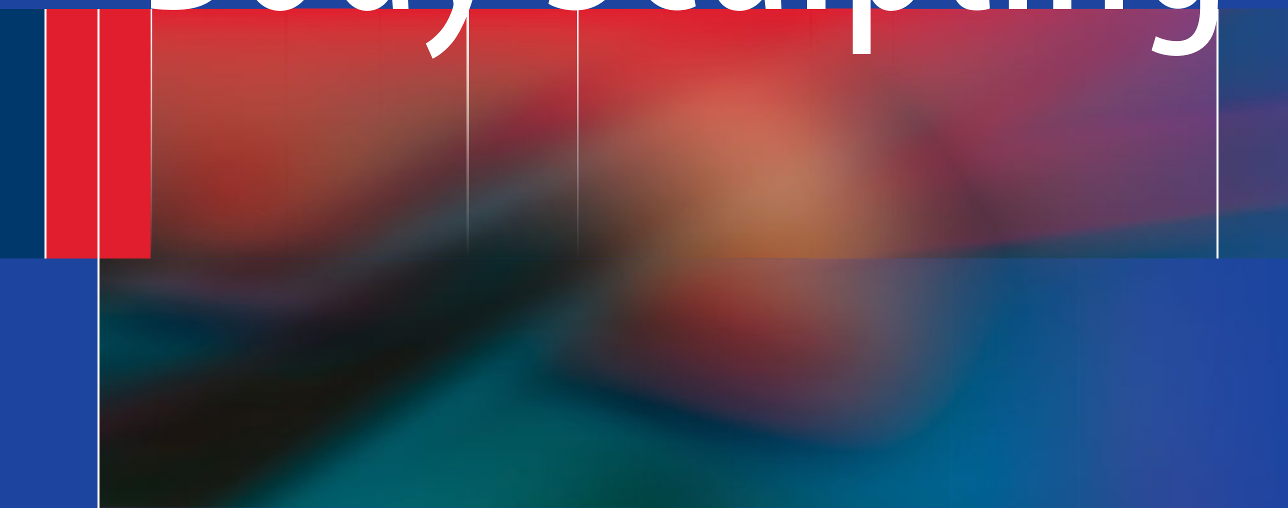
Alfredo E. Hoyos
Peter M. Prendergast

High Definition Body Sculpting



Art and Advanced Lipoplasty Techniques

Springer

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Foreword

> The Plastic Surgeon is undoubtedly the greatest of all contemporary artists. He paints on living canvas and sculpts in human flesh. C. H. Willi 1955

Charles H. Willi (1926) [1] was the first surgeon to inject small pieces of fat with a syringe for aesthetic purposes. Giorgio Fischer (1975) [2] was the first to describe the removal of fat through small incisions (5 mm) using a cannula with an internal cutting mechanism (to be used at the discretion of the surgeon) that was called the “planotome” that was attached to a suction machine. Syringe-assisted-, ultrasound-assisted-, laser-assisted-, water jet-assisted-, power-assisted-, and percussion massage-assisted liposuction techniques evolved. Bircoll (1982) [3] described the use of autologous fat from liposuction for syringe injection for contouring and filling defects. The addition of stem cells to the fat being transferred to improve fat survival is now coming to the fore. Thus it can be seen that cosmetic surgery is forever changing and improving through new instruments, new ideas, and modifications of old techniques.

Dr. Hoyos has developed procedures for dynamic definition of body areas and has published some of his techniques, while Dr. Prendergast, well published in cosmetic medicine and surgery, has become a proponent of those techniques. This book on high definition body sculpting involves refined techniques with newer ultrasonic-assisted and power-assisted liposuction to improve the sculpted appearance of the body. The addition of fat transfer allows a more complete method of defining the features of the body. The authors, working together on the content of the book, present a unique approach to body contouring for cosmetic surgeons interested in improving their results in liposuction and fat transfer. The techniques are presented in a comprehensive and understandable manner and include most areas of the body that may need improvement for a sculpted appearance. The chapters containing the techniques make use of “Warnings” to allow the reader to avoid dangerous maneuvers. Their results are excellent and cosmetic surgeons should take into consideration adding the authors’ techniques to their own practices.

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Tustin, CA, USA Melvin A. Shiffman, MD

Preface

The evolution of fat removal techniques for the purpose of beautification has been characterized by incremental improvements and refinements over the years. Blunt and narrow cannulae replaced sharp, large-diameter ones. Wet and superwet techniques replaced aggressive, dry liposuction. Various energy or power-assisted technologies were introduced to facilitate fat removal, reduce trauma, or improve skin retraction. High-definition body sculpting represents a new concept in beautifying the human body through lipoplasty. The techniques employed in high-definition body sculpting are not merely improvements on older methods; they are significantly different.

This book represents the culmination of the pioneering work of Colombian plastic surgeon Alfredo Hoyos. The impetus for this work was the increasing demand from patients for body shape and form that appeared athletic, muscular, or sexy. As well as acquiring formal skills as an aesthetic surgeon, Hoyos's attributes as a sculptor and artist as well afforded him the unique ability to develop his passion for art through body contouring surgical techniques. His bold endeavors using novel techniques and painstakingly thorough liposuction yielded results that were hitherto unobtainable using conventional techniques. Since Hoyos published the results of his earlier experience with high-definition lipoplasty, he has refined the techniques, developed new instrumentation, and employed newer ultrasound and power-assisted devices to achieve optimum results. The results of total body sculpting are not just transformational; they are also reproducible.

In the following chapters, we provide to the liposuction surgeon an introduction to the advanced lipoplasty techniques employed in high-definition body sculpting. The book covers art and anatomy, concepts in human sculpting, ultrasound-assisted technology, instrumentation, and step-by-step techniques in all body applications for male and female patients. Numerous photographs and illustrations provide useful visual guides to the techniques, maneuvers, and results of high-definition body sculpting. The book is also intended as a manual to complement a formal preceptorship in high-definition lipoplasty.

High-definition body sculpting attempts to achieve aesthetically ideal human form by revealing underlying anatomical structures, rather than simply removing superfluous subcutaneous fat. The lipoplasty surgeon must work as a sculptor, manipulating light and shadows by adding or removing fat, and sculpting controlled irregularities to produce a convincing work of human art. This book provides a unique practical insight into these advanced lipoplasty techniques. To this end, we are confident that the book will interest body contouring surgeons who can use the information, advice, and guidelines to broaden their practice and expand their horizons in this exciting field of aesthetic surgery.

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Justin Craig, Elise Taylor, and Mary Kate Wright produced the illustrations and artwork. Without their beautiful contributions, the book would not exist.

We wish also to extend our gratitude to the real pioneers: the patients who rightfully asked for more. Now more is the new standard.

Contents

Part I

Art and Science

1 The Human Form as Art: Contours, Proportions, and Aesthetic Ideals

Introduction

Through the ages, the human form has been featured greatly in the artistic expression of artists and sculptors. In the fifth century BC, the Greek sculptor Polykleitos created *Doryphorus,* the bronze sculpture that exemplifies the perfectly harmonious and balanced proportions of the human body (Fig. 1.1). This muscular nude male exhibits athletic readiness in classic "contrapposto," or counterpose, where the arms and shoulders twist off axis to the legs and hips. There is minimal body fat and excellent muscular definition. His contemporary, Phidias, is regarded as one of the greatest sculptors of Classical Greece. Phidias' colossal chryselephantine and gold statue of Zeus at Olympia was regarded as one of the seven wonders of the ancient world.

No sculptor could carve such captivating and convincing works of art without having accurate knowledge of the human anatomy. The skin and subcutaneous fat is merely draped over the anatomical wonders beneath. If an artist or sculptor does not know all of the muscles, tendons, and bony landmarks, how can he display them through the skin in his masterpiece? He must also understand their functions and how they change with motion: a muscular body in action is characterized by concavities, convexities, and shadows that instantly portray the state of health. For millennia, the work of Claudius Galen dominated the understanding of anatomy in Europe. Galen (AD 129–201) dissected pigs and

Fig. 1.1 The sculpture *Doryphorus*, detailing the male form in classic "contrapposto" (Courtesy of Bridgeman Art)

A.E. Hoyos, P.M. Prendergast, *High Definition Body Sculpting*,
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primates and demonstrated his findings in numerous texts and treatises. His teachings remained uncontested until 1543, when the influential work of Flemish anatomist Andreas Vesalius was published, entitled *De Humani Corporis Fabrica*.

Art and Anatomy

The merging of art and anatomy is perhaps most evident and glorious in the works of Leonardo da Vinci. His anatomical manuscripts are filled with detailed and intricate drawings that elegantly reveal muscular anatomy, symmetry, and human proportions (Fig. 1.2). His knowledge of anatomy was derived from his own independent dissections and research and is elegantly and beautifully portrayed in many of his renowned paintings. Michelangelo similarly celebrated human physicality through his work as an artist and sculptor. *David* represents one of the most recognized sculptures of the Renaissance and showcases the human body in all its strength, athleticism, and youthful beauty (Fig. 1.3). The muscular definition of deltoid, biceps, pectoralis major, rectus abdominis, and

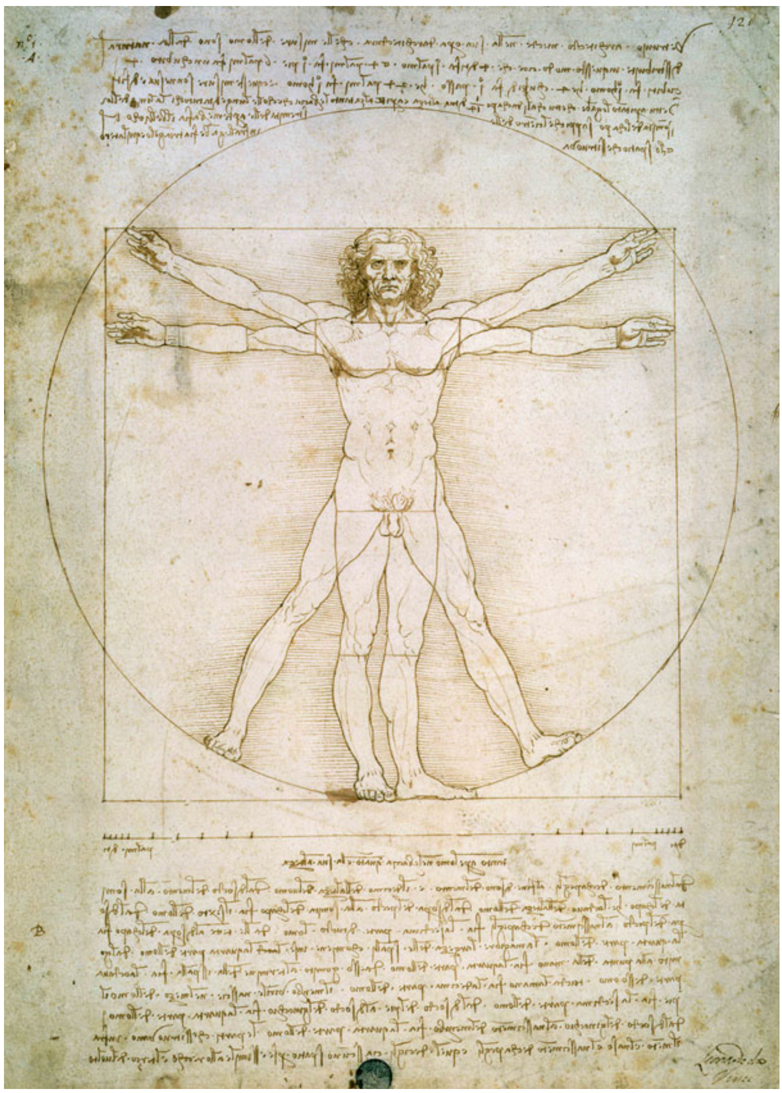

Fig. 1.2 An example of Leonardo da Vinci's manuscript showing human anatomy and proportions (Courtesy of Bridgeman Art)

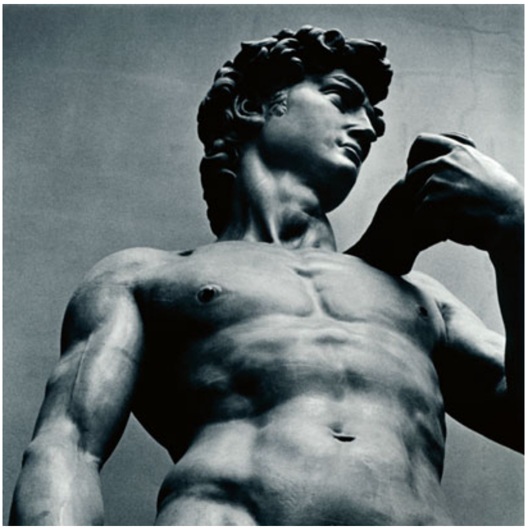

Fig. 1.3 Michelangelo's *David*

external obliques is clearly visible in Michelangelo's *David*.

