

# Greene Vardiman Black and his contribution to dentistry

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## Abstract

Greene Vardiman Black (1836–1915) is widely regarded as the “father of modern dentistry” for his fundamental role in transforming dentistry from an empirical craft into a scientifically based clinical discipline. Through the integration of research, clinical practice, and education, he established principles that continue to influence contemporary dental science.

Black developed the first widely accepted classification of carious lesions, providing a standardized system for diagnosis and treatment planning based on anatomical location. He also formulated the principles of cavity preparation, including resistance form, retention form, convenience form, caries removal, margin finishing, and cavity cleansing, thereby linking biological understanding with mechanical design. His concept of “extension for prevention” shaped operative dentistry for decades.

In dental materials science, Black conducted pioneering studies on dental amalgam, demonstrating the relationship between alloy composition and clinical performance and introducing the concept of a balanced amalgam. His investigations of dental caries emphasized the interaction of microorganisms, diet, and tooth susceptibility, contributing to the development of modern concepts of caries etiology.

Beyond his scientific achievements, Black authored influential textbooks that standardized dental education and promoted a systematic approach to clinical practice. His work also contributed to the understanding of fluorosis, oral pathology, and the development of dental instruments and research methods.

Although some of his concepts have been modified by modern minimally invasive and adhesive approaches, Black’s contributions established the scientific foundations of dentistry. His legacy continues to shape dental education, research, and clinical practice worldwide.

**Keywords:** Greene Vardiman Black, operative dentistry, dental caries, dental amalgam, cavity preparation, history of dentistry.

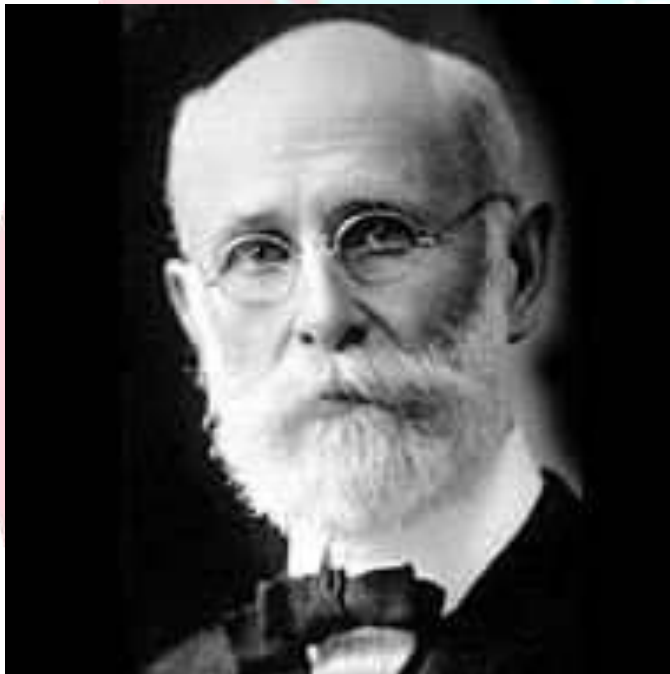
## Introduction

Greene Vardiman Black is one of the most significant figures in the history of dental medicine. Often referred to as the “father of modern dentistry,” he played a leading role in transforming dental practice from a craft into a scientifically grounded medical discipline. His research, methods,

and classifications laid the foundations of modern scientific dental practice and continue to be used today [1,2].

Before his work, dental treatment was often unsystematic, with limited understanding of the etiology of diseases and without standardized therapeutic approaches. Black changed this by integrating scientific research, clinical experience, and educational reforms [3].

### Biographical data



Greene Vardiman Black was born on August 3, 1836, near Winchester, Illinois, USA, into a farming family. He spent his childhood in a rural environment, where he developed a strong interest in nature—plants, animals, and natural phenomena. As a child, he showed little interest in formal education, preferring instead to observe the natural world. This curiosity later became the foundation of his scientific approach. At the age of 17, he began studying medicine under the guidance of his brother, Dr. Thomas Black [4]. This training provided him with fundamental knowledge of anatomy and physiology, which later proved extremely valuable for his development as a dentist. His military experience during the Civil War contributed to the development of his

discipline, observational skills, and analytical thinking [5].

