Review Article

Paternity Testing

Onoja A. M.
Department of Haematology & Blood Transfusion, Jos University Teaching Hospital. Jos, Nigeria

ABSTRACT
Molecular diagnostic techniques have found application in virtually all areas of medicine**,** including criminal investigations and forensic analysis. The techniques have become so precise that it is now possible to conclusively determine paternity using DNA from grand parents, cousins, or even saliva left on a discarded cigarette butt. This is a broad overview of paternity testing.

KEYWORDS: Paternity testing, Blood group typing, DNA testing, PCR, RFLP.

INTRODUCTION

Paternity testing, otherwise known as parentage testing is not a new concept but has evolved over time with advancing technology. It has made paternity fraud more and more difficult. Paternity fraud is a charge made when a woman falsely accused a man of fathering her child to get child support or some financial benefits [1,2].

Before surrogate motherhood became possible, the woman who gave birth to a child was obviously that child's gestational, genetic, and legal mother. A few circumstances in which the biological mother of a child may be unclear include cases of an adopted child who wish to reunify with his or her biological mother, potential hospital mix-ups, and in-vitro fertilization in which the scientist may have implanted an unrelated embryo inside the mother. In vast majority of cases, maternity determination is not much of a problem [1,2,3].

Paternity questions unfortunately, are not so easy to answer. For years, these have presented a significant challenge to scientists and potential parents. There are situations in which demands for concrete, scientific evidence of parentage are made. A request for paternity testing may be by the physician or a court order when proof of paternity is required; immigration authorities; government child support agencies or welfare benefits offices [1,3.]

Paternity testing can generate legally admissible results that can be used for child support, inheritance, social welfare benefits, immigration, or for adoption.
Adapted individuals can now have direct means to confirm their biological identity or to find their birth parents. Parentage testing is often an essential tool in proving immigration status in cases of family reunification.

DEFINITION

Paternity testing is the use of genetic fingerprinting to determine whether two individuals have a biological parent-child relationship. It establishes a genetic proof as to whether or not; a man is the true biological father of the individual. Though the genetic testing is the most reliable, older methods include the ABO blood group typing, analysis of proteins and red cell enzymes, and use of human leukocyte antigens [1,2,3,4].

THE EVOLUTION OF PATERNITY TESTING TECHNIQUES

The techniques have evolved and progressively improved over the past several decades. This has expanded the application of the various testing methods with increased accuracy of results.

THE BLOOD GROUP ANTIGEN

Before DNA analysis, the blood group antigens were the most commonly used. This is based on the way blood types are passed from generation to generation. This test is more useful for disproving than proving paternity. It is done by analyzing the blood types of the parents and the child based on the fact that some blood types, like genes, are dominant and others are recessive. The blood group antigen systems of greatest value are the ABO, Rh, MNSs, Kell, Duffy, and Kidd. These antigens are on the blood cell membranes and are coded for by genes[2,3,4].

ABO blood typing: A and B antigens are located on the red cell membrane, and the genes are on chromosome 9. This was established in the 1920s with about 30% power of exclusion [2,5]

The A and B are co-dominant while the O is recessive. If a person's blood group is A, it means the person either inherited two A alleles or one A allele and one O allele. If the a person has blood group B, it means the person inherited either two B alleles or one B allele and one O allele and if the blood group is AB, it means he or she inherited one A allele and one B allele.

In a dispute, the ABO group can be used to exclude a man from being a child's father. For example, a man whose blood is AB would only pass on either the A or the B allele to all his offspring, and so could not father a child whose blood group is O. A child with a blood group antigen that is not inherited from the mother and is not present in a man named as the putative father cannot be his child. It is usually possible to exclude a falsely accused man, but it cannot be proven that a particular man is the father [3,5].

Rh, MNSs, Kell, Duffy, and Kidd: In the course of time, addition of blood antigens like Rh, MNSs, Kell, Duffy, and Kidd refined the use of blood antigen typing for paternity and other forensic testing. The accuracy of these combined however, still remains at only 40% in

Correspondence: Onoja A. Michael, Department of Haematology & Blood Transfusion, Jos University Teaching Hospital. Jos, Nigeria; 08160669376; doctoronoja@yahoo.com

ruling out a potential father [4,5].

Human Leukocyte Antigens: The introduction of HLAs into the array of these blood group antigens in the 1970s has increased the exclusion rate to 80% [2,6]. The HLAs are proteins found in most cells of the body (except red blood cells). White cells contain the most amounts of these proteins. The HLA types can be shared with close relatives, which explain why those who need organ transplants like kidney or bone marrow have to find a donor with the same or closely similar HLA type, usually a close relative. This sharing makes it rather difficult to rule out a father if he has two or more brothers with the same HLA type. It cannot differentiate between related alleged fathers.

The effectiveness of HLA typing in paternity determination depends on how rare an alleged father's HLA type is in the population. Thus, HLA typing can not guarantee a conclusive result.

ELECTROPHORESIS OF BIOCHEMICAL MARKERS

This was introduced in the 80s, where proteins from a person's blood or tissues are placed in a gel such as potato starch, agarose or polyacrylamide and electric current were run through the gel and different forms or isozymes of the proteins were separated by their electrical charge and or size. Differences in isozymes relates to differences in the genes that code for these proteins. Thus, the presence of certain identical isozymes in samples from both a child and his or her potential father could be used to reveal the existence of a genetic relationship between the two individuals. Suggestions are that genetic testing via electrophoresis had advanced to such that it might be used to confirm paternity rather than merely exclude a man as a child's father [1,7].

THE DNA TESTING

The process of DNA fingerprinting was developed by Alec Jeffreys a professor of genetics at the University of Leicester, in 1984, and it first became available for paternity testing in 1988 [8,9].

