The science of art: Leonardo Da Vinci and facial plastic surgery

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Purpose of review
Leonardo Da Vinci possessed one of humanity’s greatest minds, known for exploring the boundaries of art and science. The discipline of facial plastic surgery also relies on art and science for its advancement. This review focuses on key elements of Leonardo Da Vinci’s work, and how they relate to concepts within facial plastic surgery.

Recent findings
Leonardo Da Vinci was a self-taught creative genius. Common themes that permeated his art were those of proportion, perspective, light and shadow, anatomy, and science. These principles are reflected in key aspects of facial plastic surgery, such as facial analysis, human gaze, facial subunits, surgery of the craniofacial skeleton, and evidence-based medicine.

Summary
Leonardo Da Vinci’s approach to scientific inquiry and artistic beauty strikes a balance from which facial plastic surgeons have much to learn. In depth study of how Leonardo Da Vinci viewed the world furthers the analytical and creative sides of a facial plastic surgeon as well as informs their personal development.

Keywords
art, facial plastic surgery, Leonardo Da Vinci, perspective, proportion, science

INTRODUCTION
It has been 500 years since the passing of one of the greatest minds humanity has ever known: Leonardo Da Vinci. While remembered primarily as a Renaissance painter, Leonardo made critical observations of concepts of nature, optics, flight, mechanics, hydrodynamics, and anatomy. Leonardo’s contributions lay at the intersection between science and art. An exploration of the themes of Leonardo’s work, including proportion, perspective, light and shadow, anatomy, and science demonstrates how these concepts inform our discipline of facial plastic surgery.

BACKGROUND
Leonardo was born out of wedlock, his mother a poor orphan from the Vinci area of Italy, his father an upper class notary. As an illegitimate son he had no formal education and never learned Latin, but Leonardo and scholars of his work believed this liberated him from traditional thinking. He discovered the power of observation, allowing him to become a ‘disciple of experience’ [1].

As a teenager, Leonardo was apprenticed to Verrochio in Florence, where he honed his artistic skills. He developed his signature sfumato – dispensing with lined edges for blurred ones, as seen famously in the smile of the Mona Lisa. In his adult life, Leonardo lived throughout Italy, accepting commissions and exploring his many interests.

Fortunately for those who have studied his work, Leonardo filled multitudes of notebooks with his daily observations, lists, drawings, designs, and imaginative musings. A quarter of his notebooks have survived, roughly 7500 pages, offering us an informal glimpse into his thought processes. Leonardo’s notebooks, filled with his peculiar mirror script and sketches, are described as ‘the most astonishing
testament to the powers of human observation and imagination ever set down on paper.’ [1].

Leonardo’s supposed weaknesses – his illegitimate birth, lack of education, homosexuality, left handedness, vegetarianism – were leveraged as advantages to see the world differently. While his curiosity around many subjects began as supportive to his artistic goals, his veracity in considering them grew so intense that he began to treat them as separate disciplines altogether. Many themes that permeate Leonardo’s studies are common to facial plastic surgery.

Proportion

“It is not any particular feature that renders something to be beautiful, but rather it is an interrelationship of all parts assembled as a whole”.

Leon Battista Alberti

Proportion is more integrally tied to human beauty than discrete measurements. The Egyptians and Greeks wrote of the Golden ratio, or Divine Proportion (Fig. 1). The Golden ratio is mathematically related to the Fibonacci sequence, found throughout the natural world. Leonardo’s most famous expression of human proportion is the Vitruvian Man: a human male figure in perfect scientific proportion within a circle and square (Fig. 2). Similarly, his sketches of human faces illustrate facial proportions such as the horizontal thirds and vertical fifths that are so frequently cited in plastic surgery texts.

Facial plastic surgery is a discipline that enhances beauty through facial alterations. A fundamental understanding of proportion is vital. While concepts of beauty may change with time, proportion is conserved as it focuses on relationships. Rhinoplasty is an example of an operation that attempts to alter the proportions of projection, length, and rotation such that any further alteration would be for the worse. This is an intriguing mixture of art and science, freehand and planning, measurement and taste, in much the same way the Vitruvian Man fits squarely within geometric shapes.

**KEY POINTS**

- Leonardo Da Vinci explored the intersection of art and science, much of which applies to the fundamentals of facial plastic surgery.
- Human facial proportion is a key element of beauty that is derived from relationships between facial structures.
- Perspective within the face refers to a centralizing eye-ward gaze. Physical deformities and asymmetries that detract from the eyes detract from beauty, whereby procedures that soften those features enhance beauty.
- Light and shadow were heavily used in Leonardo Da Vinci’s art, and are critical to how we analyze, diagnose, and alter nasal and facial contours.
- A deep interest in anatomy and science were two traits of Leonardo Da Vinci’s work that are equally important within facial plastic surgery.

**FIGURE 1.** The golden ratio. The golden ratio is as follows: a line is divided whereby the ratio of the shorter segment to the longer segment is equal to the ratio of the longer segment to the whole. Each line in this drawing is intersected in that manner. The extrapolation of these lines forms natural curves which are found repeatedly in nature, including flower patterns, seashells, hurricanes, galaxies, and the human face.
Perspective

“Perspective is nothing more than a thorough knowledge of the function of the eye”.