In 1747, the intimate relationship between art and anatomy was again exemplified by the collaborative efforts of artist Jan Wandelaar and anatomist Bernhard Siegfried Albinus [1]. Their atlas, *Tabulae Sceleti et Musculorum Corporis Humani*, showcases the musculoskeletal system in a series of exquisitely detailed engravings (Fig. 1.4). Further evidence of the importance and prominence of anatomical art in the eighteenth century lies in the works of French artist Jacques Fabien Gautier d'Agoty [1]. D'Agoty's *The Flayed Angel* demonstrates the layered architecture of the back musculature by splaying open the superficial layers (Fig. 1.5). We look on in wonder and awe. Our fascination with uncluttered human anatomy continues today and is nurtured by our access to museums and exhibitions that celebrate the human form. These include the Museo Zoologico La Specola at the University of Florence, where hundreds of life-size wax models were sculpted from cadaver dissections between 1771 and 1814. More recently, the exhibition *Körperwelten* showcases real human specimens that have been preserved by plastination, a technique pioneered by the anatomist Gunther von Hagens. Von Hagens' work reveals anatomy in motion—running, lifting, stretching, and dancing—and has captivated the public at exhibitions all around the world since 1995.

The celebration of our physicality in the natural world is expressed through our study of anatomy, art, and aesthetics. Since art may be considered the endeavor toward perfection, we may consider artistic body sculpting as an attempt to achieve perfect human form. Although "perfect" human form hardly exists and is in any case subjective, there are several determinants of physical attractiveness as well as aesthetic ideals that we can consider to strive toward our goal of achieving beautiful physical form. These include symmetry, proportions, curves, ratios, and indices.

Greek sculptors and artists strove to reduce what they observed as perfect human form to order, by measuring features and proportions, thus quantifying aesthetic ideals. Phidias used a special ratio, approximating 1.618, for many of his creations. This golden ratio, or phi (ϕ), after Phidias, appears to hold special importance in aesthetics in the natural world.

A beautiful body can be considered to be one that attracts our attention and elicits a positive emotional response. Beauty and function are also intimately related, so that a beautiful body is one that functions well. As humans, we have evolved with finely honed mating strategies, complete with the evolved desire to seek mates who exhibit signs of youth and health. Both sexes have the innate desire to reproduce and to seek mates that exhibit physical signs of reproductive health [2]. These cues to health, strength, and fertility include muscular definition and athleticism in males and curvaceousness in females. The surgeon performing advanced body sculpting aims to improve attractiveness by enhancing muscular definition and curvaceousness.

We inherit many physical attributes, including body type and shape. In the 1940s, American psychologist William Sheldon proposed a classification of body types that is still widely used today [3]. This system of somatotypology describes three main body types: ectomorph, mesomorph, and endomorph (Fig. 1.6). An ectomorph is typically tall and thin with low fat content, narrow shoulders, and high metabolism. Ectomorphs find it difficult to gain weight.

Fig. 1.4 Engraving of an animated skeleton from *Tabulae Sceleti et Musculorum* (Courtesy of Bridgeman Art)

Mesomorphs are muscular and lean, with medium bones and a solid torso. They may gain some fat if calorific intake is too high or exercise is deficient. Endomorphs have big bones, a wide waist, and a tendency toward fatness. Endomorphs gain weight easily and require high-intensity exercise and dieting to become lean. Through diet and exercise, all body types have the ability to increase muscle tone and mass, reduce body fat, improve posture, and acquire other physical manifestations of health and beauty.

Liposuction Technology and Body Art

For exercise and diet-resistant fatty deposits, liposuction has been utilized as a surgical solution for unwanted convex adiposities for decades. The introduction of the tumescent technique by Klein in the 1990s transformed the safety of suction-assisted lipoplasty [4]. However, traditional liposuction has inherent limitations based on instrumentation and technique, relegating it to

Fig. 1.5 D'Agoty's *The Flayed Angel* revealing the muscular and bony anatomy of the back (Courtesy of Bridgeman Art)

a procedure indicated primarily for debulking and unrefined body contouring.

In 2000, Sound Surgical Technologies introduced an efficient third-generation ultrasound-assisted lipoplasty technology called VASER, an acronym for vibration amplification of sound energy at resonance [5]. The introduction of VASER allowed efficient and safe emulsification of fat in deep and superficial planes through cavitation while preserving vascular and neural structures. It also represented the sculptor's chisel in a new technique that would change the concept of surgical body contouring. Pioneered by Hoyos in 2002, VASER-assisted high-definition lipoplasty (VAHDL) radically altered the tenets of lipoplasty in aesthetic surgery [6]. The human body can be sculpted like a work of art, working in all subcutaneous planes, by adding and subtracting fat with delicate instruments and refined techniques. The subdermal plane is no longer a no-go area, controlled deformities are desirable, and muscular definition is attainable through lipoplasty by revealing the underlying anatomy.

High-definition body sculpting requires experience in basic lipoplasty as an initial step. Equally important are an appreciation of the human form, aesthetic ideals, and an understanding of anatomy, technique, and safety. The latter three are described later in this book. Let us first mention form, considered to be the outward visible shape of an object.

Human Form

Human form, shape, and size have several determinants. These include the underlying skeletal framework, muscle mass and tone, and distribution and volume of subcutaneous fat. Many anatomical features are named after the geometric form they resemble, including deltoid, rhomboideus, trapezius, and scalenus muscles. Poor posture, related to lack of exercise or infirmity, also affects the shape of the body (Fig. 1.7). An understanding of human aesthetics requires an appreciation of various shapes and lines that delineate the human body in repose and in dynamic states. These forms include "C" curves, "S" curves, and "R" curves (Fig. 1.8). Curves are essential cues to human reproductive health, endocrine status, athleticism and strength, and longevity. In women, physical features that produce attractive curves include lumbar lordosis, convexities of the chest and buttocks, and muscular definition in the calves (Fig. 1.9). In men, well-developed muscle mass also produces curves, although the form tends to be more angular rather than curvaceous (Fig. 1.10). Undesirable curves appear when there is muscle atrophy, obesity, or advancing age when posture deteriorates and hormonal changes occur. With poorly developed abdominal wall muscles, for example, the intra-abdominal organs are displaced and the abdomen protrudes (Fig. 1.11). Since lipoplasty affects only subcutaneous abdominal fat, it is not a solution for abdominal protrusion secondary to muscle wall weakness or intra-abdominal fat. This requires a specific exercise program to improve core body strength and flatten the

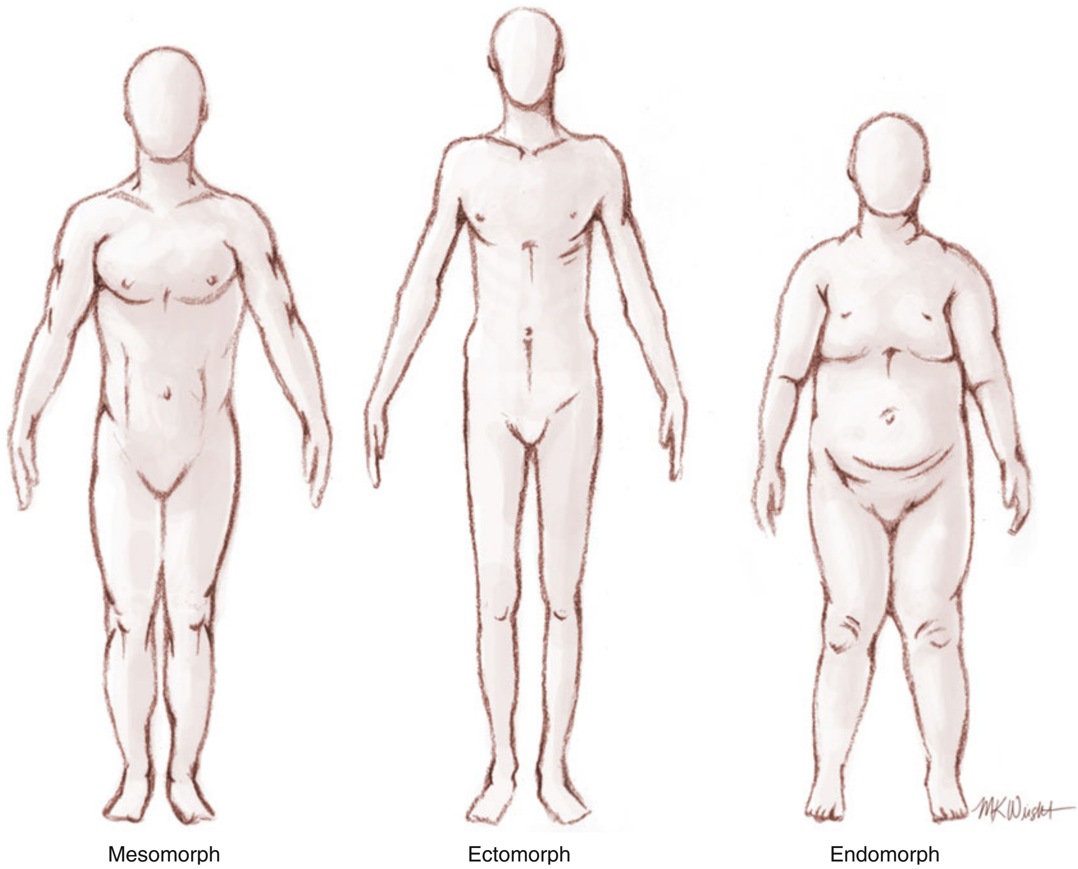

Fig. 1.6 Sheldon's three main body types

abdomen, often in combination with lipoplasty to reduce stubborn subcutaneous fat.

Physical attractiveness, especially female beauty, has been the subject of extensive research over a number of decades by experts in the fields of biology, psychology, and anthropology. Unsurprisingly, there is no unifying or undisputed answer to the question, "what determines physical attractiveness?" In other words, beauty is still somewhat in the eye of the beholder. That which is considered beautiful human form changes temporally and geographically. From the available literature, however, we can propose aesthetic ideals based on ranges and constants that describe measurements such as body mass index, waist-hip ratio, and curvaceousness. Throughout nature, symmetry and ideal proportions are also intimately related to health, vitality, and beauty.

Symmetry and Proportions

Students of art, anatomy, and aesthetic surgery will be captivated by the unique arrangement and design of the human body. Cells are arranged as units to form tissues, tissues work synchronously to form organs, and organs work harmoniously to function within the body. Proportions have always played a central role in art. Leonardo da Vinci's *On the Proportions and on the Movements of the Human Figure* and Albrecht Dürer's *Four Books on Human Proportions* detail human proportions and highlight the importance that harmony and proportions play in aesthetics and in art.

Probably the most significant measurement in human proportions and aesthetics is the golden ratio mentioned before in this chapter, approximating 1.618 (ϕ). This ratio, measureable throughout nature, explains dynamic symmetry in human

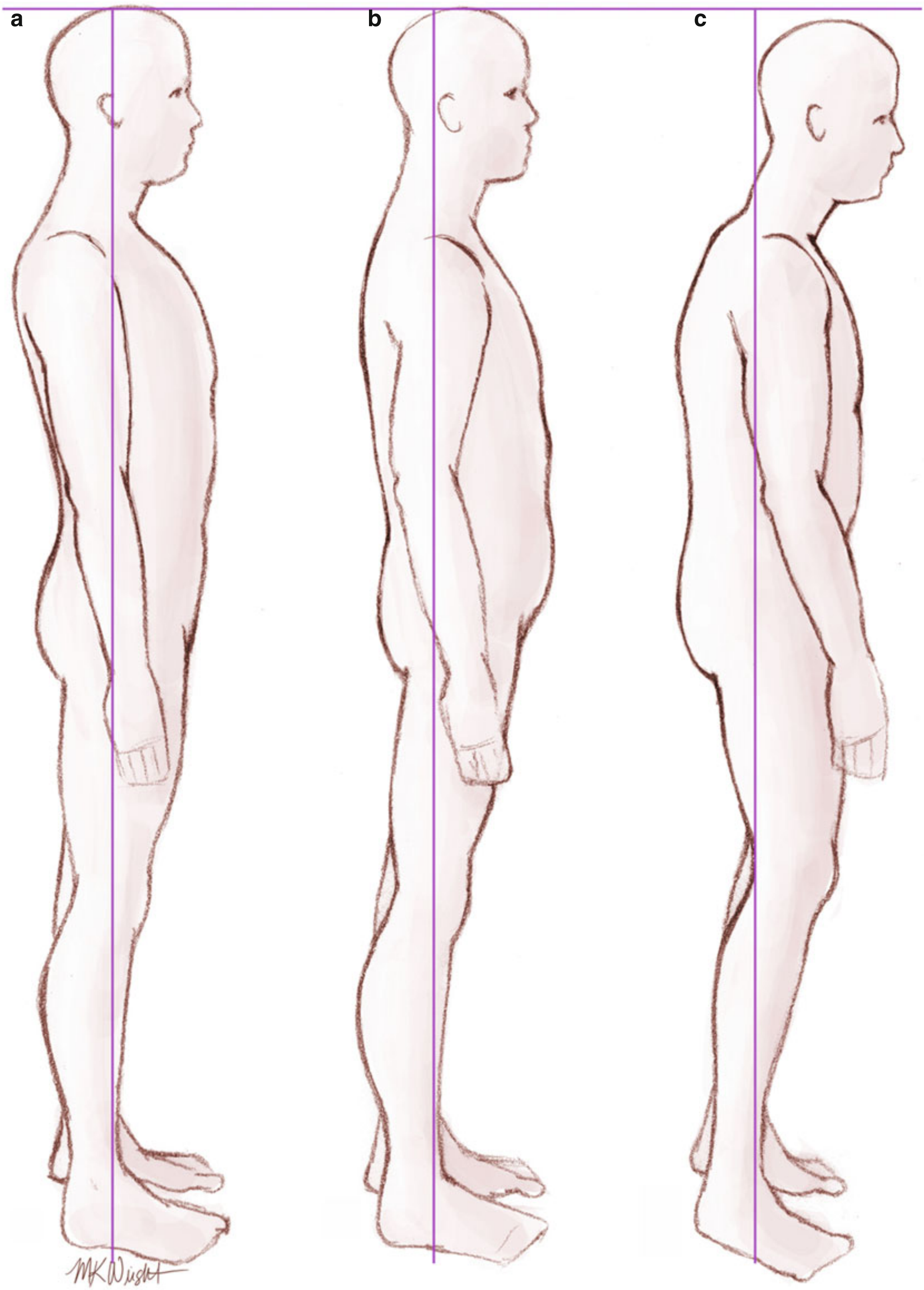

Fig. 1.7 How posture affects form. (**a**) Normal upright posture produces good form. (**b**) Shoulders forward and abdomen protruding. (**c**) Shoulders slouched forward, back curved, and neck hanging forward, producing poor form

