Ageing face, an overview – Aetiology, assessment and management

Abstract
Ageing in humans refers to a multidimensional process of physical, psychological, and social change. These changes are interpreted and accepted in different ways for every different human. The face is the most distinguished part of the human body and is the conveyer of the effects of ageing to the observer. Accepting the new look of ageing differs from individual to individual and the longing of the ageing person to return to a younger place is what propels facial rejuvenation surgery. As the baby boomers age the demand for the naturally young face continues to increase and surgeons continue to strive to produce this look and previously accepted surgeries are changing everyday.
To be able to produce the natural facial ideal of youth the facial plastic surgeon must have op-timal knowledge of facial anatomy and the effects of ageing on the face.

Keywords
Ageing, facial rejuvenation, facial cosmetic, facial plastic surgery.

Introduction
From the study by Gompertz in 1825 that stated that mortality increases exponentially with age to the hypothesis that ageing is due to a decline in restorative capacity of tissue stem cells by Sharpless et al. in 2004, senescence and the reversal of the process has been a constant matter of debate among physicians.
Ageing in humans refers to a multidimensional process of physical, psychological, and social change. Although research into ageing was mostly directed at the effects of ageing on the general physical well-being of a human, in the past few decades research into the effects of ageing on the skin and most notably the face has greatly increased. This is probably down to the fact that facial rejuvenation has become a lucrative business and that social stigma regarding surgery towards “looking younger” has gradually decreased. Even more importantly we have begun to look deeper and not only evaluate the effect of a procedure on ageing but also from the viewpoint of cause and effect thus not only surgically correcting the ageing process but improving and inhibiting the actual causes of these changes.
The face is the most defining aspect of a human being. Changes associated with ageing are perceivable even to the most indifferent observer and although the changes that concord with ageing differ from person to person it is how a person perceives these changes that is the defining aspect when seeking improvement for senescence.

Aetiology
The clinical reflections of ageing in the face are quite constant. Loss of thickness and elasticity due to loss of collagen and elastin, creates a sagging and relative excess of skin, together with wrinkling associated with the decrease in cross-linking between fibroblasts and collagen fibrils. Concurrent lipoatrophy, both in the hypodermis and the facial fat pads leads to the hollowing observed at the periorbital, malar and temporal regions. Deepening of the nasojugal, nasolabial and nasomental creases is due to weakening of various ligaments that fat pads are suspended in and there resulting shift downwards.
loss of fat may also be a contributing factor to the laxity in the skin as the previously stretched skin becomes flaccid as its underlying fat volume decreases. Fat accumulation occurring in the submental area, lateral to the nasolabial and nasomental creases is also an important feature in the facial ageing process. In addition to the soft tissue and skin changes bony remodeling of the facial skeleton is also an important factor in the evolvement of the ageing face. Mechanotransduction, the process of skeletal remodeling due to the mechanical forces of soft tissue on the bone has been hypothesized to cause the changes seen in the craniofacial skeleton with age.

Ageing in human skin consists of two components, intrinsic or chronological aging and extrinsic or often referred to as photoageing. The intrinsic ageing process relates to naturally occurring biological processes, whereas extrinsic ageing occurs as a result of extended UV exposure of the skin over a prolonged period of time. The skin appears thin, pale and finely wrinkled as a result of intrinsic aging whereas it is more coarsely wrinkled and composes blemishes caused by abnormal pigmentation when associated with extrinsic ageing. Smoking, another extrinsic factor is also considered to have an important role in macroscopic ageing or wrinkling.

A review of lipoatrophy was performed by an assembly where a more precise definition of facial lipoatrophy was created by consensus and the definition of lipoatrophy was stated as: loss of facial fat due to ageing, trauma, or disease, manifested by flattening or indentation of normally convex contours. In the ageing process atrophy of fat is associated with decreased fat cell size, demised fat cell function, impaired fat cell differentiation, and redistribution of fat cells. Lipoatrophy due to the ageing process begins in the second or third decade and is usually noticeable after 30 years of age, with the first apparent presentation occurring in the temple and cheek. The descent of fat associated with ageing that occurs submental and lateral to the crease of the face due to gravity, pull the lax skin downwards leading to a downward and anterior vector of skin movement.

Craniofacial bony remodeling is an important contributor in the ageing process. Many studies have been performed regarding these phenomena but there is still no consensus on the exact changes. Pessa showed in a study that the craniofacial skeleton continues to grow with age and the remodeling that occurs could be summarized as a clockwise rotation of the maxilla to the cranial base. This in turn leads to a decrease in midfacial height.

