J Community Health (2015) 40:103–109
DOI 10.1007/s10900-014-9942-7

ORIGINAL PAPER

Clinical Manifestations of Waardenburg Syndrome in a Male Adolescent in Mali, West Africa

Pascal James Imperato · Gavin H. Imperato

Published online: 16 September 2014

Abstract Waardenburg syndrome (WS) is a genetic disorder of which there are four distinct types. These four types are differentiated by the physical defects which they produce. Presented here is the case of a 13-year-old boy with WS Type I who was observed and physically assessed in Mali, West Africa in 1969. His physical findings included a bright blue coloring to the irises of the eyes, profound sensorineural deafness, mutism, dystopia canthorum (lateral displacement of the inner canthi of the eyes), broad nasal root, bushy eyebrows, and scaphoid deformities of the supraorbital portions of the frontal bone. Because family members were not available for interviews or physical examinations, it was not possible to determine if this patient was suffering from a congenital form of the disorder or from a spontaneous mutation. Given the patient's then location in a remote rural area of Mali where electricity was absent, it was not possible to perform additional diagnostic tests. The patient described here is the first with WS in Mali, West Africa to have been medically observed and evaluated and later documented in the medical literature. A second case of the syndrome in Mali was described in the medical literature in 2011 in an 18-month-old infant who did not have sensorineural hearing loss, but who did have a bilateral cleft lip. An historical overview of WS is presented along with details concerning the characteristics of the four types of the disorder.

P. J. Imperato (✉)
School of Public Health, Downstate Medical Center, State University of New York, MSC 43, 450 Clarkson Avenue, Brooklyn, NY 11203, USA
e-mail: pascal.imperato@downstate.edu

G. H. Imperato
Department of Medicine, Penn State Milton S. Hershey Medical Center, 500 University Drive, Hershey, PA 17033, USA

Keywords Waardenburg syndrome · Waardenburg syndrome in Mali · Waardenburg syndrome in Africa

Introduction

In 1947, Petrus J. Waardenburg [1], a Dutch ophthalmologist, presented the case of a man who was both deaf and mute, and who had "dystopia punctorum lacrimarum, blepharaophimosis, and partial iris atrophy". The patient also had blue eyes and was bald. As Reed and Newton have described in great detail, Waardenburg was prompted to undertake a comprehensive study of 1,050 patients in five institutions for the deaf after Klein in Geneva showed him a 10-year-old girl with severe auditory-pigmentary defects and dystopia canthorum (lateral displacement of the inner corner of the eye) [2]. This research led to Waardenburg's landmark paper on a syndrome that would eventually carry his name [3]. Read and Newton have provided a comprehensive overview of the history of the subsequent scientific elaboration of this syndrome, its overall incidence, and the genetic basis for the four types currently recognized.[1]

In essence, Waardenburg syndrome (WS) is an auditory-pigmentary disorder which is the result of the absence of melanocytes from key anatomical structures including the eyes, skin, hair, or the stria vascularis of the cochlea. However, other abnormalities may also be present such as musculo-skeletal defects which can include hypoplasia of limb muscles, contractures, bilateral cutaneous syndactyly, aplasia of the ribs, and congenital upward displacement of the shoulder blade (Sprengel shoulder) [4, 5]. The last listed is not unique to WS and can be associated with other

[1] Read and Newton [2, pp. 660–663].

Table 1 Features of the various types of Waardenburg Syndrome

Type	Features
Type WS I	1. Non-progressive sensori-congenital neural hearing loss 2. Lateral displacement of the inner corners of the eyes (dystopia canthorum) 3. Blue eyes 4. Broad nasal root 5. Bushy eyebrows (may join in the midline) 6. Pigmentary differences in the iris of the eye 7. Hirsute and hypo-pigmented skin 8. White forelock or premature graying of the hair
Type WS II	All the features of Type I may be present except dystopia canthorum
Type WS III (also known as Klein–Waardenburg syndrome)	1. Features similar to Type I but with hypoplasia of the muscles 2. Sprengel shoulder 3. Cutaneous syndactyly 4. Contractures of muscles of elbow and fingers
Type WS IV (also known as Shah–Waardenburg syndrome)	All the features of Type II plus Hirschsprung's disease

conditions. In Type IV of WS, Hirschsprung's disease is also present (Table 1).[2]

