Plastic Surgery in the Elderly

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The longer I live, the more beautiful life becomes. – Frank Lloyd Wright

Introduction

As the population of the United States continues to age, there is an increasing demand for plastic surgery among the elderly population. The American Society of Plastic Surgeons reported a year to year 2% increase in procedures by patients over the age of 55 to 4.2 million cosmetic procedures in 2018 alone [1]. By 2050, the United States is expected to accelerate its elderly population growth of people 65 or older to 88.5 million people from its current 50 million today [2]. With age, there is an increasing demand for reconstructive surgeries such as wound care, tumor removal, and cancer reconstruction. ASPS statistics reveal a 29% increase in breast reconstruction alone with over 101,000 cases performed in 2018 [1]. The fastest rising trend in plastic surgery is the demand for post-bariatric body lifts with arm and lower truncal lift accounting for 5000% increase in numbers over the past two decades. With a third of Americans obese, there is no doubt these interventions will continue to rise. Furthermore, media and global access drive the celebrity culture and medical tourism which in turn have created a disproportionate demand for "minimally invasive" procedures that have made "60 is the new 40 years of age" culture and have contributed to the $40 billion plastic surgery global market. Therefore it is important to understand the plastic surgery principles surrounding the aging needs of the elderly

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population as it pertains to economic impact, improved outcomes, and the health of our society.

Biological Factors of Skin Aging

Over the past decade there has been tremendous amount of published literature focused on aging. With regard to plastic surgery, we are interested in factors that cause aging of the skin, muscle, bone, tendons, and peripheral nerves.

Extrinsic Factors

By far the most damaging external factor that can lead to "premature aging" is considered to be exposure to the sun. UVA and UVB rays of the sun can lead to free radicals which can directly damage the dermal layer, impair DNA repair of the skin, and suppress the immune mediated defense of the skin mediators. The buildup of damaged elastin at the dermal layer, combined with increased collagen breakdown and lack of repair, leads to uneven epidermal thickening and dermal thinning of the skin called solar elastosis which then further exacerbates the morphology of the skin with vessels that come close to the surface known as telangiectasia, and congregation of pigment-producing melanocyte cells called solar lentigo and dyschromia. Other factors that play a large role in the aging of the skin include dehydration, wind (primarily through dehydration), cold exposure, and smoking. Guyuron et al. studied the role of smoking in facial aging and found that a 5 year history of smoking can cause a noticeable difference in the appearance of aging in identical twins [3]. Similarly Ichibori and colleagues studied 67 pairs of Japanese monozygotic twins and found that cigarette smoke and sun exposure were the primary factors to worsen facial texturing [4] (Fig. 25.1).

Fig. 25.1 Facial changes caused by smoking: a comparison between smoking and nonsmoking identical twins. (Reprinted with permission from Plast Reconstr Surg. 2009;123(4):1321–31)

Fig. 25.2 The aging of French actress Bridget Bardot over a 50 year period revealing the intrinsic and extrinsic forces at play in aging with loss of facial definition and diamond shape and descent of soft tissue in the neck

Another major noted factor for aging on our planet is the presence of gravity. Gravity places forces on our body which require a counterforce directed by our muscles, bones, tendons, and ligaments. Over time, with repetitive motion of these activities, a typical pattern of aging emerges in the face which has been well documented by investigators [5–7].

In a series of carefully reported studies of computed tomography scans of various age groups, Kahn and his team have shown that there is definitive changes in facial skeleton over time as the glabellar and maxillary angle in both the male and female subjects decrease with increasing age while there is a significant increase in pyriform aperture area from the young to the middle age group for both sexes. The pyriform and orbital aperture width and surface area increases significantly with age for both sexes. Mandibular length and height both decrease significantly for each sex while the mandibular angle significantly increases with age for both sexes. Coupled with Mendelson's work which showed increased descent of mid cheek soft tissue and loss of malar and mandibular ligament support, we can start to put together a predictable pattern of facial aging in all humans [8]. One cannot help but wonder about the circular nature of life since these facial patterns are very similar to the morphology of a baby's face (Fig. 25.2).

