 46,XX,t(1;15) (p35;q24) mat;pat
11.	46,XX,t(7; 11) (q11;p15)	BOH: 46,XX,t(7;11) (q11;p15)	26.	46,XY,t(8;14) (p22;q32)	BOH:46,XY,t(8;14) (p22;q32)pat Familial Female sib rcpt carrier
12.	46,XX,t(11;16) (p11;q23)	BOH: 46,XX,t(11;16) (p11;q23)	-	-	-
13.	46,XX,t(15;20) (q13;q12)	BOH: 46,XY,t(15;20) (q13;q12)	-	-	-
14.	46,XX,t(13;17) (q33;p11)	BOH: 46,XY,t(13;17) (q33;p11)	-	-	-
15.	46,XX,t(1;7) (q21;q11)	FF: 46,XY,t(1;7) (q21;q11)	-	-	-

* MR: mental retardation; MCA: multiple congenital anomaly; DS: Down syndrome; PA: primary amenorrhea; BOH: bad obstetric history; FF: fertility failure

Table 3: Observations:

- The observed rcpt in 26 carrier parents were: 1;15/ 1;21/ 5;8 in 2 each (n6) and 1;7/ 2;9/ 2;21/ 3;8/ 3;14/ 3;15/ 4;12/ 6;20/ 7;11/ 7;18/ 8;14/ 9;10/ 9;12/ 9;15/ 9;21/ 11;16/ 11;22/ 13;17/ 13;18/ 15;20 in one each parent (n20) respectively.
- The observed rcpt in 15 carrier mothers were: 1;21 in two mothers and 1;7/ 1;15/ 3;8/ 4;12/ 6;20/ 7;11/ 9;12/ 9;15/ 9;21/ 11;16/ 11;22/ 13;17/ 15;20 one in each mother (n13) respectively.
- The observed rcpt in 11 carrier fathers were 5;8 in two fathers and 1;15/ 2;9/ 2;21/ 3;14/ 3;15/ 7;18/ 8;14/ 9;10/ 13;18 one in each father (n9) respectively.
- Fifteen mothers with rcpt carrier status had eight female and seven male offsprings. The chief complaints in the eight females were DS in one, MCA in three and BOH in four and in the seven males were MR/MCA in two, MCA in two, BOH in two and FF in one.
- Eleven fathers with rcpt carrier status had three female and eight male children. The chief complaints in the three female children MR, MR/MCA and BOH in one each and in the eight male children were MR, MR/MCA, BOH in one each and MCA in five.
- The four female and two male offsprings with BOH and one male with FF had balanced rcpt as in their mothers: i) Female: BOH: 1;15/ 4;12/ 7;11/ 11;16/; ii) Male: BOH: 13;17/ 15;20 and FF iii) 1;7. The one female and one male offsprings with BOH had balanced rcpt as in their fathers: i) Female: 1;15. It is to be noted that the female proband's both parents (father and mother) were carriers for rcpt 1;15 (serial numbers 9 and 25). ii) Male: 8;14.
- The remaining four female and four male with maternal origin and two female and seven male with paternal origin had derivative chromosomes; either trisomy or monosomy for the chromosomes involved in rcpt in the parents. The gain or the loss of the chromosomal segments has resulted in DS, MR or MR/MCA or MCA in the children.
- Familial presence of rcpts: The rcpts were observed to be familial in five cases; out of which one was maternal in origin and four were paternal in origin. Maternal origin: rcpt for (1;21); the mother had a

female and a male offspring with 47 chromosomes and translocation DS. Paternal origin: i) in the case with rcpt (3;14) (serial no 18) the male offspring's sister had the same rcpt as in the father; ii & iii) in the two male paternal cousins, rcpt in both their fathers was (5;8) and both fathers were sibs (serial nos 20 & 21); the male proband (serial no 20) along with derivative 5 from father he has received derivative 22 from mother [mother; rcpt (11;22); father: rcpt (5;8)] iv) in the case with rcpt for (9;10) (serial no 23) the paternal grandmother/ three paternal aunts/paternal male cousin also were carriers for (9;10) translocation.