The principal characteristics of the currently recognized four types of WS are presented in Table 1. It is important to note, however, that hearing loss may or may not be present in cases categorized in any of the four types. Dystopia canthorum is absent in Types II and IV, and Hirschsprung's disease is present in Type IV.[3]

The categorization of WS into four types came about because of the observations of other medical scientists. In 1971, Arias pointed out Type I patients who did not present with dystopia canthorum. He categorized such patients as belonging to a separate type, which he named Type II [6]. Similarly, in 1983, Klein, who had originally presented his 10-year-old patient to Waardenburg in 1948, acknowledged, based on reports of other patients with her features, that his patient was affected by a variant of Type I [7]. This variant is often referred to as Klein–Waardenburg syndrome, or Type III.

The Waardenburg Consortium has proposed criteria for the diagnosis of WS Type I. An individual must have two major criteria or one major and two minor criteria to meet the diagnostic standard. Thus, a given individual may be considered affected by Type I, even if other major or minor criteria are not met, provided that the above diagnostic standard is met. This means then that not all the possible major and minor criteria need be present in a given individual for the diagnosis to be made. The five major criteria are: congenital sensorineural hearing loss, hypopigmentation of the hair or a white forelock, pigmentation abnormality of the iris (often resulting in blue eyes), dystopia canthorum, and an affected first-degree relative. The five minor criteria are: skin hypopigmentation, medial eyebrow flare, broad or high nasal root or prominent columella, hypoplastic alae nasi, and premature gray hair below the age of 30 years [8]. Thus, an individual does not need to have all of the signs described in the major and minor criteria, but only a combination of two major ones or one major criterion along with two minor ones. Therefore, there is obvious clinical variability between cases.[4]

Prevalence of Waardenburg Syndrome

Waardenburg himself concluded that the prevalence of the disorder was 1/42,000 of the general population. Fraser found the prevalence to be 2.12 to 3.01/100,000 among 2,355 deaf school children. He estimated the prevalence to be 1.44 to 2.05/100,000 in the general population [9]. The frequency of WS Type I and Type II is about the same [10]. Waardenburg estimated the mutation rate as 0.4/100,000 gametes.[5]

In 1981, Shah et al. [11] described a dozen infants in Bombay with Hirschsprung's disease, white forelocks, and white eyelashes. It was not possible to test the hearing of these children because they died in the neonatal period. This syndrome, which incorporates the features of WS Type II and Hirschsprung's disease was eventually termed Shah–WS Type IV.[6]

Genetics of the Waardenburg Syndrome

WS Types I, II and III have an autosomal dominant mode of inheritance. Thus, there is a 50 % possibility of a child of an affected parent developing the syndrome. WS Type IV, on the other hand, is inherited in an autosomal recessive manner. Thus, a child of an affected parent has a 25 % possibility of developing the syndrome. All four types of

[2] Read and Newton [2, p. 657].

[3] Kiani et al. [4, p. 55].

[4] Reynolds et al. [5, pp. 541–544].

[5] Waardenburg [3, p. 237].

[6] Read and Newton [2, pp. 656–657].

WS may result from de novo mutations in a child whose parents are not affected by the syndrome.[7]

A number of studies have demonstrated that WS Type I and Type II are found in individuals with several mutations in the *PAX3* gene which is situated on chromosome band 2q35 [12].[8] The *PAX3* gene is of importance in activating *MITF* (microphthalmia-associated transcription factor). *MITF* in turn is associated with the activation of the tyrosinase gene. This gene plays a role in the differentiation of melanocytes.[9]

Complicating matters is the fact that mutations in other genes have been demonstrated to be involved in WS Type II. These include the *MITF* gene itself, the *SNA12* gene, and the *SLUG* gene [13–15]. With regard to WS Type IV, there are two possible genes involved, Endothelin-3 (*EDN3*) or Endothelin-B receptor (EDNRB) [16]. Of interest is the fact that the heterozygous mutation of either of these genes results in Hirschsprung's disease only, while the homozygous mutation causes WS Type IV [17]. Pignault et al. [18] reported that mutation of the *SOX10* gene can be present in individuals with WS Type IV.