Intrinsic Factors

The ability of the skin to age well also depends on a multitude of factors including collagen which provides the structure foundation of the extracellular matrix (ECM) in the dermis. There are two major subtypes of collagen in the human skin: Type I collagen forms up to 90% of the skin while type III is responsible for about 10% of the dermis. El domiyati et al. have shown that human skin which primarily contains type I and III collagen can maintain its proportion well into the eighth decade of life unless interrupted by extrinsic factors [9], while Lovell and his team have suggested that the intrinsic effects of aging are primarily related to the inhibited synthesis of type I collagen [10]. Collagen, which is a major component of ECM, becomes fragmented and unevenly distributed due to increased activity of matrix metalloproteinases, and reactive oxygen species disrupt the normal signaling mechanism of transforming growth factor-β during aging.

The reduction in the amount of collagen hinders the mechanical interaction between fibroblasts and the ECM, and consequently leads to the deterioration of fibroblast function and further decrease in the amount of dermal collagen. Other ECM components, including elastic fibers, glycosaminoglycans (GAGs), and proteoglycans (PGs), are also negatively affected by aging. Dermal elastin which primarily stores energy for skin recoil and hyaluronic acid which gives its turgor decrease in intrinsically aged skin giving the typical appearance of dry skin that does not bounce. There is plenty of evidence that supports the loss of all these major components of the skin from ongoing protein glycation and inherent inflammatory damage [11–16].

There is also loss of muscle mass, and declining strength with age as nearly 30% of muscle mass is lost by the ninth decade of life [17]. This is likely due to decreased muscle build with lower body protein and increased expression of inflammatory factors leading to skeletal muscle catabolism with concomitant increased apoptosis and decreased mitochondrial function.

Age-related changes in bone involve reduced calcium and phosphate metabolism with resultant loss of mass and mineral content, increased marrow fat content, and altered response to growth factors and hormones [18]. Osteoblasts, osteoclasts, and osteocytes, like most other stem and progenitor cells, slow their activity leading to osteoporosis and skeletal fragility, increasing susceptibility to fractures [19]. The decline in structure and function of aged tendons results from degeneration of tenocytes and collagen fibers, accumulation of lipids and ground substance, and calcium deposits. Tenoblast metabolic activity also decreases which results in tensile strength loss, stiffness, and increased susceptibility to damage.

Within the peripheral nervous system, there is impaired regeneration of neurons which accumulate lipofuscin granules, with subsequent axonal loss, demyelination, and synapse number reduction and attenuated growth factor response [20]. These changes result in age-related declines in nerve conduction velocity, muscle strength, sensory discrimination, and autonomic responses and lead to poorer outcomes in reinnervation following peripheral nerve injury in the aging population [21] (Fig. 25.3).

Along with the molecular changes, there is a remarkable change that also happens in the facial soft tissue. Pesa and his colleagues have published a series of papers that have shown the intricate nature of the facial fat compartments and their relative contribution to aging over time. We now have a better understanding of why aging happens in such a predictable pattern in the periorbital area followed by fat involution in distinct compartments of the cheeks and lower face [23–25]. Even more fascinating is the knowledge about why men seem to age "slower" than women. MRI studies have shown that women tend to lose their diamond facial shape

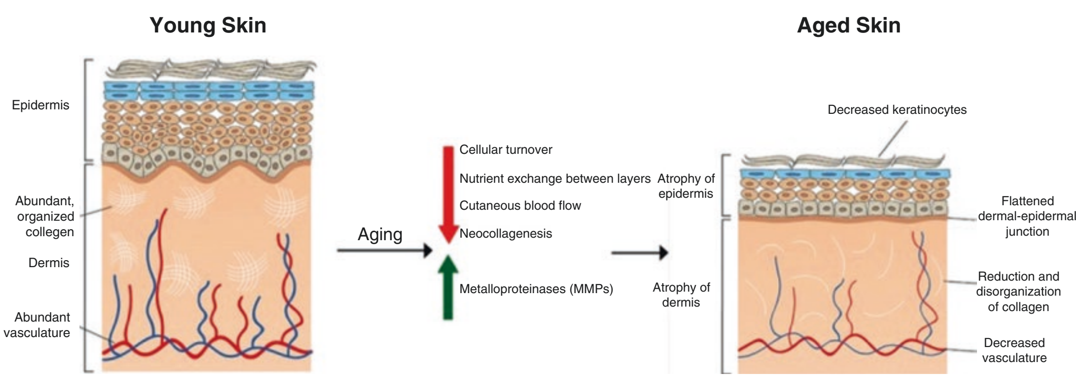

Fig. 25.3 Skin aging. Decreased cellular turnover and inefficient nutrient exchange between the different layers occurring with aging result in atrophy of both the epidermis and dermis. The decrease in collagen number and organization result from decreased production of collagen as well as increased breakdown by metalloproteinases. A reduction in the vasculature is also seen leading to inefficient cutaneous blood supply [22]

with time whereas men maintain their square shape as they age [26]. The result is that both men and women age with square-shaped faces as the bones resorb and soft tissue descend into jowls and lower neck. However, our brains perceive that women's faces lose their rejuvenated appeal as they lose their diamond shape (Table 25.1).

