Waardenburg syndrome

Waardenburg syndrome is a group of genetic conditions that can cause hearing loss and changes in coloring (pigmentation) of the hair, skin, and eyes. Although most people with Waardenburg syndrome have normal hearing, moderate to profound hearing loss can occur in one or both ears. The hearing loss is present from birth (congenital). People with this condition often have very pale blue eyes or different colored eyes, such as one blue eye and one brown eye. Sometimes one eye has segments of two different colors. Distinctive hair coloring (such as a patch of white hair or hair that prematurely turns gray) is another common sign of the condition. The features of Waardenburg syndrome vary among affected individuals, even among people in the same family.

There are four recognized types of Waardenburg syndrome, which are distinguished by their physical characteristics and sometimes by their genetic cause. Types I and II have very similar features, although people with type I almost always have eyes that appear widely spaced and people with type II do not. In addition, hearing loss occurs more often in people with type II than in those with type I. Type III (sometimes called Klein-Waardenburg syndrome) includes abnormalities of the arms and hands in addition to hearing loss and changes in pigmentation. Type IV (also known as Waardenburg-Shah syndrome) has signs and symptoms of both Waardenburg syndrome and Hirschsprung disease, an intestinal disorder that causes severe constipation or blockage of the intestine.

Frequency

Waardenburg syndrome affects an estimated 1 in 40,000 people. It accounts for 2 to 5 percent of all cases of congenital hearing loss. Types I and II are the most common forms of Waardenburg syndrome, while types III and IV are rare.

Causes

Mutations in the \textit{EDN3, EDNRB, MITF, PAX3, SNAI2, and SOX10} genes can cause Waardenburg syndrome. These genes are involved in the formation and development of several types of cells, including pigment-producing cells called melanocytes. Melanocytes make a pigment called melanin, which contributes to skin, hair, and eye color and plays an essential role in the normal function of the inner ear. Mutations in any of these genes disrupt the normal development of melanocytes, leading to abnormal pigmentation of the skin, hair, and eyes and problems with hearing.

Waardenburg syndrome types I and III are caused by mutations in the \textit{PAX3} gene. Mutations in the \textit{MITF} or \textit{SNAI2} gene can cause Waardenburg syndrome type II.
Mutations in the *SOX10*, *EDN3*, or *EDNRB* gene can cause Waardenburg syndrome type IV. In addition to melanocyte development, these genes are important for the development of nerve cells in the large intestine. Mutations in one of these genes result in hearing loss, changes in pigmentation, and intestinal problems related to Hirschsprung disease.

In some cases, the genetic cause of Waardenburg syndrome has not been identified.

### Inheritance Pattern

Waardenburg syndrome is usually inherited in an autosomal dominant pattern, which means one copy of the altered gene in each cell is sufficient to cause the disorder. In most cases, an affected person has one parent with the condition. A small percentage of cases result from new mutations in the gene; these cases occur in people with no history of the disorder in their family.

Some cases of Waardenburg syndrome type II and type IV appear to have an autosomal recessive pattern of inheritance, which means both copies of the gene in each cell have mutations. Most often, the parents of an individual with an autosomal recessive condition each carry one copy of the mutated gene, but do not show signs and symptoms of the condition.

### Other Names for This Condition

- Waardenburg's syndrome

### Diagnosis & Management

#### Formal Diagnostic Criteria

- ACT Sheet: Congenital hearing loss >~30db  
  https://www.ncbi.nlm.nih.gov/books/NBK55827/bin/Hearing_Loss.pdf