Intellectual and Psychiatric Issues

Two obvious questions arise concerning patients with various types of WS. These are whether or not they are intellectually disabled and whether or not they suffer from psychiatric illnesses. It is obvious that perceived intellectual disability could be related to the fact that many patients with WS are profoundly deaf. Smith et al. [19] found that WS did not cause intellectual disability. On the other hand, de Saxe et al. [20] studied 11 Afrikaner families with 52 individuals, and reported developmental delays and poor performance in school among those with WS I and II. Interestingly, they also found that the earliest known family member with WS Type 1 was born in 1842, and that the syndrome had persisted for 12 generations [21]. Kawabata et al. [22] described a young teenage boy with WS who had severe mental and motor retardation and other abnormalities. Pasteris et al. [23] reported on a patient with WS with microcephaly, mental retardation, and skeletal abnormalities.

Unfortunately, these isolated reports contain insufficient numbers of individuals to permit cause and effect conclusions. Those who are deaf and mute are at obvious disadvantages in terms of intellectual development unless provided with special interventions. The reports of mental and motor retardation as well as a variety of other abnormalities are isolated in nature, and could be simply coincidental. However, recently, Kiani et al. described a possible association between WS Type III and autistic spectrum disorder, aggressive behavior, and intellectual disability in two adult patients. The authors wisely conclude that it is uncertain that WS was directly causal for autistic spectrum disorder in these patients. They also conclude that it is not certain if the autistic spectrum disorder was in some way facilitated by intellectual disability and hearing impairment. The report of Kiani et al. is very valuable as it alerts others to the possible association of WS with these other disorders.[10]

Background to the Discovery of a Case of Waardenburg Syndrome in Rural Mali

In March 1969, one of us (PJI) traveled into southwestern Mali to assess the outcomes of mobile teams of vaccinators. These teams were administering smallpox, measles, and yellow fever vaccines in the context of a Smallpox Eradication and Measles Control Program funded by the United States Agency for International Development, and staffed with medical and technical personnel from the Communicable Disease Center, now known as the Center for Disease Control and Prevention (CDC) of the United States Public Health Service [24].

Through methodical and collaborative planning with Malian health authorities, the population of the entire country was vaccinated by June of 1970 following initial vaccination efforts in early 1967. This entailed not only the mass vaccination of the population, but also the investigation of outbreaks and their rapid control [25].

To assure the success of the program, advance planning had to take place before each dry season, October through June, when mobile health services were feasible. This temporal feasibility was not only determined by the facts that roads and tracks were passable, but also because people were generally at home in their villages during the dry season. During the rainy season, July through September, roads and tracks were often impassable, and most farmers are away on their fields cultivating cereal crops.

Objective measures of the program's success included greatly improved disease surveillance and reporting, the rapid implementation of outbreak control measures, assuring a high level of vaccination coverage, and the objective evaluation of the efficacy of the smallpox vaccine. Levels of population coverage were determined in the field not only by reports detailing the number of people vaccinated, but also by objective evaluation of the

[7] Kiani et al. [4, p. 54], Read and Newton [2, pp. 660–663], Farrer et al. [8, pp. 903–908].

[8] Kiani et al. [4, p. 54], Read and Newton [2, pp. 660–661].

[9] Kiani et al. [4, p. 54].

[10] Kiani et al. [4, pp. 55–61].

frequency of skin reactions to the smallpox vaccine. This latter outcome also served as a means of assuring the viability of the vaccine and the integrity of the chain of refrigeration that was crucial to vaccine efficacy (Fig. 1) [26].

The Cercle (district) of Yanfolila is situated in the southwestern corner of Mali, only accessible at that time by a rough laterite track. During our visit to the village of Yanfolila, the cercle headquarters, one of us (PJI) and Mark D. LaPointe, the program's operations officer, met with the Control Team. This mobile team was comprised of a driver, a male nurse, and assistants. Their responsibility was to assure acceptable outcomes with the field operations as outlined above (Fig. 2).

