J. Life Science. (2001), 11(2), 81−82

JOURNAL OF
Life Science

Human RPS4X/Y Genes and Pseudogene Family: Chromosomal Localization and Phylogenetic Analysis

Ji-Won Lee, Joo-Mi Yi, Kyung-Mi Shin and Heui-Soo Kim†

Division of Biological Sciences, College of Natural Sciences, Pusan National University, Pusan 609-735, Korea

Received: July 14, 2001

Abstract The human ribosomal protein S4 genes, RPS4X and RPS4Y are located on the X and Y chromosomes. They have been postulated as candidate for Turner syndrome which was characterized by gonadal dysgenesis, short stature, and various external and internal anomalies. Using the BLAST search program, we identified sixteen RPS4 pseudogenes from the human genome and analyzed them phylogenetically. The RPS4-C12-1, C12-2, and C12-3 pseudogenes from chromosome 12 have been evolved independently during hominid evolution. The RPS4X gene from X chromosome is closely related to the RPS4-C12-2 from chromosome 12 and RPS4-C5 from chromosome 5, whereas the RPS4Y gene is very closely related to RPS4-C16 from chromosome 16. The exact mapping of the RPS4 pseudogene family was performed, indicating that the RPS4 pseudogene family was mapped on human chromosomes 1, 2, 5, 6, 8, 10, 11, 12, 13, 16, 18, 19 and 20. Taken together, the precise chromosomal localization and phylogenetic relationship of the RPS4 pseudogenes could be of great use in further study for understanding the Turner syndrome.

Key words: Chromosomal localization, phylogeny, RPS4 pseudogenes, Turner syndrome

Introduction

The human ribosomal protein S4 genes, RPS4X and RPS4Y are located on the X and Y chromosomes. They have been postulated as candidate for Turner syndrome [1]. The RPS4X and RPS4Y proteins differ at 19 of 263 amino acids. Both genes are widely transcribed in human tissues, suggesting that the ribosomes of human males and females are structurally distinct. Omoe and Endo [2] compared sequences of the X- and Y-linked RPS4 genes from several mammals and analysed them phylogenetically, indicating that these two loci diverged prior to the radiation of the placental mammals and evolved independently. Furthermore, the Y-linked homolog was absent in many species such as cat, dog, horse, pig, and cattle, members of which can show the monosomy X phenotype (Turner syndrome in humans). In our previous study, we cloned and sequenced the RPS4Y gene from testis cDNA library of the Japanese monkey [3]. This study was undertaken in an effort to analyze the phylogenetic relationship among RPS4 pseudogene family and their chromosomal localization in human genome.

†Corresponding author
Phone: 82-51-510-2259, Fax: 82-51-581-2962
E-mail: khs307@hyowon.cc.pusan.ac.kr

Materials and Methods

Nucleotide sequences of RPS4X/Y genes and their pseudogene family were retrieved from the GenBank database (http://www.ncbi.nlm.nih.gov/). The neighbor-joining phylogenetic analysis was performed with the MEGA program and PILEUP program from the GCG software (University of Wisconsin). The pairwise distance of the number of nucleotide substitutions was estimated using the method of Tajima and Nei [4]. The chromosomal localization was determined with the aid of BLAST network server (http://www.ncbi.nlm.nih.gov/BLAST/) [5].

Results and Discussion

Up to date, the localization of RPS4X (Xq13.1) and RPS4Y (Yp11.3) genes were analysed by *in situ* hybridisation [1]. Using the BLAST search program, we identified and analysed sixteen RPS4 pseudogenes from the human genome. The exact mapping of the RPS4 pseudogene family was performed, indicating that the RPS4 pseudogene family was mapped on human chromosomes 1, 2, 5, 6, 8, 10, 11, 12, 13, 16, 18, 19 and 20 (Fig. 1). Table 1 summarized the precise localization of the RPS4 pseudogene family. To our knowledge, this is the first time the RPS4 pseudogene family has been mapped. On chromosomes 12 and 19, three copies (RPS4-C12-1, C12-2, C12-3) and two copies (RPS4-C19-1, C19-2) are localized at different loci of the same chromosome, respectively. Erickson et al. [6] found a patient with Turner-like neonatal hydrops and an apparently balanced Y;16 translocation. This allow us speculate that the RPS4-C16 pseudogene from chromosome 16 (16q22.3) could be implicated

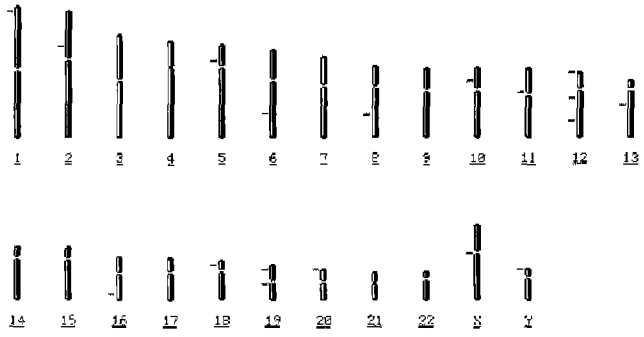

Fig. 1. Chromosomal localization of RPS4X/Y and their pseudogenes on human chromosomes.