In 1857, Black met Dr. J. C. Speer, who introduced him to dentistry. At that time, dentistry was considered part of medicine but was far from being a fully developed science. He believed that dentistry should be regarded as a profession independent from medicine, yet equal in status. He underwent a 20-month dental apprenticeship, which was standard at the time. After a short period of apprenticeship, he opened his own practice in Winchester. He began teaching at the College of Dentistry at the University of Iowa in 1890, before later moving to Chicago. During this period, he developed as a professional—he not only practiced dentistry but also actively studied and experimented, which distinguished him from most dentists of his time. In Jacksonville, Black began systematic research in the field of dentistry. He did not limit himself to clinical practice but instead sought to understand the underlying scientific principles of disease and treatment.

He later became a faculty member at the University of Iowa and eventually served as professor and dean. As an educator, he had a major influence on the training of future dentists, introducing a scientific approach and standardization in dental education. His career is an example of the combination of clinical practice, scientific thinking, and educational activity [6].

## Main Scientific Contributions

### Classification of Carious Lesions

Greene Black introduced the first widely accepted and systematically organized classification of carious lesions in the late 19th century, which—despite modifications—remains fundamental to operative dentistry today. The main purpose of this system is to standardize diagnosis and treatment planning through a clear division of caries based on their anatomical location on tooth surfaces [1]. The classification initially included five main classes, with a sixth added later. It is based not on the etiology of the disease but on the location of the lesion, which makes it highly practical for clinical use [1,3].

Black's classification has not only diagnostic but also therapeutic value. It determines the form of cavity preparation, the choice of restorative material, the approach to retention and resistance, and the amount of tissue removal. In this way, it directly links diagnosis with treatment, which is a key concept in operative dentistry [3].

This classification represents the first attempt at a universal language in dentistry. It allows different specialists to communicate clearly and consistently regarding the location and treatment of carious lesions [1]. Today, although modern diagnostic systems and minimally invasive approaches exist, Black's classification remains a core part of dental education and clinical terminology. It is used as a foundational structure upon which modern concepts of adhesive and preventive dentistry are built [3].

### Principles of Cavity Preparation

The principles of cavity preparation formulated by Greene Black in the late 19th and early 20th centuries represent a fundamental system in operative dentistry. Their goal is to ensure predictability, mechanical stability, and long-term durability of restorations in the treatment of carious teeth. Although modern dentistry now incorporates minimally invasive and adhesive approaches, Black's core logic remains essential for clinical decision-making [1,7].

The main principles of cavity preparation are as follows:

#### 1. Resistance form

This principle requires the cavity to be shaped so that the remaining tooth structure can withstand masticatory forces without fracture. Black emphasized proper cavity geometry, including flat pulpal floors, sufficient wall thickness, and avoidance of sharp internal angles. This reduces stress concentration and prevents structural damage [1].

#### 2. Retention form

Retention aims to prevent displacement of the restoration from the cavity. In Black's era, when adhesive materials did not exist, mechanical retention was the only reliable stabilization method. This was achieved through converging walls, retention grooves, and undercuts, as well as specific cavity shapes. This principle is especially important for amalgam restorations [1,7].

### 3. Convenience form (access and visibility)

Black emphasized that the cavity should be sufficiently open to allow good visualization, easy access for instruments, and complete removal of carious tissue. This improves treatment quality and reduces the risk of residual caries [7].

### 4. Removal of carious dentin

A fundamental biological principle stating that all infected and necrotic tissue must be removed. Black viewed caries as a progressive process that cannot be stopped without mechanically eliminating affected structures [1].

### 5. Finishing of enamel margins

Cavity margins must be shaped to ensure tight contact with the restorative material, minimal risk of fracture, and proper adaptation. This principle is critical for preventing marginal microleakage [7].

### 6. Cavity cleansing and preparation

Before restoration placement, the cavity must be thoroughly cleaned and disinfected, including removal of tissue debris, drying, and surface preparation. Black emphasized the importance of a clean working field for treatment success [1].

These principles directly influence restoration longevity, the incidence of secondary caries, mechanical resistance of the tooth, and overall clinical outcomes. They represent the first systematic approach in operative dentistry, integrating biology, mechanics, and clinical technique [7].

## Dental Materials

Greene Black was among the first researchers to transform dental amalgam from an empirically used material into an object of systematic scientific investigation. In the late 19th century, amalgam was widely used in dentistry but without a standardized formulation, leading to unpredictable clinical outcomes such as fractures, expansion, microleakage, and secondary caries. In this context, Black began a series of experiments aimed at clarifying the relationship between alloy composition and clinical behavior [1].