Physical Exam and Analysis

Armed with the knowledge of intrinsic and extrinsic factors of aging, it is important to evaluate the patients carefully based on these known parameters and document it carefully before one undertakes any surgery on the elderly. The Table 25.2 below shows what the surgeon needs to evaluate and document prior to operating on the geriatric patient.

Table 25.1 Changes in dermal extracellular components in the aging process

Photoaging	Components	Intrinsic Aging
Decreased and fragmented	Collagen	Decreased and fragmented
Abnormally accumulated (SE)	Elastic fiber	Decreased
Increased in SE region	Hyaluronic acid	Not changed
Increased	Total sulfated GAGs	Decreased
Increased in SE region	Versican	Not changed?
Not changed	Biglycan	Decreased
Decreased in SE region	Decorin	Not changed?

GAG glycosaminoglycan, *SE* solar elastosis
Source: Shin JW, Kwon SH, Choi JY, et al. Molecular Mechanisms of Dermal Aging and Antiaging Approaches. Int J Mol Sci. 2019;20(9):2126. Published 2019 Apr 29. https://doi:10.3390/ijms20092126

Planning for Plastic Surgery

It is important to note that although many of the changes of aging manifest themselves in the cosmetic evaluation, we also need to be aware of the physiological aspects of aging that can affect the surgical outcome in the elderly patient. The core values of plastic surgery dictate that the physician first address the functional impairments, next focus on form, and finally maximize the aesthetic benefit of the operation for the patient. There are a number of important considerations in planning reconstructive surgery for the geriatric patient.

Breast Reconstruction

With the aging of the world, the prevalence of breast cancer among elderly women is increasing. Nearly half of all women who are diagnosed with breast cancer are over the age of 65. As a result, more elderly women require breast reconstruction.

Table 25.2 A check list of all these factors must be considered when evaluating the progression of aging in facial surgery

Differential aging of the body part
Skin state and scarring history
Photo damage, dyschromia, and telangiectasia
Bony structure and previous fractures
Status of teeth and dental surgery
Fat vs muscle soft tissue cover
Quality vs quantity of facial rhytids
Thickness vs oiliness of the skin
Elasticity vs hyaluronic acid component of skin
Differential soft tissue descent of the face
Motor vs sensory deficits

Historically breast reconstruction after mastectomy in elderly women has been examined in the form of autologous vs implant-based techniques. The options for autologous approach in the elderly have included pedicled transverse rectus abdominis myocutaneous (TRAM) flaps or latissimus flaps vs free tissue transfer with abdominal tissue or other distant sites that limit the donor site at the cost of longer operative time and hospitalization. The non-autologous approach has involved use of expanders and permanent implant prosthesis and acellular dermal matrix (ADM) to provide a reliable aesthetic outcome. The latest trend in breast reconstruction involves a skin and nipple sparing mastectomy followed by use of a pre-pectoral implant and ADM for lower pole control [27]. These cases often require a secondary fat grafting to the upper pole to provide for better symmetry (Fig. 25.4).

There have been limited studies examining elderly women using a direct-to-implant reconstructive approach. The appeals of this approach in this particular population come in the form of a single surgical procedure, no tissue expansion needed and fewer follow-up visits. This study was a retrospective chart review over 4 years. A total of 24 breasts in 19 elderly patients were analyzed who underwent direct-to-implant reconstruction [28]. This was compared to a significantly younger control group population that underwent tissue expander with subsequent implant. Between the two groups there was no significant difference between wound complication rates or failed reconstruction. However, older individuals had significantly lower number of drain days, length of stay, readmissions, and postoperative visits.