Leonardo Da Vinci

Perspective is a point of view, both objectively and metaphorically. Leonardo, like many of his contemporaries, used perspective to add dimension to his work and direct a viewer’s attention. The Last Supper has architectural lines of sight that focus attention to the central figure of Jesus (Fig. 3). In addition to linear perspective (a mathematical reduction in size with distance), Leonardo described how both color and clarity degrade with distance. These artistic techniques direct the viewer’s gaze, and bring life to art.

The canvas of the human face has an ‘ocular perspective’. The eyes are the focal point of human

FIGURE 2. Vitruvian Man. Pen and ink with wash over metalpoint drawing on paper by Leonardo Da Vinci, c. 1487. Gallerie dell’Academia, Venice, Italy. An outspread male figure perfectly seated within both a circle and a square. The surrounding script is written in Leonardo’s peculiar, left-handed mirror script.
gaze [2], which is why they are critical to meaningful communication (Fig. 4). Beautiful features are pleasantly ignored so that the eyes may remain the dominant focus. Facial deformities such as nasal asymmetry or facial paralysis detract from this process [3]. Procedures that reduce ill-proportioned and asymmetric features enhance beauty, while procedures that excessively amplify these features are distracting. Understanding human gaze provides a fundamental understanding of facial plastic surgery.

Light and Shadow

“Shadow is the means by which bodies display their form”.

Leonardo Da Vinci

Chiaroscuro – the use of light and shadow to show dimension – is a unifying feature in Leonardo’s art. He wrote more on the topic of shadows than any other artistic topic, categorizing types of shadows, describing rebounded and reflected light, and experimenting
with optics. It was the use of shadows, not lines, that were of supreme importance to Leonardo.

Fundamental concepts in facial plastic surgery are derived from the importance of light and shadow. Subunit concepts of the face [4] and nose [5] take advantage of natural shadow lines, leaving incisions discreetly hidden. The way light spills over an infant’s philtral column creates delicate shadows that form the underpinning of all cleft lip repair techniques. The contours of the nose have been expressed in topographical light and shadow, permitting a deeper understanding of rhinoplasty (Fig. 5) [6]. An appreciation of light and shadow has informed, and will continue to inform, facial plastic surgeons, as it did Leonardo the artist.

Anatomy

“Isolate each bone of the animal, on this add its muscles, then clothe all of it with its flesh”.

Leon Battista Alberti

In an effort to paint the most realistic of figures, Leonardo wished to understand the human body beyond the skin. This desire led to an obsessive pursuit of anatomy through cadaver dissection, which was largely prohibited at the time. During his lifetime, Leonardo dissected over 20 human cadavers, spending hours drawing them before they decomposed. His anatomical drawings, had they been published at the time he was alive, would have marked the birth of modern anatomy. They have been described as a ‘triumph of science and art’ [1].

The accuracy of his human skull depiction is astonishing, showing foramina and shadings that were intensely detailed (Fig. 6). His novel ideas of depicting the brain and cranial nerves using the exploding, or cut-away view, were intuitively educational.

A fervent grasp of anatomy is a prerequisite for facial plastic surgery, and there is no substitution for cadaveric dissection. The human face must be conceived from the inside out. This principle emphasizes the importance of the bony facial skeleton in facial aesthetics. Trauma involving the facial skeleton requires precise restoration of bony anatomy so that soft tissues drape naturally. Modifications of an intact facial skeleton (e.g., congenital or orthognathic surgery), produce changes that translate through to facial tissues. Recognition of sex differences between male and female skulls has led to gender-affirming facial surgeries such as feminizing cranioplasty, mandibular contouring, and genioplasty. The evolution of the field of craniofacial surgery affirms Leonardo’s concept that anatomical structures radiate their form outward through tissues.

Science

“All our knowledge has its origins in our perceptions”.

Leonardo Da Vinci

The sheer number of discoveries Leonardo made by experimentation and direct observation are astonishing. His study of birds led him to surmise that air is also a fluid, like water, creating the nascent field of aerodynamics. Leonardo hypothesized that air must be compressed during flight, a prelude to the Bernoulli principle. His observations on physical laws of motion describe, in words, Newton’s laws of motion 200 years before Newton himself. Leonardo predicted that flow vortices were responsible for passive closure of the aortic valve, recently confirmed by four-dimensional MRI [7]. Even Leonardo’s morality, for instance his decision to be a vegetarian, was derived from rational thought. He reasoned that since animals could move, nature had granted them the ability to feel pain, therefore, he refused to eat meat, wear leather, or hurt animals.
Facial plastic surgery is an equipoise of art and science. Evidence-based advancements are increasing within our field and we are learning how these complement the artistic side. Fundamentally, scientific discovery is driven by curiosity and wonder. The same creativity that applies to surgery drives scientific inquiry.

Regrettably, the majority of Leonardo's discoveries were never published. He was intrigued by the inception of an idea, and less so with seeing it through to fruition and disseminated, meaning his findings had little influence on later science. This neglect to put his systematic observations in writing for others serves as a reminder that a critical part of science is the teaching and sharing of knowledge.

CONCLUSION

Leonardo Da Vinci pursued knowledge with a curiosity and fervor that was extraordinary. His approach to scientific inquiry and artistic beauty strikes a balance from which facial plastic surgeons have much to learn. Leonardo married observation with imagination to explain the natural world. In-depth study of how Leonardo viewed the world can nurture the creative and analytic elements within facial plastic surgeons. Immersing ourselves within his art and creative genius leaves us all wondering, how we can each be a little bit more like Leonardo?

Acknowledgements
None.

Financial support and sponsorship
None.

Conflicts of interest
There are no conflicts of interest.

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■ of outstanding interest

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