- Three male offsprings were deceased; i) (serial no: two) male child deceased because of partial trisomy for the long arms of one and 21 transmitted from the mother ii) (serial nos: eight, 20) male child with derivatives (5) and (22); derivative (5) was paternal in origin and derivative (22) maternal in origin; child could not survive because of the two times partial trisomy for the long arms of eight and 11 and two times partial monosomy for the short arm of five and long arm of 22 iii) (serial no 23) male child with partial monosomy for the short arms of nine and trisomy for the long arm of ten.
- Mothers with rcpt have given rise to: three offsprings with 47 chromosomes and un-balanced karyotypes to DS, MR/MCA and MCA (serial nos: one, two, six); seven offsprings with 46 chromosomes and balanced karyotypes with BOH in six and FF in one (serial nos: nine, ten,11,12,13,14,15) and five offsprings with 46 chromosomes and un-balanced karyotypes with MCA in four (serial nos: four,five, seven,eight).
- Fathers with rcpt have given rise to two offsprings with 46 chromosomes and balanced karyotypes with BOH (serial nos: 25,26) and nine offsprings with 46 chromosomes and un-balanced karyotypes with MR in one (serial no: 17) , MR/MCA in two (serial nos: 16,19) and MCA in six (serial nos: 18,20,21,22,23,24) .
- Maternal origin and its association to the clinical conditions as per the sex of the offsprings showed: DS in a female; FF in a male; MR/MCA in two males; MCA in two males and three females and BOH in two males and four females. Paternal origin and its association to the clinical conditions as per the sex of the offsprings showed: MR in a male; MR/MCA in a male and a female; MCA in five males and one female and BOH in one male and one female.
- In the maternal origin, in female offsprings, the chromosomes that were not involved in rcpt were 2, 3, 5, 8, 10, 13, 14, 17, 18, 19, 22, X, Y and in the male offsprings they were 2, 4, 5, 6, 10, 14, 16, 18, 19, X, Y.
- In the paternal origin, in the female offsprings the chromosomes that were not involved in rcpt were 4, 5, 6, 7, 8, 10, 11, 12, 13, 16, 17, 18, 19, 20, 21, 22, X, Y and for the male offsprings 1, 4, 6, 11, 12, 16, 17, 19, 20, 22, X, Y.
- In the maternal origin, whether in female or male offsprings, the chromosomes that were common in not being involved in rcpt were 2, 5, 10, 14, 18, 19, X, Y.
- In the paternal origin, whether in the female or male offsprings, the chromosomes that were common in not being involved in rcpt were 4, 6, 11, 12, 16, 17, 19, 20, 22, X, Y and between the maternal origin and paternal origin, the common chromosomes were 19, X, Y.
- In the maternal origin, in female and male offsprings, the chromosomes that were commonly involved in rcpt were 1, 7, 9, 11, 12, 15, 20, 21. In the paternal origin, in female and male offsprings the chromosomes that were commonly involved in rcpt were 2, 3, 9, 14, 15.
- Chromosomes and clinical conditions:

Chromosome 1 → BOH and FF,DS, MR/MCA.
Chromosome 2 → MR/MCA and MR with the same breakpoints in its short arms in a male and a female offsprings of paternal origin.
Chromosome 3 → MR/MCA with breakpoints in the short arms.
Chromosome 5→ MCA in two male offsprings of paternal origin with the same breakpoints in its short arms.
Chromosome 7 → BOH in a female and FF in a male offspring with the same breakpoints in its long arms of maternal origin and MCA.
Chromosome 8 → MCA with the same breakpoints of paternal origin in two male offsprings and BOH and MR/MCA with adjacent breakpoints in its short arms.
Chromosome 9→ MCA with same breakpoints in two female offsprings of maternal origin and MCA in two male offsprings with adjacent breakpoints in its short arms.
Chromosome 11 → BOH and MCA.
Chromosome 12 → BOH in a female and MCA in a male offspring with the same break points of maternal origin in its long arms.
Chromosome 15→ BOH and MR/MCA with breakpoints in its long arms and MCAs.
Chromosome 18→ MCA with same breakpoints in two male offsprings of paternal origin in its long arms.
Chromosome 21→ MR/MCA and MCA with the same breakpoints in its long arms in two male offsprings of maternal origin.

IV. Discussion

In literature, it is stated that in the Turkish population 52% of mothers seemed to be carriers for rcpt/ robt when compared to the fathers who were reported to be of 48% for rcpt and robt.[9] It could be interpreted that mothers as carriers have greater chance to carry the conceptions to term; whereas when fathers are carriers; the conception may not be carried to term. In the present study, it is 64% (27/42) mothers and 36% (15/42) fathers who are carriers for rcpt / robt which suggests mothers as carriers were of more percentage than fathers as carriers.