#### Genetic Testing Information

- What is genetic testing?  
  /primer/testing/genetictesting
- Genetic Testing Registry: Waardenburg syndrome type 1  
  https://www.ncbi.nlm.nih.gov/gtr/conditions/C1847800/
- Genetic Testing Registry: Waardenburg syndrome type 2A  
  https://www.ncbi.nlm.nih.gov/gtr/conditions/C1860339/
- Genetic Testing Registry: Waardenburg syndrome type 2B  
  https://www.ncbi.nlm.nih.gov/gtr/conditions/C1838447/
- Genetic Testing Registry: Waardenburg syndrome type 2C  
  https://www.ncbi.nlm.nih.gov/gtr/conditions/C1847722/
- Genetic Testing Registry: Waardenburg syndrome type 2D  
  https://www.ncbi.nlm.nih.gov/gtr/conditions/C1837203/
• Genetic Testing Registry: Waardenburg syndrome type 2E
  https://www.ncbi.nlm.nih.gov/gtr/conditions/C2700405/
• Genetic Testing Registry: Waardenburg syndrome type 4A
  https://www.ncbi.nlm.nih.gov/gtr/conditions/C1848519/
• Genetic Testing Registry: Waardenburg syndrome type 4B
  https://www.ncbi.nlm.nih.gov/gtr/conditions/C2750457/
• Genetic Testing Registry: Waardenburg syndrome type 4C
  https://www.ncbi.nlm.nih.gov/gtr/conditions/C2750452/

Research Studies from ClinicalTrials.gov
• ClinicalTrials.gov
  https://clinicaltrials.gov/ct2/results?cond=%22waardenburg+syndrome%22

Other Diagnosis and Management Resources
• GeneReview: Waardenburg Syndrome Type I
  https://www.ncbi.nlm.nih.gov/books/NBK1531
• MedlinePlus Encyclopedia: Waardenburg Syndrome
  https://medlineplus.gov/ency/article/001428.htm

Additional Information & Resources

Health Information from MedlinePlus
• Encyclopedia: Waardenburg Syndrome
  https://medlineplus.gov/ency/article/001428.htm
• Health Topic: Hearing Disorders and Deafness
  https://medlineplus.gov/hearingdisordersanddeafness.html
• Health Topic: Skin Pigmentation Disorders
  https://medlineplus.gov/skinpigmentationdisorders.html

Genetic and Rare Diseases Information Center
• Waardenburg syndrome
  https://rarediseases.info.nih.gov/diseases/5525/waardenburg-syndrome
• Waardenburg syndrome type 1
  https://rarediseases.info.nih.gov/diseases/5519/waardenburg-syndrome-type-1
• Waardenburg syndrome type 2
  https://rarediseases.info.nih.gov/diseases/5520/waardenburg-syndrome-type-2
• Waardenburg syndrome type 3
  https://rarediseases.info.nih.gov/diseases/5523/waardenburg-syndrome-type-3
• Waardenburg syndrome type 4
  https://rarediseases.info.nih.gov/diseases/5524/waardenburg-syndrome-type-4
Educational Resources

- MalaCards: waardenburg syndrome, type 1
  https://www.malacards.org/card/waardenburg_syndrome_type_1
- Orphanet: Waardenburg-Shah syndrome
  https://www.orpha.net/consor/cgi-bin/OC_Exp.php?Lng=EN&Expert=897
- Orphanet: Waardenburg syndrome
  https://www.orpha.net/consor/cgi-bin/OC_Exp.php?Lng=EN&Expert=3440
- Orphanet: Waardenburg syndrome type 1
  https://www.orpha.net/consor/cgi-bin/OC_Exp.php?Lng=EN&Expert=894
- Orphanet: Waardenburg syndrome type 2
  https://www.orpha.net/consor/cgi-bin/OC_Exp.php?Lng=EN&Expert=895
- Orphanet: Waardenburg syndrome type 3
  https://www.orpha.net/consor/cgi-bin/OC_Exp.php?Lng=EN&Expert=896

Patient Support and Advocacy Resources

- American Society for Deaf Children
  https://deafchildren.org/
- National Organization for Rare Disorders (NORD)
  https://rarediseases.org/rare-diseases/waardenburg-syndrome/
- Resource list from the University of Kansas Medical Center: Hard-of-Hearing/Deafness
  http://www.kumc.edu/gec/support/hearing.html

Clinical Information from GeneReviews

- Waardenburg Syndrome Type I
  https://www.ncbi.nlm.nih.gov/books/NBK1531

Scientific Articles on PubMed

- PubMed
  https://www.ncbi.nlm.nih.gov/pubmed?term=%28Waardenburg's+Syndrome%5BMAJR%5D%29+AND+%28Waardenburg%5BTIAB%5D%29+AND+english%5Bla%5D+AND+human%5Bmh%5D+AND+%22last+1800+days%22%5Bdp%5D