Torabi and colleagues examined 339 patients that underwent deep inferior epigastric perforator (DIEP) microsurgical tissue transfer flaps (285 non elderly vs 54 elderly patients) with primary outcomes of complete flap loss, partial flap loss, or return to OR and were able to demonstrate a higher prevalence of medical comorbidities such as diabetes and hypertension with age [29]. When compared to the nonelderly population, elderly patients had a higher rate of complete flap loss and wound complications. More specifically, patients in the elderly cohort demonstrated an odds ratio of 10.92 for complete flap loss and had significantly higher rates of wound dehiscence (24.1% vs. 8.4%) vs the younger cohort. Success rates of free flap reconstruction in both cohorts were compared and found to be similar (99.6% in the elderly population compared to 96.3% in the nonelderly population). The study concluded that autologous free flap breast reconstruction remains a viable option for elderly patients although age is an independent risk factor for complete flap loss.

Santosa and colleagues published a high evidence-level multicenter prospective study which showed patients over the age of 60 did not have increased complications compared to their younger cohorts, although they tended to get more unilateral and delayed pedicled autologous options [30].

Hand and Microsurgery

It is important to preclude comorbidities such as vascular disease, smoking, and injury mechanism when analyzing the role of age in hand and microsurgery outcomes. Retrouvey took on this task when his team analyzed 284 patients that underwent finger reimplantation or revascularization with 32 of these patients over 60 years old [31]. Approximately half of the total population measured underwent revascularization alone while the other group underwent revascularization with reimplantation of the digit. When comparing the two populations, the older group had higher ASA scores and had more associated comorbidities. Overall a total of 88 patients had reimplanted digit failure or thrombosis of revascularization. Furthermore, this encompassed a total of 12 failures within the elderly group. When a multivariate logistic regression was performed, this showed that older patients did not experience major complications or failure rates when compared to younger age groups; however, they had higher rates of minor complications such as wound infections. Therefore, based on the data gathered from this study, ASA class and age should not preclude elderly patients from undergoing digital revascularization or reimplantation. The results of this

Fig. 25.4 (**a**) (front view) and (**b**) (side view) This patient was diagnosed with ductal cell carcinoma and required a skin and nipple sparing mastectomy followed by immediate implant reconstruction with acellular dermal matrix for lower pole support. (**c**) (front post-op) and (**d**). (Side view post-op) Patient is seen 4 months post reconstruction after having undergone an intermediary fat grafting session to the upper and medial poles to improve her projection and symmetry

study were corroborated by Barzin et al. in the *Journal of Hand Surgery* [32]. On the other hand (pun intended), Kwon et al. found that patients over age 70 had worse functional recovery than their younger cohorts with longer rehabilitation parameters [33]. Similarly, studies on tendon repair have found that older patients are more likely to require reoperation after flexor tendon repair [34, 35].

Microsurgical literature is more controversial with regard to the effect of aging on outcomes. A systematic review incorporated a total of 45 articles including 115 patients [36]. Majority of the included individuals were male and the mean age for this population was 73. Mean flap size was 598 cm^2 which ranged from 82 to 2500 cm^2. Only two of the 115 cases reported flap failure and the mortality rate for this population was 0.9 percent. Total complication rate for patients undergoing microvascular reconstruction was reported to be 22%. However, when stratified by flap type, there was no significant difference in complication rate. This study concluded that for microvascular reconstruction for complex scalp defects, age is not a risk factor for flap failure.

Üstün et al. [37] performed a systematic review and meta-analysis of free flaps in elderly patients. They found no difference in elderly versus young flap success rates or surgical complications; however, they did find significantly more medical complications and mortality in elderly patients. Jubbal's team analyzed 5951 cases of free tissue transfer and when controlling for comorbidities found that age itself was not significantly associated with complications. Age was significantly associated with increased mortality. As such, the authors recommended assessment of "physiological" age instead of chronological age in assessing patients for free tissue reconstruction [38].

Lower extremity reconstruction in the elderly is more complex due to peripheral artery disease and diabetes which makes it a better candidate for microsurgery where studies have found no difference in complication rates in patients >65; however, these patients required a higher rate of ICU admission [39–41].

Serletti et al. examined 100 patients >65 years retrospectively and found that chronological age did not predict flap complications [42]. However, higher ASA scores and length of operative time were significant predictors of postoperative surgical morbidity. Another literature review of head and neck free flap reconstruction found no difference in flap success, or mortality rate in elderly patients based on chronological age [43].

A large retrospective cohort study examined 211 patients 70 years or older at a single institution who underwent free tissue transfer. Although surgical complication rates were similar between the two groups (using rectus abdominis 32.7%, radial forearm 25.6%, jejunum 17.1%, fibula 18.1%, and latissimus dorsi 6.5%), there were significantly higher rates of medical complications in the octogenarian group when compared to septuagenarians. Furthermore, among this study's population it was identified that alcohol use, hypertension, and coronary artery disease were independent predictors of overall medical and surgical complications. Therefore, this study concluded that the elderly population must be carefully selected on the basis of medical comorbidities and overall functional status [44]. This was further illustrated by Chen et al. who showed a 37% surgical complication rate on their patient population over age 85 [45].