While meeting with them, the leader of the team, N'Tyi Traoré, a male nurse from the adjacent Cercle of Bougouni,

Fig. 1 The track to the town of Yanfolila, Mali (Photograph by Pascal James Imperato)

Fig. 2 Control Team members and local health workers in the town of Yanfolila. *Left to right* Zahn Sabaké Traoré (driver, partially hidden), unknown, N'Tyi Traoré (infirmier), Yacouba Koita (vaccinator), unknown, Pascal James Imperato, Cheick Tawaty (driver), and Karim Sidibe (apprentice) (Photograph by Mark D. LaPointe)

Fig. 3 The village of Banankoro with its mud brick mosque (*center*) (Photograph by Pascal James Imperato)

Fig. 4 Young girl with classical chickenpox, village of Banankoro, Arrondissement of Kéleya, Cercle of Bougouni, Mali, 1969 (Photograph by Pascal James Imperato)

stated that there was a possible outbreak of smallpox in the village of Banankoro. Banankoro was a small village in the Cercle of Bougouni, and more specifically in the Arrondissement (sub-district) of Kéleya. This possible outbreak of smallpox had been reported to N'Tyi Traoré by one of our vaccination teams that was then administrating vaccines in the Cercle of Bougouni.

The report of a possible outbreak of smallpox in this area, which was then being actively vaccinated by eight teams of vaccinators, was serious and alarming. We knew that it had to be investigated immediately. As a result, we curtailed our stay in Yanfolila and set off for the remote village of Banankoro. En route, we passed through the village of Kéleya where we stopped and were shown a child with obvious chickenpox. This somewhat relieved

our anxiety about the case in Banankoro possibly being one of smallpox (Fig. 3).

After arriving in Banankoro, we were shown a young girl who was suspected of having smallpox. However, on close clinical examination, it was clear to us that she was suffering from chickenpox based on the centripetal distribution of the rash, its having appeared in crops, and the physical character of the lesions (Fig. 4).

Soon after examining her, some adults in the village asked me if I might have medicines to treat a young boy who was about 13 years of age. They further stated that he could neither hear nor speak. We told them to bring the boy to us, which they eventually did.

Case Report

The village of Bamankoro is inhabited by Bamana people. The largest ethnic group in Mali, they are subsistence agriculturists who also keep herds of livestock. They once adhered to a body of religious and philosophical beliefs and a lifestyle which they themselves refer to as *Bamanaya*. The Bamana possess a number of initiation associations collectively referred to as *dyow*, and villages are organized as patriarchal, patrilineal, patrilocal, and polygamous societies. There is a strong belief in supernatural causation of disease and infirmity, which remains strong even as the population has progressively embraced Islam. Syncretic beliefs and practices are common, and vary in degree between different families, villages, and regions. Secrecy is highly valued in Bamana society, and inculcated in young children as a virtue as they are sequentially inducted into a hierarchy of initiation societies. There is a strong belief that secrets (*goundow*) associated with these societies and other issues should be carefully guarded.

The patient was a young male of about 13 years of age. On meeting him, one was immediately struck by several physical characteristics of his face. Prominent among these were striking blue eyes and lateral displacement of the inner corners of the eyes (dystopia canthorum). The nasal root was broad and the eyebrows somewhat bushy. There were slight skeletal abnormalities of the frontal bone with prominent scaphoiding above the left supraorbital ridge. There was also a forward bulging of the upper portion of the frontal bone, more prominent on the left than on the right (Fig. 5).

The patient was profoundly deaf. To test this, loud noises were made behind him, to which he did not respond. He was unable to speak words, but was able to utter guttural sounds. He appropriately responded to physical cues such as those indicating that he move his arms and hands in a certain way. A summary physical examination did not reveal any other apparent abnormalities. His gait and musculoskeletal system did not grossly appear abnormal except for the frontal bone abnormalities noted above (Fig. 6).

Fig. 5 Young boy with Waardenburg Syndrome Type I, Village of Banankoro, Arrondissement of Kéleya, Cercle of Bougouni, Mali, 1969 (Photograph by Pascal James Imperato)

Fig. 6 Close-up of a young boy with Waardenburg Syndrome Type I. He had brilliant blue eyes, bushy eyebrows, a broad nasal root, dystopia canthorum, scaphoiding above the left supraorbital ridge, profound deafness, and mutism (Photograph by Pascal James Imperato)

Informants considered that he was mentally impaired. However, this assessment could not be taken at face value because his deaf mutism greatly limited his ability not only to communicate, but also to socially function in a manner that was normative for the society in which he lived. Neither the boy's parents nor other close relatives were available for either questioning or examination. Thus, it was not possible to directly determine if other members of the patient's immediate family were also suffering from the syndrome. However, informants stated that the patient was the only one who had blue eyes and was deaf and mute.