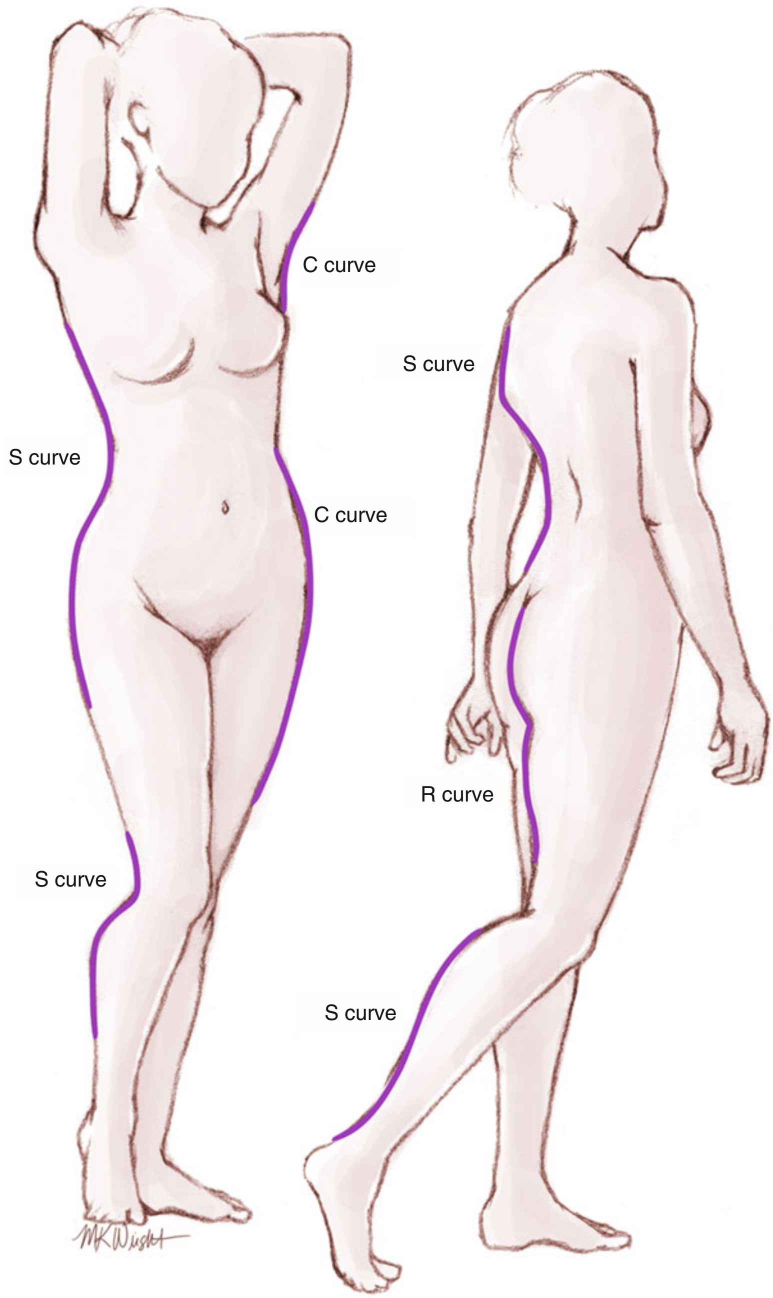

Fig. 1.8 Aesthetic curves in the human form

proportions. Mathematically, dynamic symmetry is expressed in the Fibonacci series, a series of numbers where any number in the series is the sum of the previous two numbers: 1; 1 + 1 = 2; 1 + 2 = 3; 2 + 3 = 5; 3 + 5 = 8…. Each number within a sum divided by the previous number approximates 1.62 (ϕ). When there is dynamic symmetry, numerous human proportions and aesthetically pleasing ratios approximate ϕ (Fig. 1.12).

The proportions of vertical body height are fairly consistent. The body length from the suprasternal notch to the sole of the feet can be divided into thirds. One-third forms the torso from the sternal notch to the symphysis pubis, one-third

Fig. 1.9 Beautiful female form is evident in the natural curves of lumbar lordosis, the gluteal convexity, the breasts, and the subtle convexity created by the periumbilical fat

comprises the thigh length from the anterior superior iliac spine to the patella, and the lower leg length from the patella to the sole is also one-third of the body height. The head height is one-eighth of the total height, and the neck is half of the head height (Fig. 1.13). Further proportions relative to total height are provided by George Hebert in his work, *Muscle et Beauté Plastique Féminine* published in 1919 (Fig. 1.14).

Aesthetic Ideals and the Science of Beauty

Standards of female beauty vary over time and across cultures [7]. In nineteenth-century America, two opposite images of female beauty

Fig. 1.10 Straight lines and angles predominate in aesthetically ideal male form

were presented: the slight and frail "steel-engraving lady" and the plump and curvaceous "voluptuous woman" [8]. This disparate image of feminine beauty continued into the early twentieth century. However, a trend toward slenderization occurred in the 1920s, as the body seemed to lose its curves and the focus on image was on the legs and face. In the 1930s, the *Esquire* magazine illustrator George Petty provided a new aesthetic ideal: a toned, athletic yet curvaceous girl with long, muscular legs (Fig. 1.15). Petty's successor at *Esquire,* Alberto Vargas, provided yet another aesthetic ideal in the 1940s and 1950s. He preserved the muscular athletic look of the Petty girl but added large breasts (Fig. 1.16). The trend toward larger breasts as an aesthetic ideal continued into the 1960s as "bosom mania" and probably still exists today to some extent, given the rising number of breast augmentations performed annually [9]. Since men place a great deal of importance on physical appearance in a mate, women go to greater lengths than men to conform to an aesthetic ideal. This involves cosmetics, fashion, and sometimes surgery. High-definition lipoplasty has become popular recently due to advances in technique, coupled with the demand for a toned athletic appearance, even in women.

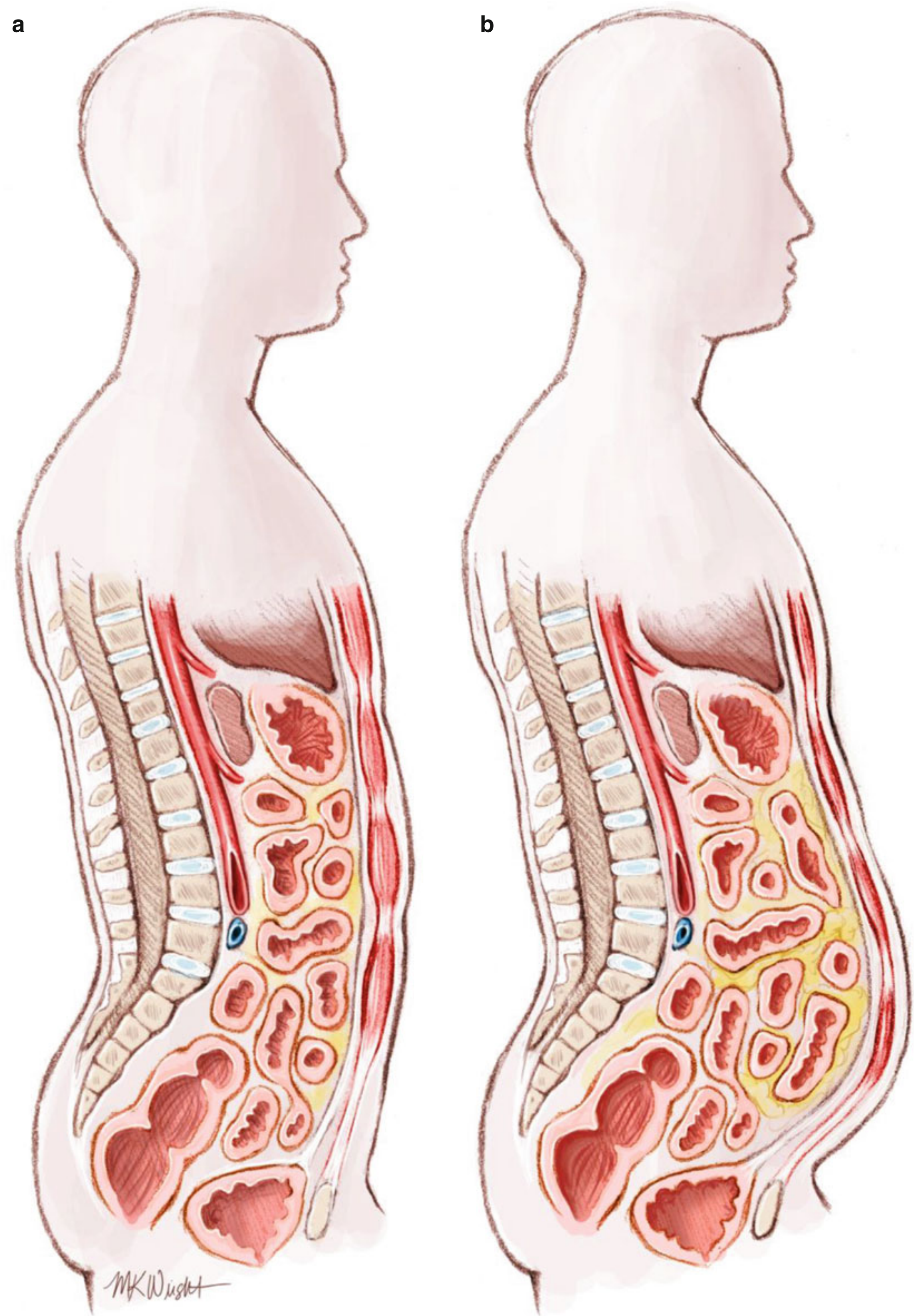

Fig. 1.11 (**a**) Flat abdomen with toned anterior abdominal wall muscles. (**b**) The abdomen protrudes when the muscles are weak. Excess intra-abdominal fat worsens abdominal wall protrusion