Facial Fractures

Facial fractures in the elderly are usually related to falls as opposed to trauma [46]. Atisha et al. found that elderly patients >64 years generally required significantly less operative intervention and also had fewer surgical complications [47]. Others have reported longer hospitalizations and rehabilitation [48]. The clinical correlation for management of these fractures in the elderly is usually a "watchful waiting" approach since one must also take into account the elderly patient's own wishes who may not want more surgery with plates and screws in their face for an improved aesthetic outcome.

Cosmetic Surgery

With the graying of the American population who want to keep looking young, there is an increased demand for cosmetic surgery among the elderly. A recent publication studies a total of

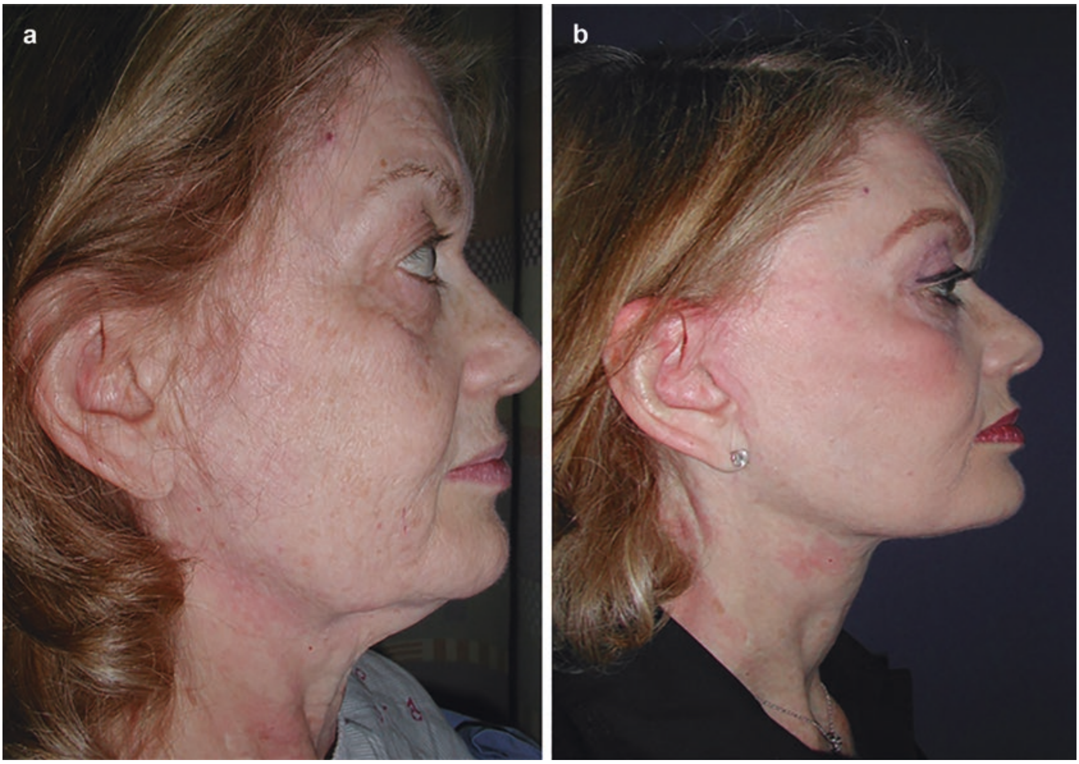

Fig. 25.5 (**a**) Sixty-year-old patient who presented for rhytidectomy and laser resurfacing to address her facial aging. (**b**) Same patient at age 70 returns 10 years post-op revealing increased facial skin aging with elastosis despite maintaining excellent skin contour of the neck

6786 elderly patients who underwent cosmetic procedures [49]. In the postoperative period, the overall complication rate was compared between elderly and younger populations and was found to have no statistical significant difference between the two groups. Furthermore, this was still true when stratified to octogenarians which showed no significant difference in complication rates among this population, although they had higher rates of postoperative infection and hematoma. This article concluded that there is no added risk to performing cosmetic procedures in the elderly, including octogenarians.