Black's main contribution was the introduction of strictly controlled comparative studies in which he varied the proportions of silver, tin, copper, and mercury and observed their effects on the physical properties of the material. He analyzed hardness, wear resistance, thermal expansion, and behavior under masticatory load. These experiments clearly demonstrated that even small compositional changes could lead to significant clinical differences [7].

As a result, Black formulated the concept of a "balanced amalgam," in which the ratio of metals was optimized to achieve maximum stability and minimal undesirable changes after placement. He paid particular attention to controlling volumetric changes, since excessive expansion could lead to postoperative pain and structural damage to teeth [1,7].

Another important aspect of his work was the study of amalgam adaptation to cavity walls. Black demonstrated that restoration success depends not only on material properties but also on cavity geometry. Proper cavity design significantly improves retention and reduces the risk of microleakage [1].

He investigated corrosion. Although considered undesirable today, Black observed that in certain cases corrosion products could contribute to a “self-sealing” effect, reducing microscopic gaps between amalgam and tooth structure [3].

The significance of this work goes beyond the material itself. Black’s research established dental materials science as a discipline based on experimentation, measurement, and reproducibility. He introduced the idea that clinical success depends not only on operator technique but also on scientifically validated material properties [3,7].

### **Etiology and Pathogenesis of Caries**

The understanding of dental caries as a disease underwent significant development in the late 19th century, with Black being one of the key figures in this process. His observations and clinical studies contributed to the formation of an early systematic concept of caries etiology and pathogenesis based on the interaction of biological, chemical, and mechanical factors [1,3].

Black recognized the interaction between microbial activity, dietary factors and tooth susceptibility, anticipating later multifactorial models of dental caries. His work emphasizes the interaction of three main groups of factors: microorganisms, diet, and tooth structure [1].

Black recognized that microorganisms in the oral cavity play a central role in the destruction of dental tissues. Although bacteriology was still in its early stages at the time, he clearly linked the presence of plaque and carbohydrate fermentation to the onset of the carious process [3].

Significant attention was given to diet, particularly carbohydrates. Black observed that frequent consumption of sugars and sticky foods increases caries risk, as they retain acidic products on the tooth surface [1].

The third factor involves anatomical characteristics of teeth, such as deep fissures, narrow interproximal spaces, and weak enamel. These features create conditions for plaque retention and lesion development [3].

### **Dental Anatomy**

Greene Black’s research in the field of dental anatomy is of substantial importance for the development of dentistry as a scientific discipline. In his work *\*Dental Anatomy\** (1890), he presents a systematic description of tooth morphology, establishing the foundation for the relationship between form, function, and clinical application [8].

Black analyzed the anatomical features of different groups of teeth and emphasized the importance of individual variation for diagnosis and treatment. He paid particular attention to high-risk areas for caries, such as fissures and interproximal spaces, which favor plaque retention.

A particularly important contribution was his connection between anatomy and operative dentistry. He emphasized that cavity preparation should be adapted to the natural morphology of the tooth in order to preserve healthy tissue and ensure restoration durability.

His work contributed to the standardization of dental education by introducing an anatomically oriented approach to clinical thinking. Despite modern technological advances, the importance of dental anatomy remains fundamental for successful dental practice.

## Textbooks and Scientific Works

Greene Black left a lasting impact on dental science not only through his clinical and experimental research, but also through the textbooks he wrote in the late 19th and early 20th centuries, which long served as the foundation of dental education. His works represent the first systematic attempt to organize dentistry as a scientifically structured discipline in which theory, anatomy, and clinical practice are clearly interconnected.

In 1883, he prepared his first book, *\*The Formation of Poisons by Microorganisms\**. He was the first to propose that all life, including microorganisms, produces harmful waste products and that these are largely responsible for disease, including dental caries [9].

Another important work is *\*Dental Anatomy\** (1890), which played a key role in teaching dental morphology in the late 19th century. In this book, Black described dental anatomy and its functional characteristics in detail, establishing a foundation for linking form and function in dentistry. Between 1890 and 1900, this textbook was widely used in dental colleges in the United States, including institutions such as Northwestern University Dental School, where Black taught. He also published *\*The Periosteum and Peridental Membrane\** (1887), which examines the supporting structures of the teeth and represents one of the first systematic studies of periodontal tissues. This work appeared at a time when periodontology was not yet an established specialty and contributed to its later development.

His most significant work is *\*Operative Dentistry\** (1908), published in two volumes. It quickly became the primary textbook in dental schools in the United States and Europe in the early 20th century. In it, Black described treatment techniques and developed a comprehensive system of thinking in operative dentistry. The book is structured to guide the reader from pathology to diagnosis and then to clinical methods, which was a novel approach in medical education around 1900–1910.