DNA testing is currently the most advanced and accurate technology to determine parentage. Today, with the advent of numerous DNA sequencing, amplification and testing techniques, paternity testing has evolved even further than predicted.

The DNA of an individual is almost exactly the same in all somatic cells. Sexual reproduction brings the DNA of both parents together randomly to create a unique combination of genetic material in a new cell. The genetic material of an individual is therefore derived from the genetic material of both parents in roughly equal amounts.

This genetic material is known as the nuclear genome of the individual, because it is found in the nucleus. Comparing the DNA sequence of two individuals can show whether one of them was derived from the other [1,8,9]

Specific sequences are usually analyzed to see whether one individual's genomes were copied exactly to the other individual's genomes. If that was the case, then the genetic material of one individual could have been derived from that of the other, that is, one is the parent of the other.

Apart from the nuclear DNA in the nucleus, the mitochondria in the cells also have their own genetic material called the mitochondrial DNA or genome. The mitochondrial DNA comes only from the mother. Comparing the mitochondrial DNA in order to establish a relationship is much easier than the use of nuclear genome. Mitochondrial genome however can only prove that two persons are related by common descent through maternal lines from a common ancestor, it cannot be used to prove paternity.

The male counterpart of mitochondrial DNA is the Y chromosome. Paternity of a male child can be tested by comparing the Y chromosome since it is passed directly from father to son [1,8,9].

DNA testing has now advanced to a stage where cheek cells alone can be used. The inside of a cheek is swabbed with a cotton bud to obtain the sample for DNA analysis [10]. With the availability of DNA test kit, samples can even be taken at home, without pain or discomfort and results ready in just a few days of testing. Samples from hair, clothing and cigarette butt are also DNA sources [1,10].

Indeed, present day genetic testing has an accuracy rate of up to 99.99% (9,999 out of 10,000) [1,10]. Thus, DNA-based forms of paternity testing have taken over earlier methods. Better sensitivity and automation have allowed DNA testing to be performed on ever-smaller and sometimes degraded DNA samples with greater speed and excellent accuracy.

DNA testing is based on comparism of two strands of DNA from two people. It generally utilizes one of two possible tests; restriction fragment length polymorphism (RFLP), or polymerase chain reaction (PCR) [1,5,7,10].

DNA TESTING VIA RFLP

In RFLP test which came in the 1980s, DNA is cut into specific fragments using restriction enzymes. These fragments are then sorted by size using a special gel with an electric charge at one end. The longer fragments are sorted out of the tube because they do not move through the gel as fast as the short fragments. The shorter fragments are compared for similarities in their patterns. The child's DNA fragments match half of the mother's and half of the father's. RFLP testing was found to be rather tedious and result takes longer time. However, the accuracy was placed at 99.99% [1,5,10,11].

DNA TESTING VIA PCR

This was established in the 1990s [3,4,11]. The PCR test uses a DNA polymerase to replicate a portion of DNA many

times over. This creates an amplified section of DNA for analysis. Scientists select a limited section which allows them to develop a genetic fingerprint for an individual. The result takes shorter time and as little as a tiny drop of blood is sufficient to make many DNA copies. DNA testing via PCR is the fastest, most accurate method for paternity determination [1,5,11].

The availability of DNA testing services is growing world-wide, and there seems to be growing demands even in Nigeria for paternity testing services. Unfortunately, in Nigeria there seems to be no law on the accreditation of paternity testing laboratories [8,12]. Accreditation is the only assurance of the legitimacy and the reliability of the individual's paternity test.
The few paternity testing laboratories and hospitals in Abuja and Lagos, serve as collection centers and partner hospitals for accredited laboratories in the U.K and the U.S [10,11,12].

Accrediting agencies in the U.S among others include: The American Association of Blood banks (AABB); Forensic Quality Services-ISO 17025; The New York State Department of Health and The College of American Pathologist [13].

The AABB, for example, among other things, conducts on-site inspections of the laboratories and ensures that every accredited laboratory follows accepted procedures and performs at least the minimum required level of testing [13].

The ISO 17025 Paternity Testing Corporation provides international accreditation for paternity and forensic testing. This serves paternity testing for individuals residing outside United States. This Forensic Quality Services Company also performs regular on-site inspections on the accredited laboratories [13].

In Nigeria, the industry is still unregulated, and the Direct-to-Consumer testing (DTC) is the practice. DTC is one in which DNA samples are collected and sent to the laboratory by the individuals themselves, using test kits available from stores [14].

The danger here is that without any regulation or accrediting agencies to oversee these tests in the laboratories that perform them, the laboratories need not adhere to any industry standards for quality assurance.

If samples are not collected under strict, verifiable identification chain-of-custody, the test results will not be legally defensible and the parties will have no legal recourse against the laboratories, in an event of error.

To satisfy the chain-of-custody's legal requirements, all tested parties must be properly identified and their specimens collected by a third party professional who is not related to any of the tested parties and has no interest in the outcome of the test.

CONCLUSION: Paternity, otherwise called parentage testing, remains largely inaccessible by the ordinary Nigerians despite the seeming growing demands (though undocumented), even in the setting of increasing PCR proliferations in many of our centers. At the moment, for those who could access and afford, the process is still largely on the Direct-To-Consumer (DTC) bases, which is not legally defensible.

There is an urgent need for the necessary legal and regulatory structures in place, including advocacy and skilled manpower training. This would reposition us for the challenges not only of parentage testing, but would enable us tap from the fall out of this emerging DNA technology. It will impact on our research industries and man power; medical forensics; criminal profiling and investigations, not only for convicting the guilty but also for exonerating the innocent.

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