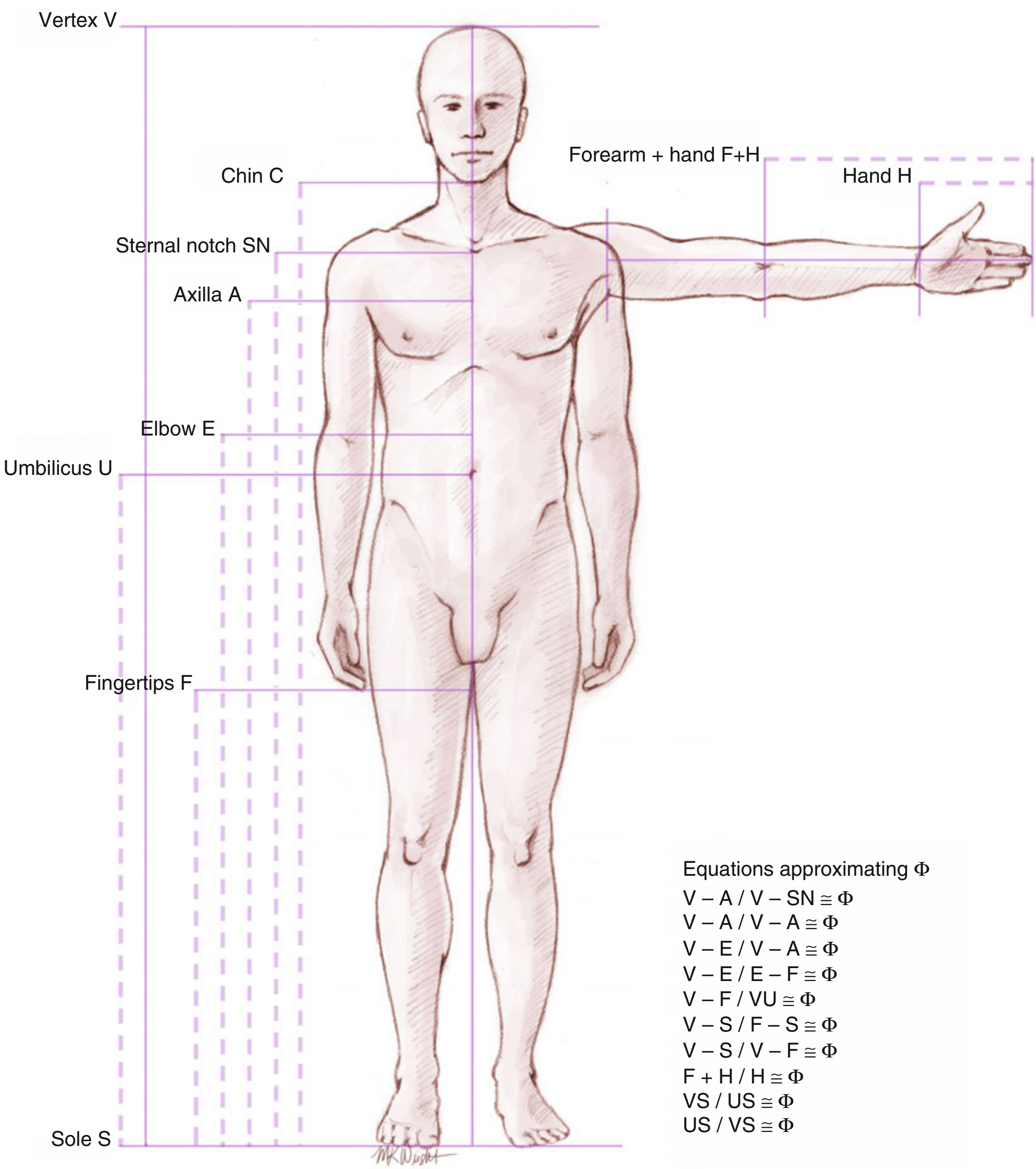

Fig. 1.12 Dynamic symmetry in human form

Three proposed and well-researched determinants of beauty are waist-to-hip ratio (WHR), body mass index (BMI), and curvaceousness [10]. Several studies conclude that the most attractive WHR, measured by dividing the circumference of the waist by that of the hips, is 0.7 [10–12]. Interestingly, the measurements of Miss America pageant winners for many years have consistently approximated this optimum ratio. Since estrogen has the effect of depositing fat in the hip area and preventing deposition in the abdomen, it follows that premenopausal women

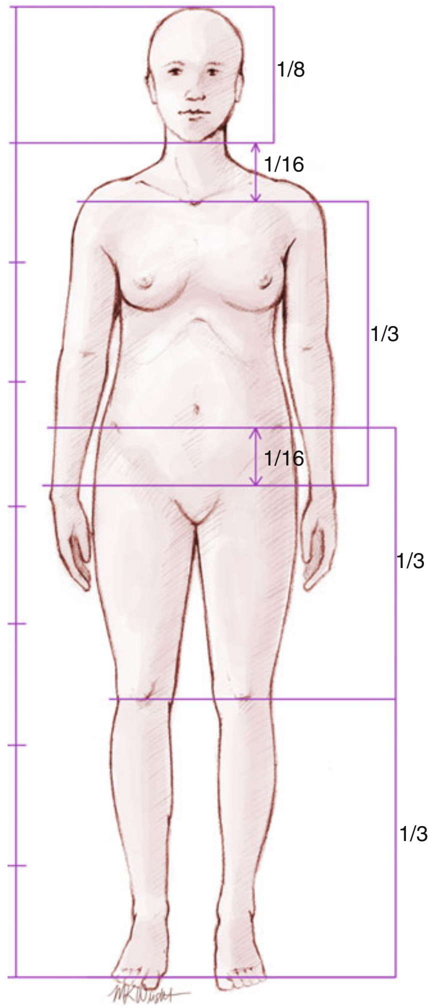

Fig. 1.13 Human proportions related to vertical body and head height

with normal estrogen levels will have lower WHR than women who have reached menopause. Lipoplasty procedures that remove fat from the waist and transfer it to the hips aim to lower the WHR and improve attractiveness (Fig. 1.17). Body mass index (BMI), calculated by dividing the body weight in kilograms by the height in meters squared, can be considered to be an index of overall fat percentage. Although a BMI in females of 20–25 is normal, studies reveal that a BMI of 20 is considered optimally attractive [13]. Curvaceousness is the degree of "hourglass shape" of a woman, such that the breasts and hips are relatively large and the waist relatively slender. A more curvaceous body is a cue to reproductive health and is considered more attractive to a male [2]. Lipoplasty, breast augmentation, and fat grafting to buttocks improve curvaceousness by amplifying these indices. The relative importance of WHR and BMI as models of physical attractiveness is debated. Since there is a positive correlation between the two, when BMI increases, so too does WHR. Cornelissen et al. proposes an explanation for this positive relationship between WHR and BMI based on a biologically intuitive additive model of fat deposition [14]. This model suggests a method for separating WHR associated with BMI (WHR_{BMI}) and that not related to BMI (WHR_{NONBMI}) but due to underlying musculoskeletal frame and endocrine-related and genetically determined body fat distribution. The analysis of Cornelissen and others conclude that it is primarily BMI, and not WHR, that determines measurements of physical attractiveness [14, 15]. In cross-cultural studies, BMI was found to account for over 75 % of the variance in attractiveness ratings, whereas WHR failed to emerge as a strong predictor [16]. There is still a role for WHR in attractiveness judgments, and improved WHR has been shown on fMRI studies to activate in observers regions of the brain associated with neural reward mechanisms, such as the anterior cingulate cortex and nucleus accumbens [17].

For men, attractiveness ratings propose that a low waist-to-chest ratio is desirable [18]. This "V"-shaped body form results from increased muscular mass in the chest and upper back, combined with minimal fat and good muscular tone in the abdominal wall. The tendinous intersections of rectus abdominis can be seen and appreciated in individuals with minimal fat overlying the anterior abdominal wall.

Men place a higher value on women's appearance than women do on men's. Nonetheless, body image plays an important role in the psyche of both sexes. A healthy, curvaceous, and toned appearance in women represents a cue to vitality

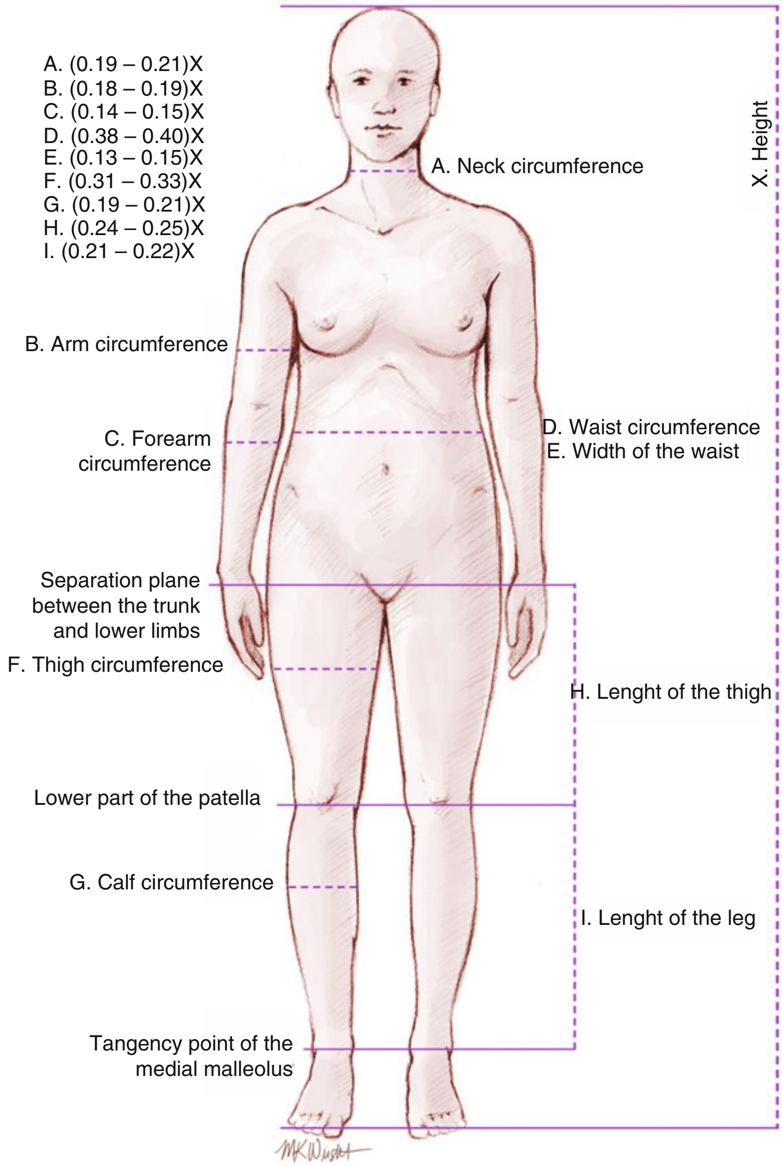

Fig. 1.14 Proportions relative to total height after George Hebert's *Muscle et Beauté Plastique Féminine*

and reproductive health and plays a major role in physical attraction. Similarly, a powerful, muscular, and athletic appearance in men also signifies reproductive health and strength, both desirable to mates in evolutionary terms. Cardiovascular and resistance exercises, together with a healthy lifestyle and eating habits, contribute significantly to the BMI and appearance of the human body. Advanced lipoplasty techniques can also be employed to remove stubborn fat and reveal the underlying muscular anatomy, contributing further to physical attractiveness and desirability.

Fig. 1.15 The Petty girl (c.1938). George Petty's illustrations portrayed attractive women as athletic and toned with long muscular legs (From *Alberto Vargas* by Reid Stewart Austin; foreword by Hugh Hefner. Introduction and text copyright © 2006 by Reid Stewart Austin; images copyright © by The Estate of Max Vargas. By permission of Bullfinch. All rights reserved)

Fig. 1.16 *Ivory and Black* by Alberto Vargas (c.1955) (From *Alberto Vargas* by Reid Stewart Austin; foreword by Hugh Hefner. Introduction and text copyright © 2006 by Reid Stewart Austin; images copyright © by The Estate of Max Vargas. By permission of Bullfinch. All rights reserved)

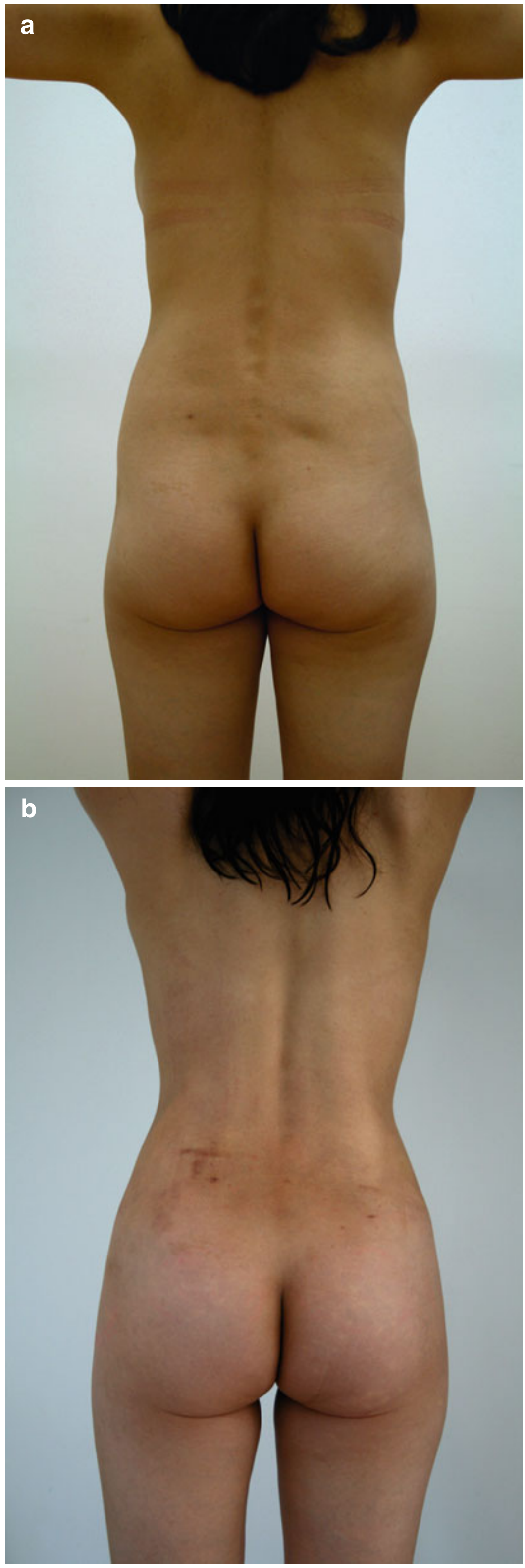

Fig. 1.17 Before (**a**) and after (**b**) lipoplasty and fat grafting to improve contours and waist-hip ratio

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2 Muscular and Surface Anatomy

Introduction

Sculpting the human body in order to improve definition is impossible without a thorough knowledge of muscular anatomy. The surgeon must also develop an artist's eye so that the form ideally created by the superficial musculature can be "visualized" and then revealed through selective lipoplasty techniques [1, 2]. In most individuals with a normal body mass index, an athletic and toned appearance can be created through high-definition body sculpting by removing fat and highlighting major muscle groups [2]. The anatomy and form of the most important muscles and muscle groups for high-definition lipoplasty are detailed in this chapter. These include muscles of the trunk, shoulder, upper arm, hip, thigh, and leg. The salient features of the muscular anatomy relevant to body contouring are outlined, such as the origin, insertion, orientation, form created, and relationship to adjacent muscle groups.