Assessment
Achieving a good aesthetic result begins with a careful preoperative assessment of the patient’s surface anatomy and a detailed assessment of the patient’s desires. The surgeon performing facial rejuvenation should have a thorough understanding of facial soft-tissue anatomy, comprehend the anatomical changes that occur in aging that produce a change in facial shape, and understand the ideal facial shape that can be obtained for a particular patient.

Forehead and temple region
Noticeable changes in the forehead and temple region can be summed up as;

- formation of rhytids (horizontal forehead and vertical glabellar)
- ptosis of the eyebrows
- changes in the hairline
- appearance of skin lesions
- fat volume depletion in the temporal areas

The formation of horizontal rhytids generally begins during the 3rd and 4th decade. These rhytids are formed by the contraction of the frontalis muscle during expressive facial gestures. Elevation of the eyebrows as a gesture to inform the onlooker of emotions will cause the forehead to crease into multiple horizontal lines that in time will become permanent giving a person a constantly worried or surprised look. Similarly the constant use of the glabellar muscle whether it be squinting in the sunlight or frowning will cause vertical grooves between the eyebrows. Although the use of these muscles are constant from the moment of birth the loss of subcutaneous tissue and fat in the forehead region makes the muscle more visible on the skin, hence the production of rhytids.

In a recent study by Scalafani and Jung the desired position of the eyebrow peak should be just medial to the lateral canthus which is further lateral to the previously advised more medial peak. This diversity comes as no surprise as Gunter and Antrobus stated that understanding of the attractive eyebrow is influenced by the age, sex, culture, and ethnicity of the patient and by the surgeon and the observer. During the ageing process the lateral third of the eyebrow is the first to start to droop. Accentuation of this ptosis leads to the constant sad look. As the eyebrow continues to droop problems in the field of vision may occur and the patient may seek to relieve this symptom without any intention of having a younger look. While evaluating eyebrow ptosis, the upper eyelid must also be taken into consideration, as both of these ageing related problems can aggravate one another.

The deep and superficial fat pads together with the temporalis muscle make up the concave appearance of the temple region. As the individual ages the fat pads tend to decrease in size giving the temple region a hollower, concave appearance.

Skin lesions in contrast to the aforementioned findings are generally caused by extrinsic rather than intrinsic aging. The formation of pigmented areas such as lentigines and keratotic lesions such as acanthomas are related to sun exposure. These tend to form 2-3 decades after rhytids and ptosis.

Orbital and periocular region
Ageing related changes in the orbital and periocular region can be summed up as follows;

- Drooping of the upper eyelid skin (dermatoclastic)
- Increase in the height and width of the bony orbit
- Pseudoherniation of fat through the orbital septum
- Formation of horizontal wrinkles at the lateral aspect of the eyes (crow’s feet)

In the periocular region the eyelids are probably the first structures where the ageing process is observed. The loss of skin tone coupled with the weakening of the orbital septum leads to sagging and bulging of the upper eyelid skin. Although a weakening of the orbicularis oculi muscle is sometimes indicated in the protrusion of fat a recent study by Pottier et al indicated that the anatopphysiologic characteristics of this muscle remains intact despite the
advancement of age.13 In total these changes combined with the drooping of the eyebrows leads to ptosis that may cause limitation of visual fields and an unattractive upper eyelid.

The inferior displacement of the lateral canthus as aging continues allows descent of the eyeball decreasing the space between the globe and the floor of the orbit which consequently pushes the extraconal fat anteriorly. This in turn will lead to bulging of this fat to produce the palpbral bags. As the skin is attached firmly to the underlying bone by the orbitomalar ligaments (orbital retaining ligaments) the protruded fat will droop over this ligament forming the tear trough deformity and the double convex deformity. The loss of subcutaneous tissue over the orbicularis oculi muscle will reveal the lower border of this muscle which in turn will contribute to the development of the malar crescent over the glabellar and nasion regions. The weakening of structural support of the lower lateral cartilages creates tip ptosis that is increased by the narrowing of the nasolabial angle due to maxillary resorption. This resorption also contributes to the pseudo-lengthening of the nose. Chin pad ptosis, which tends to droop as the ageing process continues, may contribute to the development of the malar crescent over the glabellar and nasion regions.

The formation of crow’s feet or rhytids at the lateral aspect of the eyes is as in the forehead region attributed to loss of subcutaneous tissue accentuating the effects of the muscle on the skin.

