Bridging Science and Beauty

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Abstract

The pursuit of beauty can be traced back to ancient times. The history of human beautification spans the realms of religion, medicine, and philosophy, and the means by which humans have attempted to enhance their appearance evolved from a practice of rituals based on empirical knowledge to a legitimate medical specialty. Humans first used natural resources from their environment—plants, animals, and minerals—for beautification. Unfortunately, at times this experimentation led to deleterious results. Modern-day aesthetic medical techniques are subjected to rigorous scientific testing, although some discoveries were made by pure serendipity. This chapter highlights the past, present, and future of the closely intertwined relationship between science and beauty.

Introduction

What constitutes beauty is a question that artists, philosophers, and scientists have debated over millennia. What is beauty? A simple answer is elusive. Is there an objective beauty ideal, or does beauty, according to Plato, lie in the eyes of the beholder? Is beauty a constant that transcends geographical and chronological borders, or does it change with place and time? Is our sense of beauty innate or learned? Can beauty be quantified? In Survival of the Prettiest, Nancy Etcoff takes a
Darwinian stance and theorizes that the human pursuit of beauty is a struggle to ensure the survival of one’s genes [1]. Phi, or the golden ratio, is used to mathematically define the ideal human face and body shape [2]. A complete discourse on the meaning of beauty is beyond the scope of this chapter, but interested readers will find a plethora of opinions on the matter.

**Historical Methods of Beautification**

Dating back to prehistoric times, humans have experimented with botanical ingredients, animal products, and minerals to enhance their appearance. Tattooing, or placing tints under the skin to make them permanent, was among the first cosmetic procedures [3]. Since the ancient Egyptians, beautification rituals were important for religious purposes or to attract members of the opposite sex. The *Ebers Papyrus* devoted a chapter to hair care that recommended ointments made of animal fat or blood to facilitate hair growth [3]. *Mesdemet*, the “black paste” for the eyes, was composed of plumbic sulfate or antimony sulfide, while green-colored cosmetics were produced with copper salts [4]. Henna, a vegetable dye derived from *Lawsonia inermis* or *Lawsonia alba*, was used to paint the skin, hair, and nails a dark red color [4]. It is said that Cleopatra bathed in goat’s milk, almond, and honey [5]. Unrefrigerated milk sours to produce lactic acid, an alpha-hydroxy acid, which acts as a chemoexfoliant [6] while honey is a natural humectant. The Egyptians also used clay and herbal masks to draw out toxins from the skin, flower and tree oils for aromatherapy, and fruit acids of sugar cane, mangos, and apples to smoothen the skin [5].

The history of beautification methods is also fraught with examples of risky and potentially harmful practices. The ancient Greeks used lead-based makeup to lighten the skin, a technique that persisted through the European Elizabethan era to modern nineteenth-century America. Elizabethan women painted their faces with ceruse, a mixture of white lead and vinegar, which unfortunately slowly poisoned its users [3]. Both women and men took great measures to acquire pallor, going so far as to apply leeches for bloodletting [3]. Women of Renaissance Italy used eye drops prepared from the berries of the deadly nightshade plant, *Atropa belladonna*, to dilate their pupils, an effect considered to enhance their beauty [7]. In the 1800s, Victorian women swallowed the cysts of tapeworms in a quest to stay slim, a dangerous practice that continues to resurface in modern times among diet faddists [8].

**Beautification in Modern Times**

Aesthetic surgery gained momentum in the nineteenth century, aided by the widespread knowledge of antiseptic technique pioneered by the British surgeon Josef Lister as well as the advent of general anesthesia. Rhinoplasty, blepharoplasty, and facelifts were introduced at this time. In the latter half of the twentieth century, mammoplasty, hair transplantation, and liposuction became commonplace procedures [9].