Trunk Muscles

The trunk muscles consist of large and small groups arranged anteriorly and posteriorly over the abdomen and back, respectively. They also include the chest wall muscles. They form the muscular body wall, where they connect the rib cage to the bony pelvis. The trunk muscles have various actions on the torso, including flexion, extension, lateral bending, and rotation. The definition of the trunk muscles provides an appearance of athleticism, strength, and health. In men, the posterior trunk muscles create a V-shaped form, or triangular wedge; the broad latissimus dorsi tapers inferiorly to a narrow waist (Fig. 2.1). Anteriorly, the fleshy bellies of the rectus abdominis bulge between tendinous intersections, and the pectoralis major provides a convex muscular mass over the chest (Fig. 2.2). In women, the anterior and posterior trunk muscles between the rib cage and pelvis narrow the waist. Posteriorly, the broad V shape is lacking, but the smaller erector spinae provide attractive definition on either side of the midline (Fig. 2.3). Anteriorly, a subtle shadow over linea alba and at the lateral borders of the rectus abdominis creates beautiful definition of the female abdomen (Fig. 2.4) [2].

Rectus Abdominis

This vertically oriented paired strap muscle occupies most of the central part of the anterior abdominal wall (Fig. 2.5). It is narrow and thick inferiorly and broader and flatter in the upper abdomen. The rectus abdominis arises from the symphysis, crest, and pecten of the pubis and runs upward to insert into the xiphoid process and costal cartilages of the fifth to seventh ribs. Its main action is to flex the trunk. The inferior part of the rectus abdominis is covered only on its anterior surface by the rectus sheath, and above the costal margin, the muscle lies directly

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Fig. 2.1 The posterior male trunk. A "V" shape is produced by the back muscles tapering inferiorly to a narrow waist

Fig. 2.2 Anterior male abdomen. The major muscle groups and their tendinous intersections create a highly defined appearance

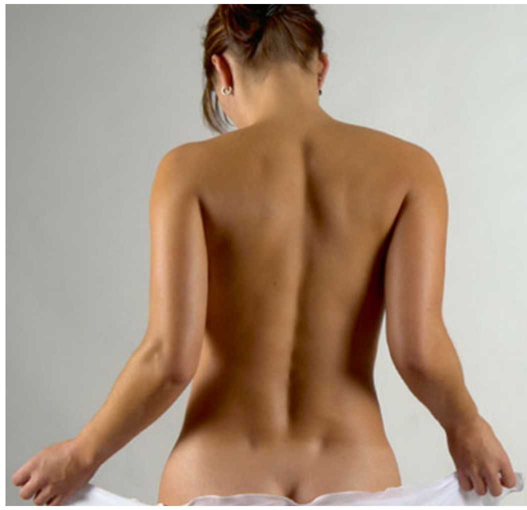

Fig. 2.3 Definition and form of the female back. Note the midline groove between the spinous muscles and the dimples in the lower back marking the location of the posterior superior iliac spines

Fig. 2.4 Anterior female abdomen. The most defining features in the athletic female abdomen are the linea alba and linea semilunaris

on the costal cartilages. The paired rectus abdominis is separated in the midline by the linea alba and by three horizontal tendinous intersections. These fibrous bands are usually located at the level of the xiphoid process, at or just above the umbilicus, and halfway between these two. A fourth tendinous intersection may be visible below the umbilicus and marks the location of the arcuate line. The tendinous intersections on one side may be in line with the contralateral side or may be at different levels, giving an asymmetrical appearance to the anterior abdominal musculature. The intersections closest to the umbilicus tend to run horizontally,

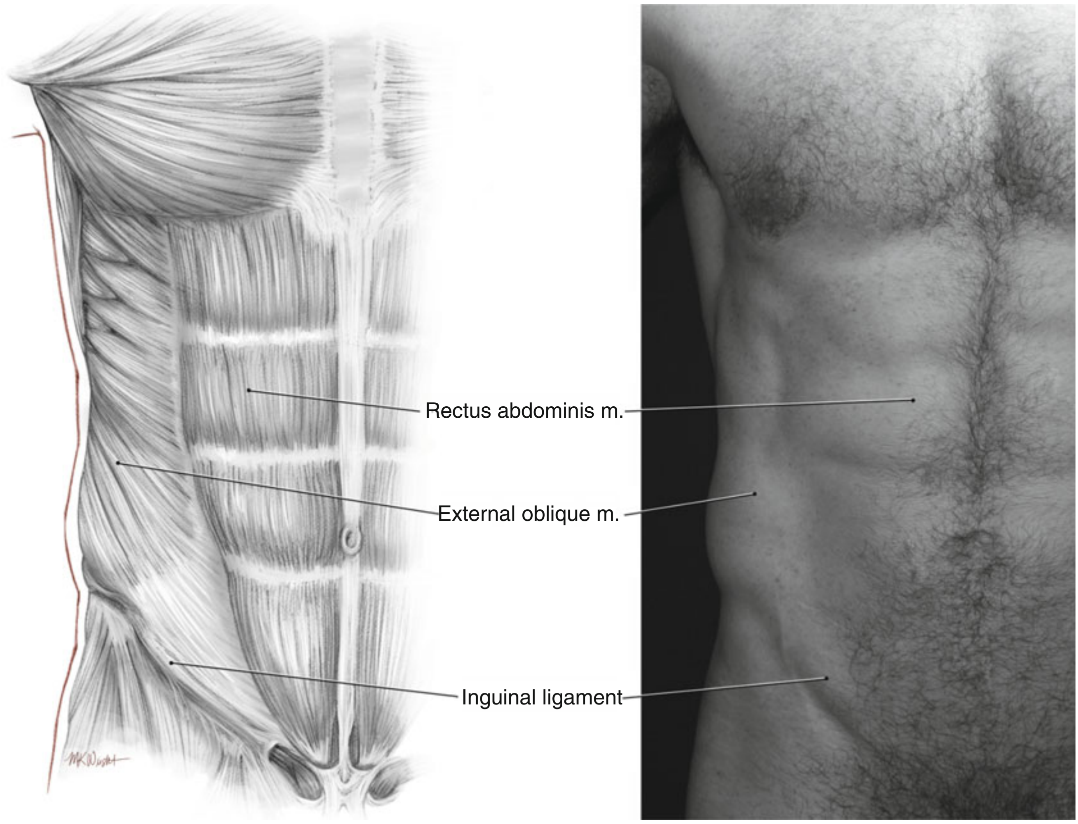

Fig. 2.5 Rectus abdominis. This represents the most important muscle in high-definition body sculpting of the anterior abdominal wall

whereas the uppermost tendinous intersections often run more diagonally. The orientation of tendinous intersections is highly variable, and all may be horizontal. Careful palpation of the anterior abdominal wall in slim individuals confirms the surface anatomy. The intersections divide the muscle into segments of fleshy protruding bellies that create the quintessential muscular male abdomen commonly referred to as the six-pack [2]. The superior borders of the upper segments usually coincide with the inferior margin of the pectoralis major, but variations exist. The muscle may continue superiorly under the pectoralis major or may end lower down, exposing the costal cartilages and creating a depression between the lower border of the pectoralis major and the superior border of the rectus abdominis. The borders of the segments created by the intersections are rounded. The lateral border of the rectus abdominis is often visible as a vertical groove in the anterior abdominal wall between the ninth costal cartilage and the pubic tubercle. This semilunar line typically runs along a line drawn from the midpoint of the clavicle to the middle of the thigh. It starts superiorly as a depression just below and medial to the nipple in men, runs inferiorly between the anterior limits of the muscular part of the external oblique and the lateral border of the rectus abdominis, and expands into a triangular area over the aponeurosis of the external oblique above the inguinal ligament. In the midline, diastasis or separation of the recti muscles with widening of the linea alba occurs following pregnancy or as a congenital deformity and may result in an abnormally convex abdominal contour. Plication of the anterior or posterior rectus sheath, sometimes combined with plication of

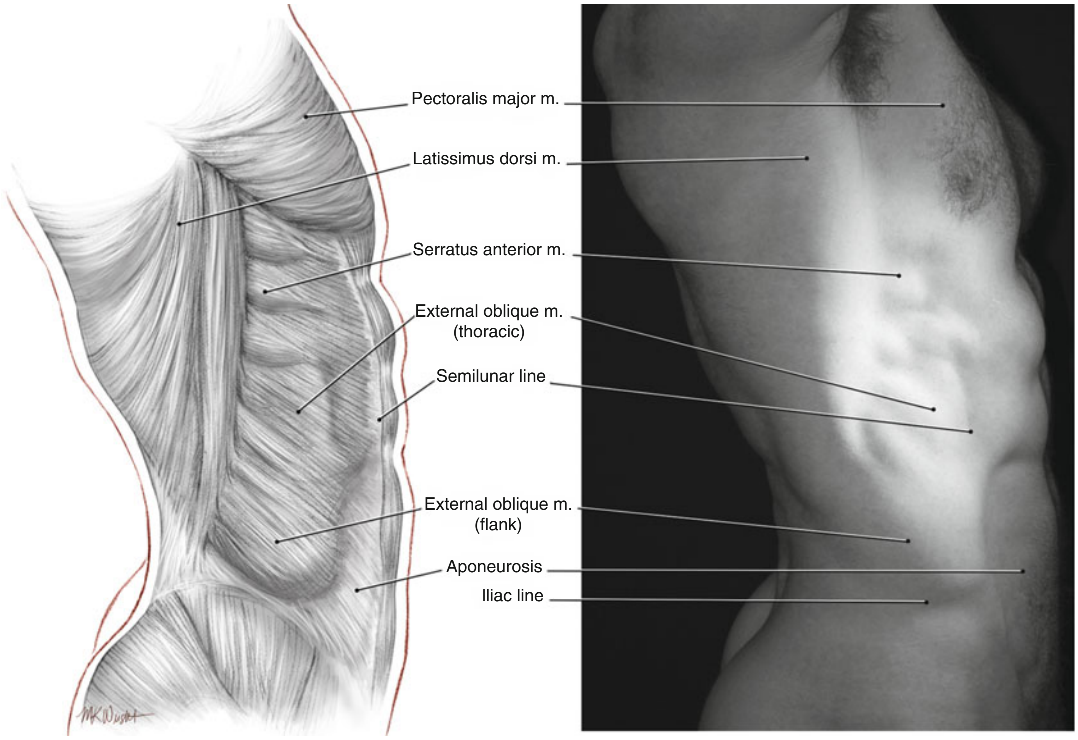

Fig. 2.6 The lateral abdominal wall. The external oblique muscle predominates, superiorly as the thoracic portion and inferiorly as the less well-defined flank portion

the external oblique aponeurosis, improves this myoaponeurotic deformity [3]. When the body is hyperextended, stretching the skin and muscle over the rib cage, a thoracic arch is easily seen where the costal cartilages meet the sternum in the midline. Even at rest, this may be seen in females and in thin individuals. The arch forms an angle of approximately 90° in males and 60° in females. In males, a more rounded arch is created by the costal margin laterally and the highest tendinous intersection of the rectus abdominis medially. The umbilicus or navel lies within a defect in the linea alba, opposite the fourth lumbar vertebra, and about midway between the xiphoid process and symphysis pubis. In athletic males, a sharp rim is usually present at the upper border of the umbilicus, whereas the lower border is less well defined. In females, a periumbilical fat pad deepens the navel and obscures its borders.

External Oblique

This muscle forms the fleshy part of the lateral abdominal wall as its fibers pass inferiorly and inferomedially superficial to the other flat muscles (Fig. 2.6). It originates from the external and inferior surfaces of the lower 7–8 ribs. The external oblique has two parts: an upper thoracic portion and a lower flank portion. The thoracic portion consists of separate elongated bundles of muscle that run parallel to one another and in a straight line from the external surfaces of the ribs to their aponeurosis at the semilunar line. The lower fibers of the thoracic portion form a transitional zone above the flank portion that coincides with the waist. The anterior edge of the thoracic portion of the external oblique is jagged or irregular where it inserts into its own aponeurosis as separate bundles. The flank portion of the muscle runs from the external surfaces of the inferior ribs to the anterior half of the lip of the iliac crest posteriorly and the external oblique aponeurosis and linea alba anteriorly. The flank pad represents a fleshy trapezoid between the ribs and pelvis that wraps around the waist. This comprises the flank portion of the external oblique anteriorly and a flank fat pad posteriorly. Even with good muscular development, external oblique muscle fibers are not visible in the smooth, convex flank pad. The inferior margin of the flank pad is the iliac line. Since the muscle fibers of the external oblique insert into the iliac crest, an iliac line lower than this is created by ptotic fat, and not muscle. The most posterior fibers of the flank portion of the external oblique pass vertically from the lower two ribs to insert into the iliac crest, creating a posterior free border. These fibers do not insert into the thoracolumbar fascia and constitute the anterior border of the inferior lumbar triangle of Petit, with posterior and inferior borders formed by the latissimus dorsi and iliac crest, respectively. Unusual cases of herniation through Petit's triangle have been reported [4]. This triangle is usually covered with the fat pad. The external oblique becomes aponeurotic medially at the midclavicular line and inferiorly at the spinoumbilical line (between anterior superior iliac spine and umbilicus). The aponeurosis passes anterior to the rectus abdominis as part of the rectus sheath and decussates with aponeurotic fibers of the contralateral external oblique, internal oblique, and transversus abdominis at the midline. The external oblique aponeurosis passes the midline to be continuous with the aponeurosis of the contralateral internal oblique. Functionally, the external oblique and the contralateral internal oblique can be considered as a digastric muscle, since their simultaneous action flexes and rotates the abdomen, as occurs when the shoulder is turned toward the contralateral hip. The inferolateral fibers of the external oblique, below the spinoumbilical line, turn backward and upward between the anterior superior iliac spine and the pubic tubercle to form the inguinal ligament. A triangular tendinous expansion occurs just below the spinoumbilical line and lateral to the rectus abdominis. There may be a slight groove above and parallel to the inguinal ligament in this area created by the internal oblique muscle lying beneath. The tip of the tenth rib marks the base of the rib cage and the superior limit of the abdominal portion of the external oblique [5]. A small triangular depression along the semilunar line occurs here in athletic people. Subdermal lipoplasty is used to create a controlled depression in this area to enhance definition of the anterolateral abdominal wall.