At the time that this young boy was examined, it was concluded that he was suffering from a genetic syndrome

with which we were not familiar. Being in a remote rural area of Mali where there was no electricity and no running water, it would not have been possible to conduct the types of sophisticated examinations and testing now routinely performed for the diagnosis of WS. It was only several years later, after returning to the United States, that one of us (PJI) became familiar with WS by serendipitously coming across an article describing it in a medical journal.

Discussion

Waardenburg syndrome has now been reported from many different parts of the world. A thorough search of PubMed in August 2014 produced 856 articles that have been published about the syndrome in the peer-reviewed scientific literature. Up until that same date, 27 reports have been published on cases in Africa, including one from Mali [27]. At the time that the currently reported case was observed in 1969, only 68 reports of the syndrome had appeared in the scientific medical literature. The first case in Africa was reported in 1962 in an 11-year-old male African child in South Africa [28].

The case of WS presented here fits the criteria for WS Type I. This conclusion is based on the physical findings and history. It was not possible at that time to conduct the kind of exhaustive family history that would have elucidated whether the patient had the inherited form of the syndrome or one deriving from spontaneous mutation.

The patient described by Traoré et al. in Mali in 2011, was an 18-month-old child. This child had bilateral blue eyes, dystopia canthorum, and a bilateral cleft lip. The child had no hearing loss, no musculoskeletal defects, and no congenital Hirschsprung's disease. Because of the lack of resources, more advanced diagnostic testing was not undertaken. However, based on the clinical findings, the child had WS Type I. The cleft lip was surgically repaired, with an excellent result.[11]

As far as is known, the case of WS Type I presented here appears to be the first observed and reported in Mali. The reporting of this case comes some 45 years after the patient was observed and examined. While this represents a long time period, the importance of documenting this case is obvious for a syndrome that is relatively rare. It should also be recalled that Klein published his conclusion in 1983 that the WS patient he had observed in 1948 and presented to Waardenburg the same year was in effect suffering from WS Type III. Thus, Klein's conclusion concerning this patient was published 35 years after he had first observed her in Geneva, Switzerland.[12]

[11] Traoré et al. [27, pp. 54–55].

[12] Klein [7, pp. 231–239].

Waardenburg syndrome is overall a rare syndrome either due to inheritance or spontaneous mutation. The patient presented here is the second known case in Mali to be described in the scientific medical literature, and the first to have been medically examined and later reported. Unfortunately, no clinical follow-up of this patient was possible. Also, it was not possible to determine if other members of his family were affected by the syndrome. A scientific investigation of the patient and his family might still be possible.

Acknowledgments Special thanks are extended to Mark LaPointe, who participated in this inquiry, and to N'Tyi Traoré, Zahan Sabaké Traoré, Yacouba Koita, Karim Sidibé, and the Malian public health staff, who provided valuable assistance.

References

1. Waardenburg, P. J. (1940). Dystopia punitorum lachrimasum, belpharophimosis, and partial iris atrophy in a mute. *Dutch Journal of Medicine, 92*(43), 3463–3465.
2. Read, A. P., & Newton, V. E. (1997). Waardenburg syndrome. *Journal of Medical Genetics, 34*(8), 656–665.
3. Waardenburg, P. J. (1951). A new syndrome combining developmental anomalies of the eyelids, eyebrows, and nose root with pigmentary defects of the iris, head hair and with congenital deafness. *The American Journal of Human Genetics, 3*(3), 195–253.
4. Kiani, R., Gangadharen, S. K., & Miller, H. (2007). Case report. Association of Waardenburg syndrome with intellectual disability, autistic spectrum disorder and unprovoked aggressive outbursts: A behavioral phenotype. *The British Journal of Developmental Disabilities, 53*(104), 53–62.
5. Reynolds, J. E., Meyer, J. M., Landa, B., Stevens, C. A., Arnos, K. S., et al. (1995). Analysis of variability of clinical manifestations in Waardenburg Syndrome. *American Journal of Medical Genetics, 57*(4), 540–547.
6. Arias, S. (1971). Genetic heterogeneity in the Waardenburg syndrome. *Birth Defects, 7*(4), 87–101.
7. Klein, D. (1983). Historical background and evidence for dominant inheritance of the Klein–Waardenburg syndrome (type III). *American Journal of American Genetics, 14*(2), 231–239.
8. Farrer, L. A., Grundfast, K. M., Amos, J., Arnos, K. S., Asher, J. H, Jr, et al. (1992). Waardenburg syndrome (WS) type I is caused by defects at multiple loci, one of which is near ALPP on chromosome 2: First report of the WS consortium. *American Journal of Human Genetics, 59*(5), 902–913.
9. Fraser, G. R. (1976). *The causes of profound deafness in childhood*. Baltimore: Johns Hopkins University Press.
10. Liu, X. Z., Newton, V. E., & Read, A. P. (1995). Waardenburg syndrome type II: Phenotypic findings and diagnostic criteria. *American Journal of Medical Genetics, 55*(1), 95–100.
11. Shah, K. N., Dalal, S. J., Sheth, P. N., Joshi, N. C., & Ambani, L. M. (1981). White forelock, pigmentary disorder of the irides and long segment Hirschsprung disease: Possible variant of Waardenburg syndrome. *Journal of Pediatrics, 99*(3), 432–435.
12. Watanabe, A., Takeda, K., Ploplis, B., & Tachibana, M. (1998). Epistatic relationship between Waardenburg syndrome genes MITF and PAX3. *Nature Genetics, 18*(3), 283–286.
13. Jones, K. L. (1997). *Smith's recognizable patterns of human malformation* (pp. 248–249). Philadelphia: WB Saunders Co.