Table 1. Chromosomal localization of RPS4 pseudogene family

RPS4 Genes	Accession No.	Site
1. RPS4-C1	NT_004610.2	1p36.13-1p36.21
2. RPS4-C2	NT_025648.1	2p13.3
3. RPS4-C5	NT_006636.2	5p13.2-5p13.3
4. RPS4-C6	NT_007513.2	6q22.32
5. RPS4-C8	NT_008036.2	8q22.1
6. RPS4-C10	NT_008609.2	10p11.23-10p12.1
7. RPS4-C11	NT_009267.2	11p11.11
8. RPS4-C12-1	NT_019542.2	12p13.33
9. RPS4-C12-2	NT_025861.1	12q23.1
10. RPS4-C12-3	NT_024437.1	12q13.13
11. RPS4-C13	NT_009799.2	13q14.11-13q14.12
12. RPS4-C16	NT_010422	16q22.3
13. RPS4-C18	NT_011024.2	18p11.22
14. RPS4-C19-1	NT_011164.2	19p13.3
15. RPS4-C19-2	NT_011240.2	19q12
16. RPS4-C20	NT_011424.2	20p13
17. RPS4X	M58458	Xq13.1
18. RPS4Y	M58459	Yp11.3

in the translocation between chromosomes.

In order to understand the evolutionary relationship within the RPS4 pseudogene family on human chromosomes, a phylogenetic tree was constructed by the neighbor-joining method using the nucleotide sequences of the pseudogenes. As shown in Fig. 2, the RPS4-C12-1 and RPS4-C13, RPS4-C12-2 and RPS4-C5, RPS4-C12-3 and RPS4-C19-2 showed the sister relationships, respectively. The data suggests that the RPS4-C12-1, C12-2, and C12-3 pseudogenes from chromosome 12 have been evolved independently during hominid evolution. The RPS4X gene from X chromosome is closely related to the RPS4-C12-2 from chromosome 12 and RPS4-C5 from chromosome 5, whereas the RPS4Y gene is very closely related to RPS4-C16 from chromosome 16. Compared with the RPS4 pseudogenes, the RPS4-C16 pseudogene and RPS4Y gene are more diverged than that of the others. Taken together, the precise chromosomal localization and phylogenetic relationship of the RPS4 pseudogenes could be of great use in further study for understanding the Turner syndrome. These tools of the BLAST and phylogeny were powerful for analysing the gene family in previous study [7].

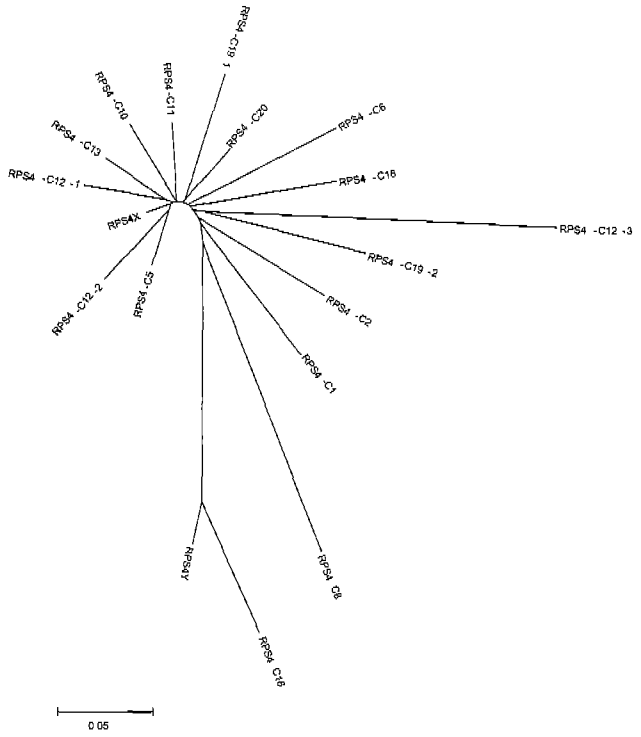

Fig. 2. Phylogenetic tree for the RPS4X/Y and pseudogene family on human chromosomes. Branch lengths are proportional to the distances between the taxa.

References

1. Fisher, E. M. C., P. Beer-Romero, L. G. Brown, A. Ridley, J. A. Mcneil, J. B. Lawrence, H. F. Willard, F. R. Bieber and D. C. Page. 1990. Homologous ribosomal protein genes on the human X and Y chromosomes: escape from X inactivation and possible implication for Turner syndrome. *Cell.* 63, 1205-1218.
2. Omoe, K. and A. Endo. 1996. Relationship between the monosomy X phenotype and Y-linked ribosomal protein S4 (Rps4) in several species of mammals: a molecular evolutionary analysis of Rps4 homologs. *Genomics.* 31, 44-50.
3. Kim, H.-S., T. Kageyama, and O. Takenaka. 2001. Molecular cloning and evolutionary analysis of the ribosomal protein S4 gene in the Japanese monkey. *Korean J. Genetics.* 23, 21-24.
4. Tajima, F. and N. Nei. 1984. Estimation of evolutionary distance between nucleotide sequences. *Mol. Biol. Evol.* 1, 269-285.
5. Altschul, S. F., T. L. Madden, A. A. Schäffer, J. Zhang, Z. Zhang, W. Miller and J. Lipman. 1997. Gapped BLAST and PSI-BLAST: a new generation of protein database search programs. *Nucleic Acids Res.* 25, 3389-3402.
6. Erickson, R. P., L. Hudgins, J. F. Stone, S. Schmidt, C. Wilke and T. W. Glover. 1995. A balanced Y;16 translocation associated with Turner-like neonatal lymphedema suggests the location of a potential anti-Turner gene on the Y chromosome. *Cytogenet. Cell Genet.* 71, 163-167.
7. Kim, H.-S. 2001. Human FGF gene family: chromosomal localization and phylogenetic analysis. *Cytogenet. Cell Genet.* 93, 131-132.