Importantly, Black presented his ideas on cavity preparation, which he had developed since the 1880s and systematized between 1905 and 1908. He did not regard treatment as a purely mechanical procedure but as the result of a biological and mechanical understanding of tooth structure.

The importance of Black's textbooks increased between 1880 and 1910, when dentistry in the United States underwent academic institutionalization. His books became a standard part of curricula at universities such as the University of Iowa College of Dentistry, where he worked in the late 19th century.

Modern analysis shows that although some clinical approaches in his works became outdated after 1950 with the development of adhesive dentistry, their structural contribution remains highly significant. His textbooks introduced a teaching model based on logic, anatomy, and cause-and-effect relationships, which still underpins dental education today.

Black investigated fluorosis with McKay and made two crucial discoveries. They showed that mottled enamel resulted from developmental defects in children's teeth. This meant that individuals whose permanent teeth had already calcified without staining would not develop discoloration, while children awaiting eruption of their permanent teeth were at high risk. They also found that teeth affected by Colorado Brown Stain were surprisingly resistant to decay. McKay

hypothesized that a substance in the water supply might be responsible, but Black remained skeptical [10].

Black developed methods for testing material hardness, standardization of instruments, and improving the durability of restorations. He patented and refined several dental instruments, including a mechanical dental drill, a gnathodynamometer for measuring bite force, microtomes, and other scientific devices. He was among the first dental practitioners to use nitrous oxide as an anesthetic. He studied oral diseases, the effects of acidic and alkaline environments on teeth, prepared microscopic specimens, and investigated the cohesive properties of gold foil and its physicochemical behavior [11]. These innovations significantly improved treatment efficiency and accuracy.



**Statue of G.V. Black in Lincoln Park, Chicago, erected in 1918**

Black's contribution is so significant that the development of dentistry is often divided into three periods:

1. Before Black – empirical practice without a scientific basis
2. During Black – introduction of scientific principles
3. After Black – development based on his foundations

His statue can be found in the southern end of Lincoln Park in Chicago, on North Avenue. He is part of the International Hall of Fame of Dentistry of the Pierre Fauchard Academy.

## Discussion

Greene Vardiman Black played a pivotal role in transforming dentistry from an empirical craft into a scientifically grounded discipline. His contributions are distinguished not only by specific clinical and experimental results but also by the creation of a conceptual framework that integrates caries etiology, operative principles, dental materials, and educational structure. In doing so, Black established the foundation for integrated clinical thinking that continues to influence dentistry today.

A central aspect of his work is the systematic use of observation and experimentation as the basis for clinical decision-making. His approach to dental amalgam and caries demonstrates an early form of the scientific method in dentistry, where clinical observations are translated into standardized principles. This model marked the beginning of a shift toward more objective and reproducible medical practice, although still limited by the technological constraints of his time.

An important contribution of Black was the introduction of standardization in diagnosis and treatment. The classification of carious lesions and the principles of cavity preparation established a universal language and methodological framework for clinical communication and treatment planning. However, these systems were strongly influenced by the mechanistic understanding of disease typical of the late 19th century and do not fully reflect the modern view of caries as a dynamic biological process with potential for remineralization and non-invasive management.

In the modern context, a significant evolution of his principles can be observed. The concept of “extension for prevention,” although historically justified, has been replaced by minimally invasive approaches that prioritize preservation of healthy tooth structure and biological disease control. Similarly, mechanical retention, which formed the basis of classical cavity preparation techniques, has largely been replaced by adhesive systems enabling more conservative and biomimetic restorations.

Despite these limitations, Black’s contribution remains fundamental to the development of modern dentistry. His ideas should be viewed as a historical and conceptual foundation that has undergone necessary scientific evolution. This transformation—from mechanistic to biologically oriented models—highlights the importance of his work as a starting point rather than a complete system.

In this way, Black can be regarded as an author who not only systematized dentistry of his time but also created an intellectual platform for its further development. His legacy should be understood not as a set of unchanging rules, but as a methodological foundation upon which modern dental science continues to evolve.

## Conclusion

The significance of Greene Vardiman Black lies not only in his specific scientific contributions but also in the establishment of dentistry as a structured and scientifically grounded discipline. His legacy continues to influence clinical practice, education, and the development of dental science, serving as the foundation for modern approaches in diagnosis, treatment, and prevention.

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