14. Firth, H. V., & Hurst, J. A. (2005). Severe deafness in early childhood. *Oxford desk reference: Clinical genetics* (pp. 91–92). Oxford: Oxford University Press.
15. Cryns, K., & van Camp, G. (2004). Deafness genes and their diagnostic applications. *Audiology and Neurotology, 9*(1), 2–15.
16. Edery, P., Attie, T., Amiel, J., Pelet, A., Eng, C., et al. (1996). Mutation of the endothelin-3 gene in the Waardenburg–Hirschsprung disease (Shah–Waardenburg syndrome). *Nature Genetics, 12*(4), 442–444.
17. Schwartz, R. A., Jozwiak, S., Bason, L., & Krantz, I. (2006). Waardenburg syndrome. Retrieved July 15, 2014 from http://www.emedicine.com/ped/topic2422htm.
18. Pignault, V., Bondurand, N., Kuhlbrodt, K., Goerich, D. E., Préhu, M. O., et al. (1998). SOX10 mutations in patients with Waardenburg–Hirschsprung disease. *Nature Genetics, 18*(2), 171–173.
19. Smith, S., Klodziej, P., & Olney, A. H. (1998). Waardenburg syndrome. *Ear, Nose, and Throat Journal, 77*(4), 257–258.
20. de Saxe, M., Kromberg, J. G., & Jenkins, T. (1984). Waardenburg syndrome in South Africa. Part I. An evaluation of the clinical findings in 11 families. *South African Medical Journal, 66*(7), 256–261.
21. de Saxe, M., Kromberg, J. G., & Jenkins, T. (1984). Waardenburg syndrome in South Africa. Part II. Is there founder effect for type 1? *South African Medical Journal, 66*(8), 291–293.
22. Kawabata, E., Ohba, N., Nakamura, A., Izumo, S., & Osame, S. (1987). Waardenburg syndrome: A variant with neurological impairment. *Ophthalmic Paediatric Genetics, 8*(3), 165–170.
23. Pasteris, N. G., Trask, B. J., Sheldon, S., & Gorski, J. L. (1993). Discordant phenotype of two overlapping deletions involving the PAX3 gene in chromosome 2q35. *Human Molecular Genetics, 2*(7), 953–959.
24. Ogden, H. G. (1987). *CDC and the smallpox crusade*. Atlanta, Georgia: U.S. Department of Health and Human Services. Public Health Service. Centers for Disease Control. HHS Publication No. (CDC) 87-8400.
25. Imperato, P. J. (1975). *A wind in Africa. A story of modern medicine in Mali*. St. Louis, MO: Warren H. Green Inc.
26. Imperato, P. J. (1996). Smallpox and measles in Mali: Contrasting control strategies and outcomes. *Caduceus, 12*(1), 61–72.
27. Traoré, H., Traoré, D., Ouane, O., Simpara, B., & Ongoiba, N. (2011). A case of Waardenburg syndrome with cleft lip. *Mali Médical, 26*(3), 53–55.
28. Scott, F. P., & van Beukering, J. A. (1962). The Waardenburg syndrome. Report of an abortive case. *South African Medical Journal, 36*, 299–300.