A revolutionary discovery that truly bridged science and beauty was that of selective photothermolysis which succeeded in harnessing lasers and light sources to enhance the skin’s appearance. Rox Anderson and John Parrish theorized that specific wavelengths of light emitted in suitably brief pulses could precisely target different structures in the skin while allowing the surrounding area to remain relatively undisturbed [10]. Lasers and light sources are now used to treat pigmentation, vascular lesions, and aid in tattoo removal, hair removal, and collagen remodeling. An important milestone in laser technology was introduced in 2004 by Dieter Manstein and called fractional photothermolysis [11]. By treating only a fraction of the skin’s surface, the remaining undamaged surrounding tissue could promote rapid repair, thus reducing downtime and side effects. Radiofrequency, microwave, and high-frequency ultrasound energy sources are currently used in devices for skin tightening, axillary hyperhidrosis, and noninvasive fat removal, respectively. Cryolipolysis is another method of noninvasive fat reduction.
The latter part of the twentieth century and the beginning of the twenty-first century saw the serendipitous discovery of cosmetic benefits from medications already in use for non-cosmetic indications. Researchers discovered that minoxidil, a vasodilator that reduces blood pressure, could also grow hair. Topical minoxidil was approved by the Food and Drug Administration (FDA) in 1988 for male pattern baldness and is available today over the counter for both men and women. In 1992, Alastair and Jean Carruthers published their discovery that injecting Clostridium botulinum-A exotoxin, previously used for blepharospasm, could also treat glabellar frown lines [12]. Botulinum toxin was approved for cosmetic use in 2002 and in 2004 acquired the FDA indication for treating severe axillary hyperhidrosis. In 2001, the FDA approved bimatoprost, a prostaglandin analog for the reduction of high intraocular pressure in open-angle glaucoma or ocular hypertension. One of the “side effects” reported was longer, fuller, and darker eyelashes [13]. This accidental discovery led to the FDA approval of bimatoprost in 2008 for eyelash hypotrichosis.

The use of dermal and subcutaneous fillers for nonsurgical facial rejuvenation evolved from early bovine collagen in the 1980s to hyaluronic acid, poly-L-lactic acid, and calcium hydroxylapatite in the early 2000s. Fillers are used to correct fine lines, wrinkles, folds, and loss of volume. Injectable fillers are also used to remove unwanted volume. In 2015, deoxycholic acid was FDA approved for the treatment of moderate-to-severe submental fat.

The Future of Science and Beauty

According to the American Society for Aesthetic Plastic Surgery (ASAPS), in 2013 more than 11 million cosmetic surgical and nonsurgical procedures were performed by board-certified plastic surgeons, dermatologists, and otolaryngologists in the United States, totaling more than 12 billion dollars [14]. The pursuit of beauty has reached insatiable levels and in turn has driven the scientific community to focus on developing less invasive, more effective, and more accessible techniques to enhance the human form. What does the future hold?

Nanotechnology is the rapidly developing discipline that uses particles 1,000 nm in size and smaller. It allows the potential to deliver molecules into the skin, which ordinarily do not penetrate the stratum corneum. In the dermatologic setting nanotechnology is most commonly used for sunscreens containing zinc oxide, rendering more elegant sun protection [15]. Topical botulinum toxin which is being studied for treatment of facial rhytides and hyperhidrosis has the potential to revolutionize the landscape of aesthetic medicine [16].

The personalization of aesthetic treatments is a fast-growing movement. The possibility of harvesting one’s own blood to extract precious substances such as growth factors and anti-inflammatory cytokines is the basis of an autologous antiaging serum [17]. An injectable suspension of autologous fibroblasts was FDA approved in 2011. In a multicenter, double-blind, placebo-controlled study, it was shown to be a safe and effective way to improve the appearance of moderate-to-severe nasolabial fold wrinkles with the added benefit of being a natural, biological treatment modality [18]. In the near future the application of genomics technologies will offer insights into skin cell biology that can be harnessed for the development of new products [19].

Also forecasted is the increasing market for home-use laser and light devices for self-administered beauty treatments. Although not as powerful as office versions, the currently available devices for hair removal, photoaging, and acne have a wide margin of safety and are less costly [20].

In an interesting arc, the use of natural botanical ingredients has gained increasing popularity in recent years. Perhaps as the pendulum swings toward scientific breakthroughs, there is a counterbalancing desire to use simple remedies for beautification. The discovery of antioxidants in various botanical ingredients, such as feverfew, green tea, licorice, soy, and coffee berry, has led to an expanding cosmeceutical market targeting the effects of photoaging [21]. The burgeoning
natural beauty market will likely continue to grow as topical vehicles improve the delivery of active ingredients to their targets in the skin.

**Conclusion**

Science and technology have influenced the quest for human beautification in unforeseen ways. Due to the efficiency of international travel and the Internet, the exchange of ideas occurs at a rapid pace. Cosmetic companies are capitalizing on this move toward globalization. Korean beauty trends have made their way onto American shores, with BB creams and sleeping masks becoming mainstream [22]. The Internet has produced a generation of bloggers whose influence eclipses traditional mass marketing [23]. Meanwhile, photo-perfecting smartphone applications and Madison Avenue airbrushed images promote an unattainable ideal of beauty for humans to try and emulate. As novel methods of beautification arise from scientific advances, the eternal pursuit of beauty will continue.

**References**