Serratus Anterior

This quadrilateral muscle originates anteriorly as fingerlike bundles from the external surfaces of the upper 8–9 ribs and wraps around the rib cage to insert into the vertical, medial edge of the scapula. It acts to draw the scapula laterally and around the rib cage, as in punching. The inferior part of the muscle rotates the tip of the scapula laterally, raising the arm. In muscular individuals, the anterior parts of the lowest 3–4 digitations of the serratus anterior can be seen on the lateral chest wall as they mingle with fibers of the external oblique (Fig. 2.7). The superior bundle is usually seen immediately below or at the inferior margin of the pectoralis major. The digitations of the serratus anterior are easily distinguished from the external oblique as thicker, more pronounced bundles of muscle that are oriented more horizontally relative to the fibers of the external oblique. A line drawn from the male nipple to the posterior superior iliac spine approximates the anterior extent of the visible portion of the serratus anterior over the torso as seen in profile view [5]. The rest of the serratus anterior is hidden from view by the pectoralis major superiorly and the latissimus dorsi posteriorly or is present between the two where it forms the medial wall of the axilla. Posteriorly, the mass of the serratus anterior can be appreciated where it bulges underneath the flat latissimus dorsi muscle that covers it. Its posterior limit sometimes extends more medial to the scapula where its fibers insert into part of the rhomboid major. Defining the serratus anterior plays an important role in high-definition body sculpting in male patients.

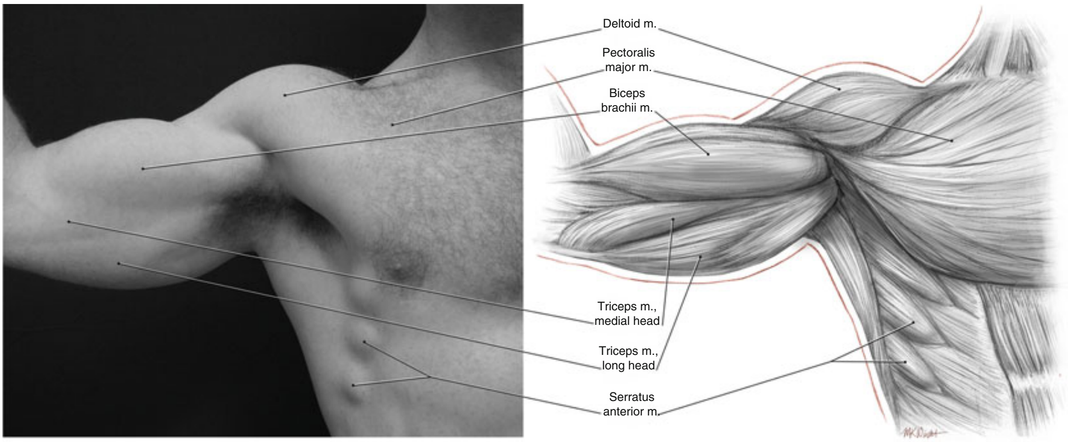

Fig. 2.7 The superolateral abdominal wall. The serratus anterior is clearly visible as three bulging slips of muscle below the lateral aspect of pectoralis major

Pectoralis Major

The pectoralis major forms most of the muscle bulk of the chest and gives the chest a smooth, convex form, particularly when the muscle is well developed (Fig. 2.8). It originates from the medial half of the clavicle, anterior surface of the sternum, costal cartilages of the first 6–7 ribs, and inferiorly the superior part of the external oblique aponeurosis of the abdomen. Based on its origin, the pectoralis major can be divided into clavicular, sternocostal, and abdominal portions. All portions of the pectoralis major insert into the lateral lip of the intertubercular groove on the anterior surface of the humerus. The clavicular portion arises from the clavicle and its fibers pass laterally and downward until they are adjacent to and parallel with fibers of the deltoid. Here the muscle bundle of the clavicular portion passes over other portions of the pectoralis major. The sternocostal portion passes almost horizontally, and the abdominal portion passes upward and laterally, deep to the other portions. Depending on the position of the arm, the pectoralis major adducts, rotates forward, flexes, and extends the humerus. Superiorly, the muscle tends to be flatter against the rib cage, whereas the inferior part of the muscle has more mass and provides a smooth convexity. The inferior margin of the pectoralis major is straight and horizontal or slightly downward sloping from medial to lateral. There is a rounded sweeping form laterally as the muscle passes upward toward the axilla. This may be interrupted by a separate curvature created by the abdominal portion of the muscle as it arises from the abdominal aponeurosis and passes toward and then beneath the sternocostal portion of the pectoralis major. A pectoral fat pad near the nipple contributes to the volume and anterior convexity of the chest. Laterally, the muscle forms the anterior wall of the axilla. Between the clavicular portion and deltoid, there is a triangular fossa, the deltopectoral fossa. A groove continues from this inferolaterally between the two muscles as the deltopectoral groove, in which lies the cephalic vein. In the midline, there is a medial depression or groove over the sternum between the insertions of both pectoralis major muscles. This is more pronounced in muscular individuals. As the origin of the muscle moves away from the midline inferiorly, the space between the left and right pectoralis muscles forms a triangular depression above the xiphoid process. Techniques used to contour the chest in males include adding volume to the clavicular portion with fat grafting and defining the borders of the sternocostal portion by removing fat in the upper abdomen and toward the axilla.

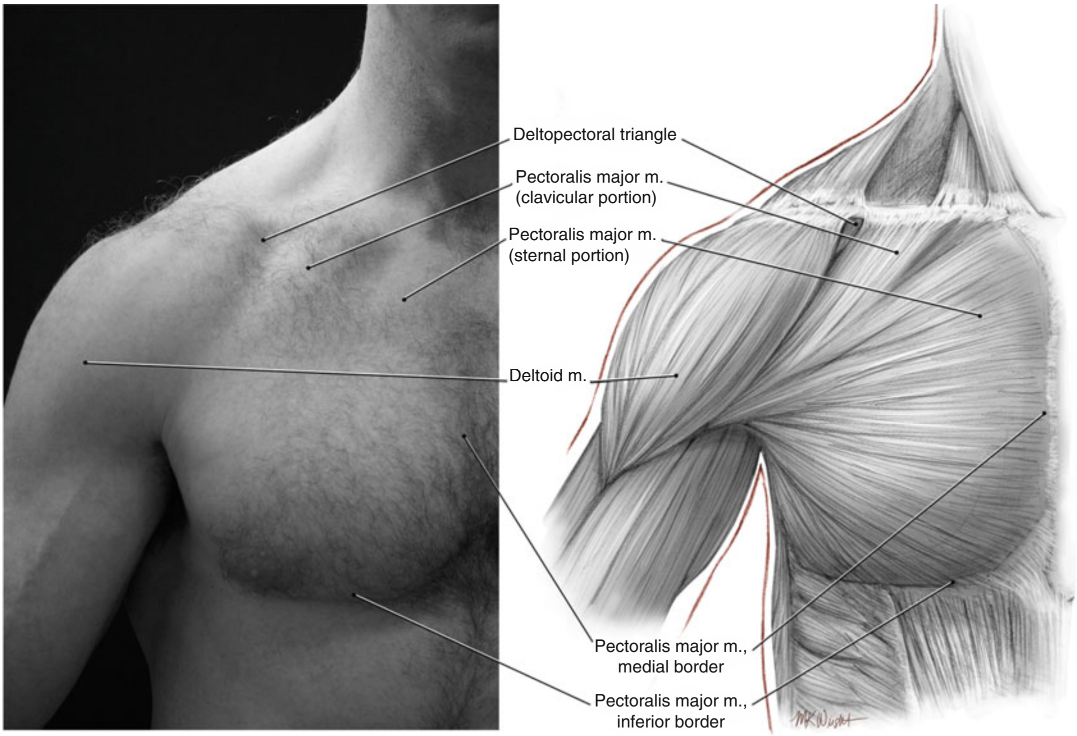

Fig. 2.8 Pectoralis major. This muscle forms the mass of the male chest

Latissimus Dorsi

The latissimus dorsi is a triangular sheetlike muscle that passes from the midline to the arm like a cape, covering the deeper muscles of the mid and lower back (Fig. 2.9). It originates from the spinous processes of the seventh to twelfth thoracic vertebrae, those of all of the lumbar and sacral vertebrae, the posterior one-third of the iliac crest, and the external surfaces of the lower three ribs. The muscle bundles converge toward the axilla and insert via a tough, square tendon into the proximal humerus proximal to the insertion of the pectoralis major. As they converge, they wrap around the teres major, forming a sling that forms the posterior wall of the axilla. The teres major forms part of that wall but appears superior and lateral to the latissimus dorsi on frontal view. The form created by both latissimus dorsi muscles is that of an inverted triangle or "V." The upper fibers of the latissimus dorsi pass horizontally from the midline and form the superior free edge of the muscle as they pass laterally at about the same level as the inferior margin of the pectoralis major anteriorly. They cover the tip of the scapula, teres major, and serratus anterior. The tendon of origin of the latissimus dorsi creates a line or curve from the midline over the thoracic vertebrae to the crest of the ilium. The latissimus dorsi and its tendon are draped over the deeper muscles, including the erector spinae, teres major, and serratus anterior. When these muscles contract or when the latissimus dorsi is stretched over them, their form is seen as bulges and shadows beneath. The lateral border of the latissimus dorsi extends upward and laterally from the waist. Although the form of the muscle is normally evident in its middle and superior portion, inferiorly, the dorsal fat pad obscures both it and the inferior flank portion of the external oblique.

Erector Spinae

The erector spinae comprises a group of muscles that fill the gutter on either side of the vertebral

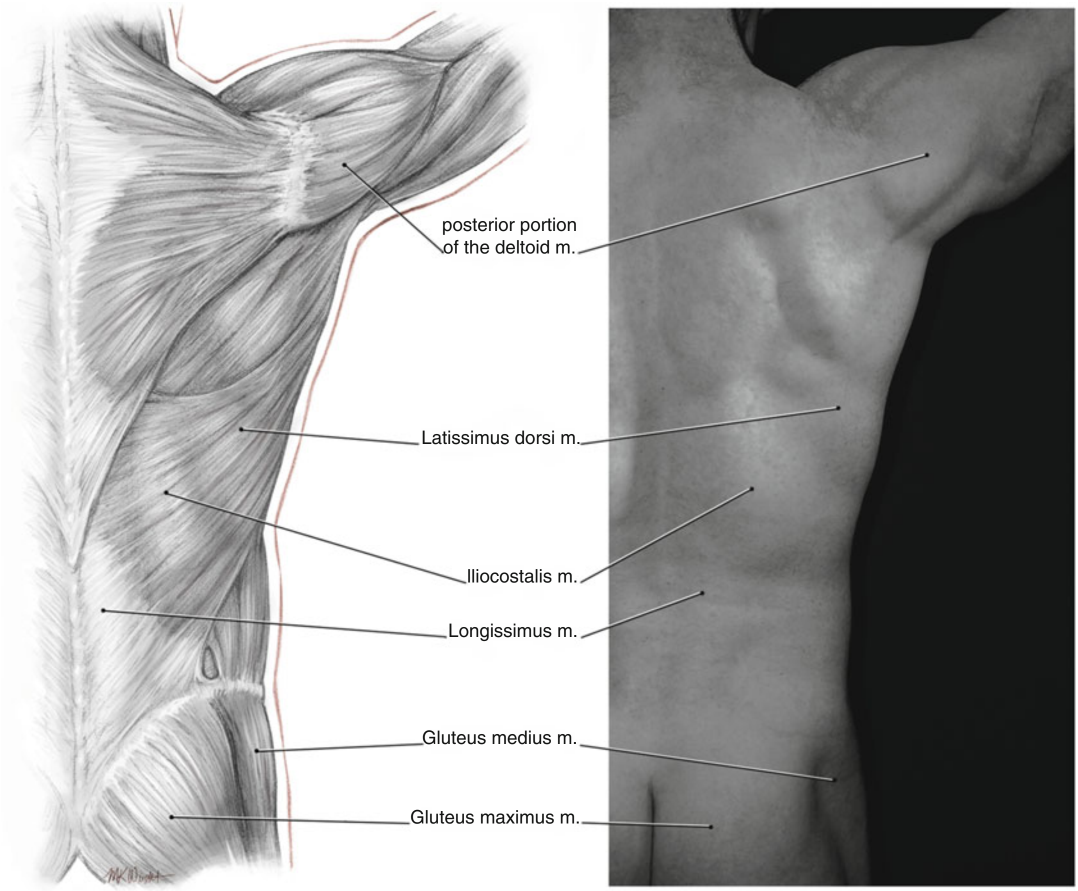

Fig. 2.9 Muscles of the back. In men, the latissimus dorsi contributes to the "V"-shaped form

column. The erector spinae group is mostly tendinous at its origin, becomes thick and fleshy in the lower back, and then tapers to form several thin slips of muscle before they end at their insertion points along the ribs and vertebrae. From lateral to medial, the erector spinae consists of the iliocostalis, longissimus, and spinalis (Fig. 2.9).