A single surgeon retrospective cohort study examined a total of 216 patients undergoing a face lift procedure. Patients were divided into an older cohort 65 and older with a total of 68 patients and a younger cohort under 65 years old with a total of 148 patients. Elderly patients' major and minor complication rates were not significantly different when compared to those in the younger age cohort with no mortality in either group. Based on these results, there was no significant difference in terms of outcomes measured from face lifts performed in the elderly and younger cohort [50].

Using a higher level of evidence, Karamanos et al. used NSQIP data to examine wound dehiscence from plastic surgery patients over a 5-year period and found that there was less than 1% dehiscence rate regardless of the age of the patient [51] (Fig. 25.5).

Abdominal Wall Reconstruction

Optimization of patients undergoing abdominal wall reconstruction for complex ventral hernias remains a complex issue. This particular cohort often presents with loss of abdominal domain, pain, difficulty performing routine physical activities in addition to being deconditioned, malnourished, and overweight. Furthermore, hernia repair and abdominal wall reconstruction of complex ventral hernias are major surgical procedures which induce further stress on the elderly population that may already have other comorbidities such as hypertension, cardiovascular disease, and diabetes. This cycle is initiated in the form of insulin resistance and proteolysis with further loss of lean body mass and the initiation of a catabolic state which leads to an impairment of immunologic function. Additional surgical adjuncts for abdominal wall closure such as implants and permanent mesh can act as a harbinger for chronic infection. However, based on previous literature there are preoperative modifiable risk factors that have been identified to reduce these effects. Obesity has been shown to be a significant risk factor for wound complications in the past. Previous studies have suggested that weight reduction with a BMI less than 40 is associated with better outcomes. A second modifiable risk factor is smoking cessation. With patients undergoing major reconstructive surgery, wound healing must be optimized. Negative effects of smoking in the form of reduction of blood and tissue oxygen tension levels as well as collagen formation lead to increased frequency of wound complications. Another modifiable risk factor includes glycemic control. It has been shown in previous studies that diabetics with a goal of HbA1c level of less than 6.5% preoperatively are associated with decreased rates of infection and other wound complications [52]. Sarcopenia is an additional modifiable risk factor that should be considered in this particular population. Sarcopenia when coupled with obesity has been shown to decrease overall survival as well as negative outcomes in the surgical as well as critical care settings. There are regimens available to counteract this detrimental disease process. Furthermore, these regimens are in the form of increased protein intake with combined resistance exercises which provide the best chance for preserving or regaining/maintaining functional status following complex hernia repair and abdominal wall reconstruction.

In terms of preoperative assessment of nutrition there is a lack of focus on preoperative nutritional optimization prior to surgery. It has been shown in previous studies that optimizing nutrition has been shown to decrease hospital stay, readmissions, and postoperative complications. There are a few tools available to clinicians to assess for nutritional status and who would benefit from nutritional intervention. One is in the form of body composition analysis which utilizes either bioelectrical impedance analysis or radiologic methods to determine body composition.

Giordano et al. used a propensity score and showed that abdominal wall reconstruction with acellular dermal matrix may result in more bulge/laxity rates in the elderly but does not significantly alter outcomes between populations over and under 65 years of age [53].

Pressure Ulcers

About 10% of elderly patients in hospitals will develop a pressure ulcer during hospitalization [54]. Much of this is related to chronic care protocols and procedures and lack of mobilization which would mean age should not be a factor. However, age and frailty are often intertwined, and Margolis et al. calculated the pressure ulcer probability of those >80 years were 4–20 times more likely to develop a pressure ulcer than the younger cohorts [55]. This makes it even more critical to make sure that the elderly patient is optimized from the nutritional and positioning standpoint while in an acute care setting.

Conclusion

Plastic surgery is always faithful to the principles of function, form, and cosmesis. The discipline is also unique in that the clinicians interact with all sexes, ages, and conditions from elective cosmetic surgery to acute posttraumatic reconstruction. With our novel understanding of the science of aging, it is imperative for the practitioner of plastic surgery to differentiate chronological age from frailty. The emerging published literature in the field shows that although one can safely operate on the elderly patient, the medical comorbidities must be thoroughly identified and discussed with the patients to make sure that the potential prolonged rehabilitation outcomes match the expectations and desires of the elderly patient. Armed with novel directions in the management of the elderly population, we can utilize "prehabilitation strategies" before major hospitalizations in order to improve outcomes, economic impact, and the health of our society.

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