The risk of recurrence to have physical or mental handicaps is five to 30% and risk for miscarriage is 20 to 30% according to Carolyn[10] who has studied pedigrees of over 900 translocation families (The Genetics Center Inc). According to Karakus,[9] it is 56% to have recurrent miscarriage, 24% mental retardation, 16% infertility, 8% amenorrhea. In carriers with rcpt involving 17p, for male balanced translocation carriers only, the rate of abnormal offspring was 18/65 (28%), and the pregnancy loss rate was 19/65 (29%). For female carriers only, the rate of abnormal offspring was 13/49 (26%), while the rate of pregnancy loss was 9/49 (18%).[11]

In the present study, the risk to have MCA is 28.5% (12/42), DS 28.5% (12/42), BOH 24% 10/42), MR/MCA 10% (4/42), MR 5% (2/42), PA 2% (1/42) and FF 2% (1/42). In Turkish population, recurrent miscarriage is observed to be more than 50%, but in Indian population it is around 24%.

In the Turkish population, the most commonly involved chromosomes that participate to form balanced configurations were chromosomes 7;9 (6 times), 1; 4 (5 times), 13;17 (4 times), 2;3 (3 times).[9]

In the present study, the chromosomes which has commonly entered into balanced translocations is 1;15 (2 times), but leading to unbalanced configurations are 1;21 (2 times) and 5;8 (2 times).

Some experimental studies have been done on human embryos / sperms to show the meiotic segregation in carriers with robt / rcpt. The involvement of the non-acrocentric chromosomes or terminal breakpoints in male carriers with rcpt was associated with increase in percentage of embryos consistent with adjacent-1 segregation.[12] In the other two studies it was alternate segregation which was more dominant over adjacent-1 mode.[13,14] Alternate and adjacent-1 segregations were almost equal in male and female carriers; but, 5.7% of embryos from female translocation carriers had adjacent-2 segregation and 20% 3:1 segregation, in male carriers it was 20.5 and 4.5%.[13]

In the present study, maternal or paternal gametogenesis has led to more of adjacent-1 segregation (13, male-10, female-3) followed by alternate segregation (9, male-4, female-5). Whether in male or female offsprings, adjacent-1 segregation has resulted in MCA, MR/MCA and alternate segregation in BOH.

Robertsonian translocation: The association between MR and robt (13;14) in the female child could be co-incidental; since the genotype is in balanced status. The child with trisomy 21 along with robt (13;14) may be due to meiotic non-disjunction (ND) error of the chromosomes 21 and the alternate type of the meiotic mode of segregation for the t(13;14). The male child with t(21;21) is also due to the meiotic segregation error; because his father's gamete must have had the t(21;21) status.

Reciprocal translocations are known to be unique to a particular family and the risk of recurrence also increases for the relative having individual with particular translocation.[11]

In the present study, from table three, it is seen that, for serial number 18, the rcpt (13;14); serial numbers 20 and 21, the rcpt (5;8) and serial number 23, the rcpt (9;10) were familial and that too on the paternal side. One couple with rcpt for (1;15) were consanguineous.

In literature it is shown that balanced rcpt (76%) were more compared to unbalanced rcpts (24%).[15]

In the present study in the offsprings, unbalanced rcpts (65%) were more compared to balanced rcpts (35%). The balanced rcpts with alternate segregation has led to BOH and FF in the offsprings.

Parents with rcpt status have two normal and two translocated chromosomes. These four chromosomes during gametogenesis undergo meiotic segregations. The normal and its pair in spite of their translocation status may segregate into 3:1 or 2:2 chromosomes. The 2:2 segregations may segregate into normal or alternate or adjacent types of segregation. The adjacent type based on the homologous or the non-homologous nature of the chromosomes along with the centromeres may further segregate into sub types as adjacent I and II.

The point to be considered is the behavior of the chromosomes involved in rcpt in the carrier parents during meiosis i.e gametogenesis. The chromosomes can't pair normally even though they align with their homologues resulting in the meiotic segregation errors in the chromosomes. It could give rise to FF, BOH, MR, MCA, loss of pregnancy and chromosomal syndromes.

In the present study the types of the meiotic segregations that have occurred in the parents with rcpt were 3:1 in three (11.6%), alternate in nine (34.6%) and adjacent in 14 (53.8%). The maternal origin of the meiotic segregations were observed in 15 (58%) and the paternal origin in 11 (42%). The types of the meiotic segregations observed in the mothers were 3:1 in three, alternate in seven and adjacent in five; whereas in the fathers they were alternate in two and adjacent in nine.