The iliocostalis forms a lateral muscle mass in the lower back. It originates from the posterior third of the iliac crest, from the lateral and median crests of the sacrum, and—through the erector spinae aponeurosis—from the spinous processes of the lumbar vertebrae. The iliocostalis has three portions, according to insertions. The iliocostalis lumborum inserts into the posterior aspects of the inferior six ribs. The iliocostalis thoracis contains muscle slips that run from the inferior six ribs to the first six ribs, and the iliocostalis cervicis runs from the first six ribs to the transverse processes of C6–C4 [6]. The form of the iliocostalis lumborum can often be appreciated through the thin anterior layer of thoracolumbar fascia that covers it.

The longissimus lies medial to the iliocostalis and also contains three portions: thoracis, cervicis, and capitis. The longissimus thoracis runs from the medial part of the posterior iliac crest and from the spinous processes of L3 to the sacrum and inserts into the base of transverse processes L1 to L5 and to the tips of transverse processes T1 to T12 as well as to the adjacent ribs. Slips from the longissimus cervicis and longissimus capitis pass to the cervical processes and mastoid process, respectively. Like the iliocostalis and longissimus, the spinalis comprises three parts, although this muscle is thinner and less consistent. The spinalis runs close to the midline with its lowest extent reaching L3. As such, it does not contribute significantly to the surface anatomy and form of the lower back.

Multifidus

The multifidus is a fleshy muscle that fills the space on either side of the midline between the spinous and transverse processes. It stabilizes the vertebral column and assists in extension, lateral flexion, and rotation of the back. The multifidus contributes to the elongated mass in the lower back on either side of the midline where it lies deep to the longissimus and spinalis.

Shoulder and Arm

The main prominence of the shoulder is attributed to the muscular mass of the deltoid that cups the shoulder joint. There is a seamless progression from the definition of the chest to the shoulder as the clavicular portion of the pectoralis major lies alongside and almost blends with the anterior portion of the deltoid. In turn, the middle portion of the deltoid points downward toward the upper arm muscles that lie on either side of its insertion. The major muscles of the shoulder and arm should not be ignored when sculpting the chest and torso.

Deltoid

This triangular muscle has three parts: anterior, middle, and posterior. The anterior portion originates from the lateral third of the clavicle, the middle portion from the acromion, and the posterior part from the inferior surface of the spine of the scapula. All portions insert into the deltoid tuberosity on the midportion of the humerus. The deltoid raises the arm anteriorly, laterally, and posteriorly. The anterior portion is usually well defined as a distinct teardrop-shaped muscle, separated from the pectoralis major by the deltopectoral triangle and groove (Fig. 2.8). There is a less well distinct groove between the anterior and middle portions of the deltoid. The middle portion gives the shoulder a rounded appearance on front view and inserts lower than the anterior and posterior parts. The posterior portion is visible as a mass that separates the deltoid from the long and lateral heads of the triceps (Fig. 2.10). The tendon of the clavicular portion of the pectoralis major passes under the tendon of the anterior portion of the deltoid. The latter inserts into the deltoid tubercle on the anterior surface of the humerus. The other two parts of the deltoid insert into the lateral aspect of the humerus. When the arm is rotated medially or laterally, the shape and

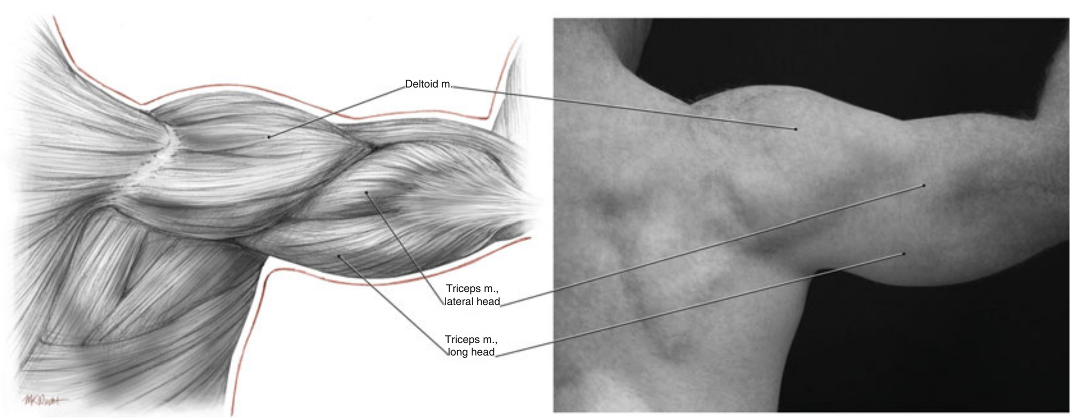

Fig. 2.10 Posterior view of the shoulder muscles. The deltoid is a prominent mass and separated from the arm extensors by a distinct groove

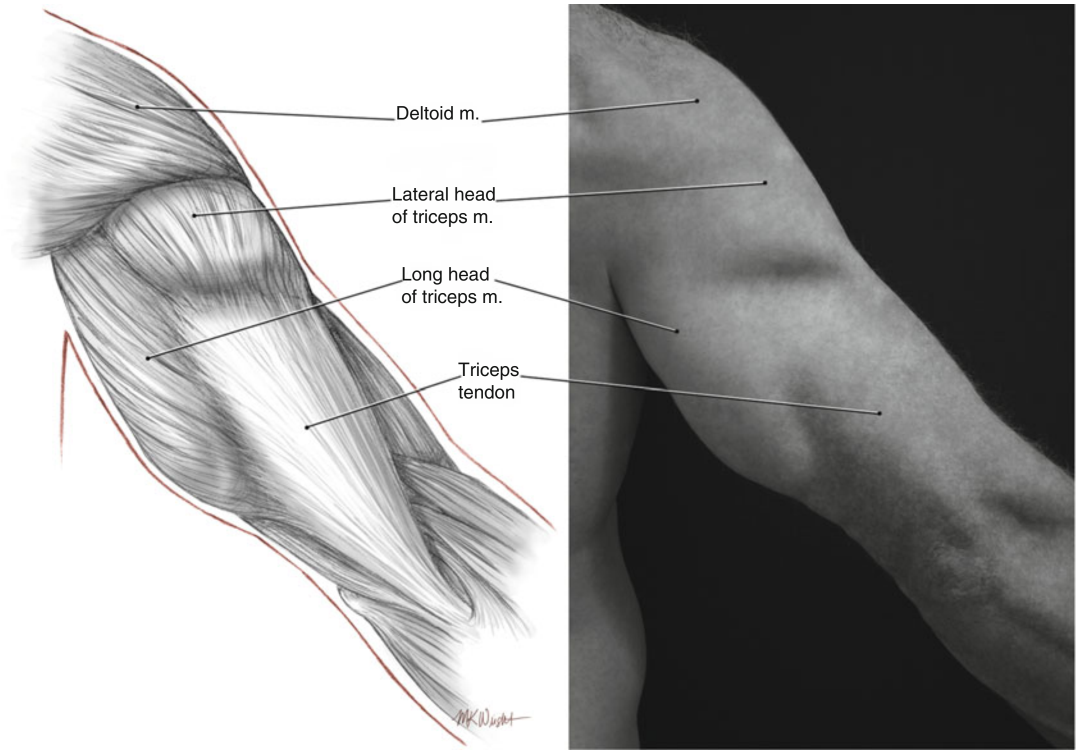

Fig. 2.11 Muscles of the posterior aspect of the upper arm. Note the grooves between the deltoid and the triceps and between the long and lateral heads of the triceps and their tendon

form of the deltoid changes slightly as the insertion points twist and the muscle moves accordingly. Unlike the anterior and posterior portions, the middle portion of the deltoid is multipennate. Tendon branches within the muscle and muscle fascicles attach obliquely to the tendons. In slim, muscular individuals, the muscle bundles can be seen to interdigitate diagonally, producing a segmented appearance over the lateral aspect of the shoulder. The definition and rounded form of the deltoid is enhanced during high-definition lipoplasty from incision access sites at the anterior and posterior axillary folds.

Triceps

The large triceps muscle consists of three heads: long, lateral, and medial. The long and lateral heads provide most of the surface form of the posterior upper arm and form a prominent bulge just distal to the rounded contour of the deltoid (Fig. 2.11). The medial head lies deeply and contributes to the volume and thickness of the arm. The long head of the triceps arises from its tendon between the teres major and teres minor, below the glenoid fossa of the scapula. It crosses the shoulder joint and forms the main mass of the posterior upper arm. Proximally, tendinous fibers from the scapula compress the long head when it is contracted, visibly dividing the belly of the muscle into anterior and posterior parts on the inner surface of the arm (Fig. 2.7). The long head inserts into the upper medial edge of the large flattened tendon of insertion of the triceps. The lateral head originates from the proximal posterior surface of the humerus and is easily visible as a mass on the lateral aspect of the arm near the deltoid. It inserts high up into the flat, rectangular triceps tendon. A thin part continues to run down along adjacent to the lateral part of the triceps tendon, creating a taillike form when the arm is tensed. All of the triceps heads insert via their tendons into the posterior aspect of the proximal

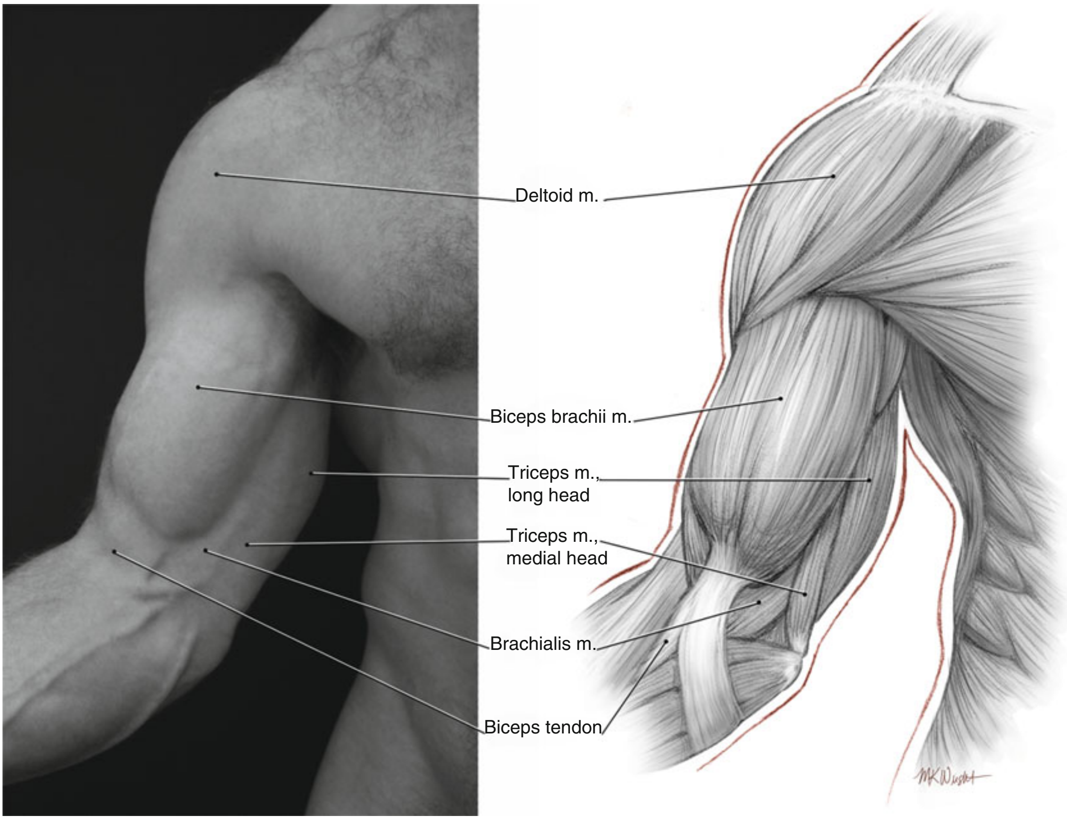

Fig. 2.12 Arm flexors. The biceps brachii forms the most defined mass on the anterior arm. The brachialis provides mass from beneath

olecranon. A cylindrical form that comprises part of the medial head of the triceps can be appreciated on the inner surface of the arm where it emerges from between the biceps brachii and the long head of the triceps about halfway down the arm (Fig. 2.7). It is possible to enhance the groove between the medial head and the biceps anteriorly and the medial head and the long head of the triceps posteriorly using very superficial and delicate ultrasound-assisted lipoplasty in this area.

