ABSTRACT
A five-year-old girl with global developmental delay and mild dysmorphic features was referred for karyotyping. Cytogenetic analysis identified an interstitial deletion in the approximate position of chromosome band 10q23.1. The patient’s DNA was analysed using an Affymetrix SNP6.0 array, and a 7.46Mbp deletion was detected within the region 10q22.3–q23.32. The deletion encompasses the BMPR1A gene, but does not extend as far as the phosphatase and tensin homolog (PTEN) locus. The location and extent of the deletion is the first of a small group of 10q deletion patients, which has been characterised at the level of resolution afforded by a SNP6.0 chip. Essentially, this case confirms that patients with microdeletions in the 10q23 region can be further divided into three sub-classes, depending on whether the deletion encompasses the BMPR1A gene, the PTEN gene or both.

Keywords: 10q22-23, BMPR1A, SNP array, juvenile polyposis

INTRODUCTION
There are many reports in the literature of interstitial deletions in the long arm of chromosome 10; however, studies that were supported with molecular analysis are rare. In the study reported here, a new patient was analysed by cytogenetic, fluorescence in situ hybridisation (FISH) and high-resolution oligonucleotide-based SNP6.0 array technology, which identified the location and extent of a deletion within 10q23.1 that supports the sub-classification of patients with interstitial microdeletions in chromosome 10.

CASE REPORT
A female baby weighing 5.1 kg was born by Caesarean section at 42 weeks after a normal pregnancy. A ventricular septal defect was diagnosed at six months of age, when she presented with poor weight gain and persistent tachypnoea, which was then surgically repaired. The patient’s early milestones were not significantly delayed, and she began walking a few months past her first birthday. Although the onset of speech was not delayed, it lacked fluency. She suffered from recurrent middle ear infections and required the insertion of tympanostomy tubes.

Due to persistent developmental delays, the child was assessed by a paediatrician at four years of age. A Griffith Mental Developmental assessment performed at 5.5 years of age demonstrated an overall functioning at the 4–4.5 year level. Specific scores were: locomotor skills 4–4.5 years; personal-social skills 5 years ± 3 months; hearing
and language skills 4–4.5 years; performance skills 4–4.5 years; and practical reasoning 4.5–5 years. She exhibited normal growth; at five years of age, her height and weight were at the 97th percentile, her head circumference at the 90th percentile, and the corrected midparental height was at the 50th percentile.

A right-sided exotropia was managed successfully by eye patching. Rectal bleeding was never observed by the child’s parents, and there was no family history of rectal bleeding or intestinal polyps. When assessed at the genetics clinic, no significant dysmorphic findings were noted. She had mild epicanthic folds and hyperkeratosis of the fifth toenail. The patient’s karyotype was found to be 46, XX, del(10)(q23.1q23.2) (Fig. 1). The parental karyotypes were normal, and therefore, she carried a de novo deletion. To investigate the presence of the tumour suppressor gene phosphatase and tensin homolog (PTEN), the loss of which is involved in several cancers,
FISH was undertaken using the locus specific probe (i.e. PTEN). Two copies of the PTEN region (89,613,175bp-89,718,512bp) were detected (Fig. 2); further testing was thus initiated in order to define the precise breakpoint and to identify genes that were present within the deleted region.

Chromosomal DNA was extracted from blood collected in EDTA using a Qiagen Midi Kit (Qiagen Pty Ltd, Valencia, CA, USA). DNA was processed for hybridisation to an Affymetrix® SNP6.0 chip according to the manufacturer’s instructions (Affymetrix Inc, Santa Clara, CA, USA). The subsequently scanned slide was analysed using Genome Console (version 3.1) software. The SNP6.0 array analysis identified a heterozygous 7.46Mbp deletion on chromosome 10q, with breakpoints located at 81,634060bp and 89,068,181bp. Fig. 3 shows the deleted region of chromosome 10 and the genes it contains (Human March 2006 (hg18) assembly; available at: http://genome.ucsc.edu/). This deletion removes several genes that are central to cognitive, behavioural development and cell proliferation, of which the BMPR1A gene is the most notable gene involved.

DISCUSSION

In recent years, the interstitial deletion of chromosome 10q22-23 has become a well-documented deletion associated with several syndromes, such as Cowden syndrome, Bannayan-Riley-Ruvalcaba (BRR) syndrome and juvenile polyposis syndrome (JPS). The clinical phenotypes observed in individuals carrying deletions in chromosome 10q23 are variable. Some of these differences may be explained by differences in the extent of the deletions, but there is no strict correlation between the location and extent of a deletion and the clinical phenotype (Fig. 4).

The 10q23 region harbours genes that are important for neurodevelopment and function. NRG3 is a candidate gene for schizophrenia, and GRID1 is associated with schizophrenia and schizoaffective disorders. Several genes in the 10q23 region (NRG3, GRID1, BMPR1A, SNCG, GLUD1) are of importance to neurobehavioural development and function. Interestingly, mutations in the BMPR1A gene are found in 20% of patients with JPS. These mutations comprise point mutations as well as exonic and whole gene deletions. Patients with JPS develop gastrointestinal polyps by 20 years of age which, if not treated, will bleed and cause anaemia. Our patient had not undergone an endoscopy as she remained asymptomatic; thus, we could not justify the procedure. In view of this, and of her young age, the possibility of JPS could not be ruled out.

The location and extent of the deletion detected in our patient, as well as the symptoms of mild developmental delay and mild dysmorphism, are very similar to those reported for patients with UM10qDel-01 and JHU10qDel-01. Critically, other patients with deletions in this region were deleted for both the PTEN and BMPRIA genes. These patients presented with juvenile polyps and macrocephaly, features which are characteristic of Cowden disease or BRR syndrome. Balciuniene et al proposed that the complex set of low-copy repeats (LCRs) in the 10q23 region increases susceptibility to chromosomal rearrangements. The deletion in the proband has breakpoints that lie in the LCR3 and LCR4 domains (Fig. 3), which suggests that the deletion occurred as a consequence of non-allelic homologous recombination.

In conclusion, this study confirms the subclassification of patients with microdeletions in the 10q23 region but with mild early-onset symptoms, into those that are deleted for the BMPRIA gene alone, as opposed to those with deletions that lie more distal and encompass the PTEN gene, and those with deletions that encompass both genes. The data supports the role of segmental duplications in deletion events, as well as the view that array-based analysis of patients with interstitial deletions in 10q23 will allow for improved patient management and counselling.

ACKNOWLEDGEMENTS

We acknowledge the assistance of Liam Williams from the School of Biological Sciences, The University of Auckland, for his technical assistance in achieving the microarray data for the patient described here. We also acknowledge the financial support of the School of Biological Sciences, The University of Auckland, for a grant-in-aid for this work.
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