Catalog of Genes and Diseases from OMIM

- WAARDENBURG SYNDROME, TYPE 1
  http://omim.org/entry/193500
- WAARDENBURG SYNDROME, TYPE 2A
  http://omim.org/entry/193510
• WAARDENBURG SYNDROME, TYPE 2B  
http://omim.org/entry/600193

• WAARDENBURG SYNDROME, TYPE 2C  
http://omim.org/entry/606662

• WAARDENBURG SYNDROME, TYPE 2D  
http://omim.org/entry/608890

• WAARDENBURG SYNDROME, TYPE 2E  
http://omim.org/entry/611584

• WAARDENBURG SYNDROME, TYPE 3  
http://omim.org/entry/148820

• WAARDENBURG SYNDROME, TYPE 4A  
http://omim.org/entry/277580

• WAARDENBURG SYNDROME, TYPE 4B  
http://omim.org/entry/613265

• WAARDENBURG SYNDROME, TYPE 4C  
http://omim.org/entry/613266

Medical Genetics Database from MedGen

• Waardenburg syndrome  
https://www.ncbi.nlm.nih.gov/medgen/473809

• Waardenburg syndrome type 1  
https://www.ncbi.nlm.nih.gov/medgen/376211

• Waardenburg syndrome type 2  
https://www.ncbi.nlm.nih.gov/medgen/398443

• Waardenburg syndrome type 2A  
https://www.ncbi.nlm.nih.gov/medgen/349786

• Waardenburg syndrome type 2B  
https://www.ncbi.nlm.nih.gov/medgen/373973

• Waardenburg syndrome type 2C  
https://www.ncbi.nlm.nih.gov/medgen/335755

• Waardenburg syndrome type 2D  
https://www.ncbi.nlm.nih.gov/medgen/323102

• Waardenburg syndrome type 2E  
https://www.ncbi.nlm.nih.gov/medgen/398476
• Waardenburg syndrome type 4A
  https://www.ncbi.nlm.nih.gov/medgen/341244

• Waardenburg syndrome type 4B
  https://www.ncbi.nlm.nih.gov/medgen/412961

Sources for This Summary

- Milunsky JM. Waardenburg Syndrome Type I. 2001 Jul 30 [updated 2017 May 4]. In: Pagon RA, Adam MP, Ardingher HH, Wallace SE, Amemiya A, Bean LJH, Bird TD, Ledbetter N, Mefford HC, Smith RJH, Stephens K, editors. GeneReviews® [Internet]. Seattle (WA): University of Washington, Seattle; 1993-2017. Available from http://www.ncbi.nlm.nih.gov/books/NBK1531/
  Citation on PubMed: https://www.ncbi.nlm.nih.gov/pubmed/20301703

- Nayak CS, Isaacson G. Worldwide distribution of Waardenburg syndrome. Ann Otol Rhinol Laryngol. 2003 Sep;112(9 Pt 1):817-20. Review.
  Citation on PubMed: https://www.ncbi.nlm.nih.gov/pubmed/14535568

- Newton VE. Clinical features of the Waardenburg syndromes. Adv Otorhinolaryngol. 2002;61:201-8. Review.
  Citation on PubMed: https://www.ncbi.nlm.nih.gov/pubmed/12408085

- Pardono E, van Bever Y, van den Ende J, Havrenne PC, Iughetti P, Maestrelli SR, Costa F O, Richieri-Costa A, Frota-Pessoa O, Otto PA. Waardenburg syndrome: clinical differentiation between types I and II. Am J Med Genet A. 2003 Mar 15;117A(3):223-35.
  Citation on PubMed: https://www.ncbi.nlm.nih.gov/pubmed/12599185

- Pingault V, Ente D, Dastot-Le Moal F, Goossens M, Marlin S, Bondurand N. Review and update of mutations causing Waardenburg syndrome. Hum Mutat. 2010 Apr;31(4):391-406. doi: 10.1002/humu.21211. Review.
  Citation on PubMed: https://www.ncbi.nlm.nih.gov/pubmed/20127975

- Zaman A, Capper R, Baddoo W. Waardenburg syndrome: more common than you think! Clin Otolaryngol. 2015 Feb;40(1):44-8. doi: 10.1111/coa.12312.
  Citation on PubMed: https://www.ncbi.nlm.nih.gov/pubmed/25200653

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