Biceps

The prominent convex form over the anterior aspect of the upper arm is provided mostly by the mass of the biceps brachii (Fig. 2.12). When well developed, the biceps brachii typifies strength, athleticism, and aesthetically ideal upper arm form. The long head of the biceps originates from the supraglenoid tubercle of the scapula. The short head originates from the coracoid process of the scapula. The biceps brachii emerges from beneath the pectoralis major and creates a groove between the two muscles, particularly when the arm is abducted and externally rotated. This groove is often accentuated by high-definition sculpting to highlight the separation between the muscles. The long and short heads of the muscle travel over the humerus but do not attach to it. Instead, they insert into the tuberosity of the radius via the biceps tendon deep between the flexors and extensors of the forearm. The two heads of the biceps brachii usually appear as one bulging form over the upper arm, although sometimes the separation between the two heads can be seen running longitudinally over the muscle just medial to the cephalic vein. In the inner part of the arm, the belly of the short head of the biceps creates a convex prominence that is directed toward the axilla. As the short head emerges from underneath the pectoralis major, it is joined by the coracobrachialis on its medial side. The coracobrachialis is a cylindrical muscle that runs from the coracoid process to the medial aspect of the midportion of the humerus. In the middle third of the arm, the biceps brachii is separated by a groove from the long head of the triceps and the medial head of the triceps more distally. The neurovascular bundle lies within the brachial fascia deep to the groove. When the arm is flexed to 90° and supinated, the rounded inferior margin on the biceps brachii is prominent. With flexion against resistance, the bicipital aponeurosis becomes prominent as a thin sharp tendinous sheet that crosses from the biceps brachii over the medial aspect of the elbow. This aponeurosis passes medially and wraps around the forearm flexors.

Brachialis

The brachialis provides width to the flexor half of the upper arm. It is a broad flat muscle that lies on the humerus behind the biceps brachii. The brachialis originates from the anterior lower part of the humerus and crosses the elbow joint to insert into the coronoid process of the ulna. On anterior view, the brachialis is seen to protrude laterally from behind the biceps brachii (Fig. 2.12). A depression or groove at the superolateral origin of the brachialis on the humerus marks the junction of the brachialis and the deltoid. Closer to the elbow, its medial fibers form the floor of a concave space bordered anteriorly by the bicipital aponeurosis and posteriorly by the medial head of the triceps. The brachial vessels occupy this space.

Thighs and Hips

In properly selected patients, superficial lipoplasty to create controlled depressions between major muscle groups enhances definition and improves the aesthetics of the lower limb. Autologous fat grafting into and around the hip muscles plays an important role in gluteal sculpting and in improving the silhouette and waist-hip ratio in female patients. The major muscles that should be considered in contouring and sculpting the hip region and lower limb are described in this section.

Gluteus Maximus

The gluteus maximus contributes to the convexity of the posterior buttocks and forms most of the buttock volume in slim individuals (Fig. 2.13). It originates from the posterior gluteal line of the inner upper ilium (from the iliac crest), the posterior lateral surface of the sacrum, the coccyx, and the sacrotuberous and sacroiliac ligaments. Most of the muscle fibers run inferolaterally, curving around the hip to insert into the iliotibial tract. Deep fibers from the lower portion of the muscle insert into the gluteal tuberosity on the posterior proximal surface of the shaft of the femur. The muscle bulk creates a convex form posteriorly that contributes to the desirable "S" curve formed by the gluteus maximus and the lumbar lordotic curve superiorly (Fig. 2.14). A depression is formed over the posterior superior iliac spine since the medial fibers of the gluteus maximus originate from, but do not cover, the spine. A triangle is formed between the two depressions or dimples on either side of the midline and the gluteal cleft. Thorough lipoplasty in this sacral triangle helps define the superior borders of the buttocks. A gluteal fat pad covers the inferior medial border of the gluteus maximus and forms the medial part of the infragluteal fold. Laterally, the gluteus maximus tapers between the long head of the biceps femoris and vastus lateralis. The inferiorly pointing form of the muscle here may be visible in male patients, but in female patients the overlying gluteal fat usually obscures the form of the muscle. Additionally, a band of fascia across the inferior part of the gluteus maximus creates a deep infragluteal crease when the hip is extended. This crease extends from the gluteal cleft in the midline for a variable distance laterally depending on the volume of the buttock and tone of the skin. Gluteal augmentation using autolo-

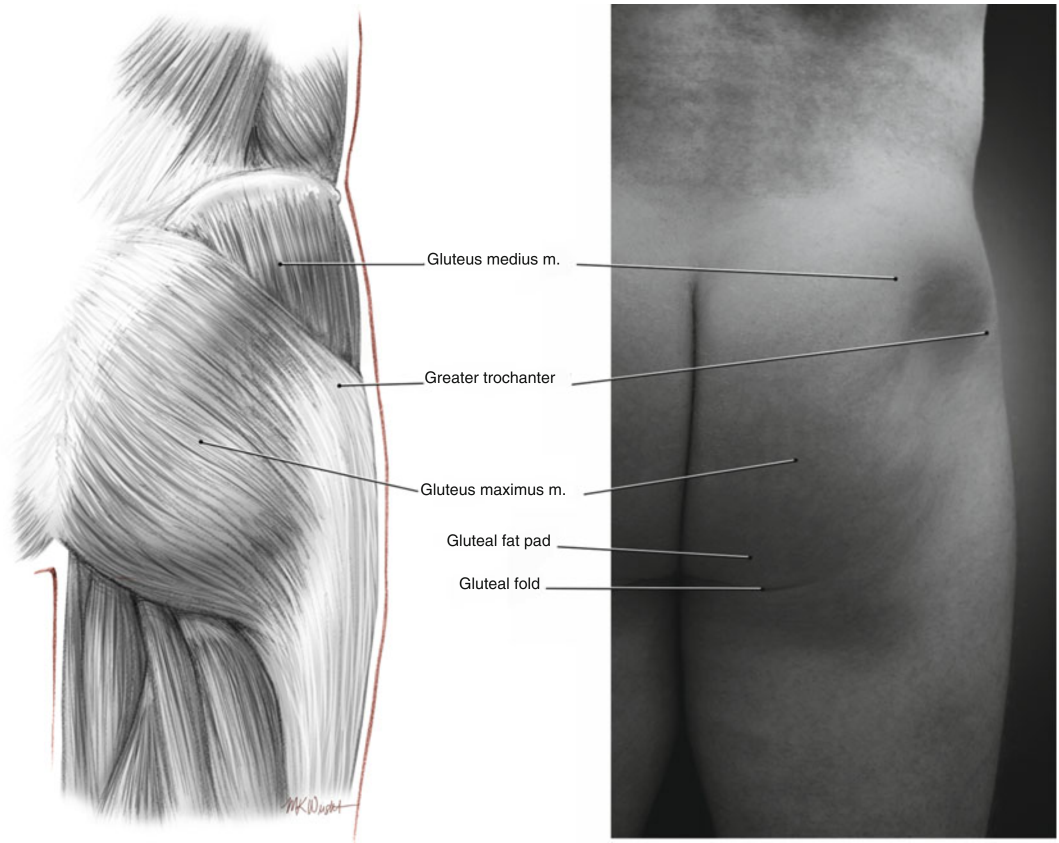

Fig. 2.13 Gluteus maximus. This muscle provides mass, shape, and projection to the buttocks

gous fat can be performed from an access site in the infragluteal crease with the patient in the prone position. On profile view, a concavity occurs between the greater trochanter and muscle fibers of the gluteus maximus where the muscle inserts into the iliotibial tract. The iliotibial tract covers the vastus lateralis and passes inferiorly to insert into the lateral condyle of the tibia. The muscle bulk of the gluteus maximus posteriorly and the gluteus medius superiorly creates a "C"-shaped form with the greater trochanter lying centrally (Fig. 2.14).

Gluteus Medius

Anterior to the gluteus maximus lies the gluteus medius, a strong fan-shaped muscle that runs from the anterior part of the lateral aspect of the ilium to the lateral surface of the greater trochanter (Fig. 2.14). The posterior part of the gluteus medius is hidden deep into the anterior fibers of the gluteus maximus. Anteriorly, the gluteus medius is bounded by the thin teardrop-shaped tensor fascia lata that passes from the iliac crest just posterior to the anterior superior iliac spine and inserts on the iliotibial tract just above the level of the infragluteal fold.

Iliopsoas

Although the form of the iliopsoas cannot usually be appreciated on the surface, it forms the floor of a triangular space bounded superiorly by the inguinal ligament and laterally by the sartorius. The iliopsoas comprises two muscles: iliacus and psoas major. The iliacus originates from the iliac

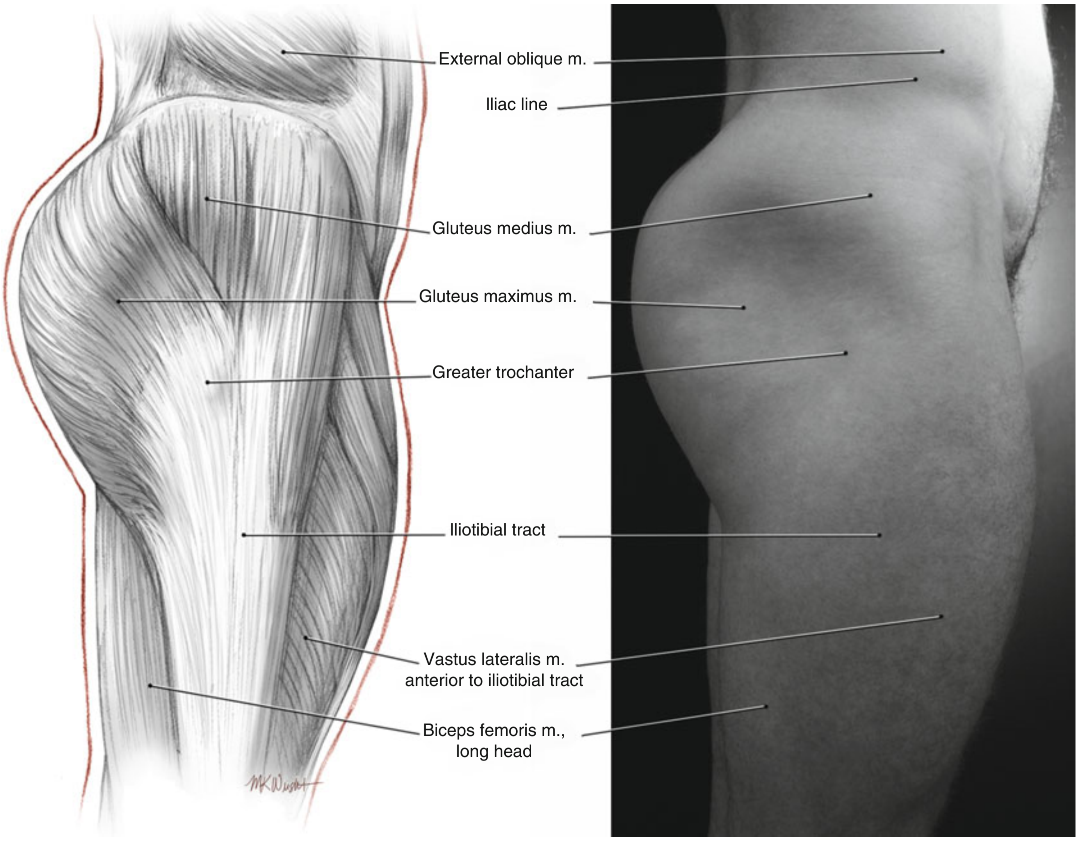

Fig. 2.14 Lateral aspect of the thigh and hip. The gluteus maximus projects posteriorly and continues anteriorly with the gluteus medius. Note the shadow between the biceps femoris and the iliotibial tract of the lateral thigh

fossa and sacrum and inserts into the shaft of the femur just below the lesser trochanter. The psoas major originates from the transverse processes and bodies of the lumbar vertebrae and inserts into the lesser trochanter of the femur. Lipoplasty over the iliopsoas just inferior to the inguinal ligament makes the ligament appear more prominent and defines the inferior extent of the abdomen.

Quadriceps

This large muscle group forms a large bulky mass over the anterior thigh. The quadriceps femoris consists of four muscles: vastus lateralis, vastus intermedius, vastus medialis, and rectus femoris. The form of the muscles, except the vastus intermedius, can be appreciated on the surface, particularly when the knee is forcefully extended (Fig. 2.15). The muscle bellies taper inferiorly toward their strong quadriceps tendon. The vastus lateralis originates from the anterior surface of the greater trochanter and along the linea aspera on the posterior surface of the shaft of the femur. The muscle sweeps over the anterolateral aspect of the thigh creating a convex form. The more bulky inferior portion ends abruptly at the quadriceps tendon below the insertion of the adjacent rectus femoris insertion into the tendon. Laterally, the iliotibial tract passes from the greater trochanter, along the lateral thigh over the vastus lateralis, and inserts into the lateral condyle of the tibia. A concave space is formed above the knee laterally that is bordered by the iliotibial tract posteriorly, the distal limit of the vastus lateralis belly superiorly, and the patella