The risk to give rise to an abnormal baby is between 1% and 10% and it depends on the sex of the carrier with the rcpt. In male, it could lead to spermatogenic arrest. The conceptions with the maternal origin of the chromosomal abnormality may have better survival in the intra uterine life.

In literature the BOH whether microscopic or submicroscopic, is associated to chromosomes 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 18, 20, 21, 22 and X;[16-21] MR and or MCA to 1, 2, 3, 4, 5, 6, 7, 8, 9,10, 11, 12, 13, 14, 15, 16, 17, 18, 21, 22, X and Y.[22-24] Nineteen is the only chromosome not involved in reciprocal translocations when observed in literature.

In the present study, almost all the chromosomes were involved except 19, X and Y. The maternal rcpt status was associated to BOH that too in their female offsprings and FF and 3:1 type of meiotic segregation. Maternal origin was associated to chromosome seven in BOH in a female and FF in a male offsprings with the same breakpoints in its long arms (7q11); chromosome nine in MCA with the same breakpoints in two female offsprings in long arms (9q22) and MCA in two male offsprings with adjacent breakpoints in its short arms (9p11, 9p13); chromosome 12 in BOH in a female and MCA in a male offspring with the same break points in its long arms (12q24); chromosome 15 in BOH in a male and a female offsprings with the breakpoints in its long arms (15q13, 15q24) and chromosome 21 in MR and MCA with the same breakpoints in its long arms in two male offsprings (21q22).

In the present study, the paternal rcpt status was associated to MR/MCA and adjacent-1 meiotic segregation in the male offsprings. Paternal origin was associated to chromosome two in MR/MCA and MR with the same breakpoints in its short arms in a female and a male offsprings (2p22); chromosome five in MCA in two male offsprings with the same breakpoints in its short arms (5p15); chromosome eight in MCA with the same breakpoints in long arms in two male offsprings (8q22); chromosome 18 in MCA with same breakpoints in two male offsprings in its long arms (18q21).

The clustering of the chromosomes as per the clinical conditions has shown chromosome one in four conditions (DS, BOH, FF, MR/MCA) and chromosome eight in three (BOH, MCA, MR/MCA); BOH to 15 in both the parents for the female offspring; MR/MCA to chromosome three in both the parents for the male offsprings; in MCA to chromosome nine in the maternal origin to both the female and the male offsprings and to five, eight, 18 to the paternal origin in the male offsprings.

Interpretation for RCPT:

From the tabulated observations given in table three, it may be proposed, that in the parents with rcpt during gametogenesis, the four chromosomes in the rcpt (two normal and two translocated) could undergo the adjacent-1, mainly AC subtype of meiotic segregation among the non-homologous chromosomes. This results in partial trisomy for the lower number chromosome and partial monosomy for the higher number chromosome irrespective of the sex in the offsprings who may manifest MR and or MCA. In case, the four chromosomes underwent the adjacent-1 BD subtype of meiotic segregation, then it could result in partial monosomy for the lower number chromosome and partial trisomy for the higher number chromosome and may be associated to MCA and the male sex in the offsprings in case of the paternal origin.

The alternate type of the meiotic segregation in the carrier parents especially in the maternal origin may be associated to BOH and the female sex in the offsprings. The 3:1 segregation may be associated to maternal origin and could result in DS/MR/MCA in the offprings irrespective of sex.

V. Conclusion

The present study reported the occurrence of the rcpt & robt in the parents. Among the total of 42 translocations, robt was detected in 16 and rcpt in 26. Twenty seven mothers were detected to have translocation; out of which Robt was in 12 and rcpt in 15. Twenty two male and 20 female offsprings were affected. The affected female children with maternal origin were 15; whereas it was ten male children with paternal origin. Out of the 15, seven childrens' mothers had robt and eight had rcpt. In the ten male children with paternal origin, two had robt and eight fathers had rcpt.

Robt has led to the clinical condition DS either in maternal or paternal origin, but also has given rise to MR, MCA, PA and BOH in one case each in maternal origin. In rcpt, the alternative mode of segregation which is more in maternal origin has led to BOH mainly in female offsprings; adjacent-1 segregation which is more in paternal origin has led to MCA in male offsprings and 3:1 segregation only in maternal origin has led to DS, MR/MCA and MCA.

This study should be taken up in large scale to hypothesize the relation between the mode of meiotic segregation, sex of offspring and its clinical condition.

Genetic counseling provided is on diagnosis, prognosis, medical management, risk of recurrence and support systems.

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