Midfacial and peri-oral region

Major findings in the midface related to ageing include;
- Downward movement of malar fat pad leading to a hollowed out cheek and a prominent nasolabial fold.
- Remodeling of the maxilla that creates a decrease in antero-posterior length of the face
- Nasal tip ptosis with lengthening of the nose
- Chin fat pad ptosis
- Changes in the thickness and height of the lip
- Vertical and horizontal rhytids forming around the perioral area
- Formation of a deep labiomental fold

As the ageing process continues a weakening in ligaments supporting various fat pads is unavoidable. In the midface the weakening of the zygomaticocutaneous ligament allows the malar fat pad to move anteriorly and inferiorly. This coupled with the weakening of the orbital retaining ligament supporting the lower lid fat pads and the orbicularis oculi creates a deeper nasolabial fold. The increased laxity of the skin with loss of tone also contributes in the formation of the nasolabial fold. The repositioning of the malar fat pad also forms a hollow between the malar fat pad and the malar eminence creating a characteristic hollowing in this space. As volume loss leading to excess skin and maxillary resorption continue the ptosis of the malar fat pad becomes more prominent and in turn the nasolabial fold is accentuated.14

The nose as with most components of the face also tend to droop as the ageing process continues. There is a loss of fullness that occurs more prominently in the glabellar and nasion regions. The weakening of structural support of the lower lateral cartilages creates tip ptosis that is increased by the narrowing of the nasolabial angle due to maxillary resorption. This resorption also contributes to the pseudo-lengthening of the nose. Chin pad ptosis, which occurs secondary to mandibular bone resorption, further contributes to the appearance of increased nasal projection and length.15

The alterations observed in the upper lip during ageing include vertical wrinkles, reduction in the height of the vermilion border accompanied by lengthening of the dermal area of the upper lip, and the disappearance of the Cupid’s bow.16 The shortening of the vermilion border leads to a decrease in the red show of the upper lip and a lengthening of the skin between the nose and vermilion border hence and increase in “white show”. A decrease of thickness due to loss of the cutis in the lip allows for the characteristic thinning associated with ageing. Thinning in the peri-oral subcutaneous tissue creates a closer association between the skin and the underlying orbicularis oris muscle which causes the vertical creases on the upper lid and the horizontal creases at the lateral corners of the mouth.

The labiomental fold deepens as the function of the zygomaticus major and minor muscles weakens allowing fat pads and muscles to collapse, which in turn causes the corner of the mouth to droop.17

Mandibular, chin and jowl region

The main characteristics of ageing in the mandibular region are as follows;
- Loss of mandibular height
- Loss of dentition
- Formation of jowls
- Exposure of submandibular contents
- Decrease of definition of the jaw line

The jaw line is a major contributor to the younger looking face and as the ageing process continues the loss of skin tone and subcutaneous tissue allows for the skin to droop. This in turn leads to the loss of the definition of the jaw line. This combined with weakening of the massteric ligament that allows for facial fat to move inferiorly produces jowls. The loss of teeth leads to a shortening of the mandible and as the lower border of the mandible recedes submandibular content becomes more visible.

Neck

Various alterations in the neck include;
- Accumulation of submental fat
- Drooping of redundant fat
- Platysmal banding
- A combination of the above forming the classic “turkey neck”
- Increase in the cervicomental angle

Ageing creates a very unique appearance to the neck commonly known as the “turkey neck” or “gobbler neck”. Various contributions from several components are associated with this change. The accumulation of submental fat and the pseudoherination of the weakened facial portion of the platysma muscle caused by diastasis of medial platysmal edges, leads to pseudoherination of subplatysmal fat which subsequently leads to an increase in the submental compartment. The cervical platysmal muscle portion continues to exert pull on the facial portion which leads to vertical fibrous bands in the anterior aspect of the neck. These coupled with the drooping of redundant skin creates a neck that is characteristic of ageing.

Ageing also causes descent of the hyoid bone and larynx which leads to an increase of the cervicomental angle causing a more straight transmission from the chin to the neck.
Management

In facial rejuvenation today we can see that the youthful face is not just a “look to go back to” for the baby boomers but a constant look that young adults or middle age citizens want to maintain. This understanding has lead to a great increase in both the research and availability of facial plastic procedures. From minor corrections such as dermabrasion to complex procedures like rhytidectomy there is an array of procedures for undesired changes associated with ageing. No one procedure is the treatment of choice for a patient and the surgeon should be prepared to discuss all options of treatment pertaining to the need and desire of the patient. As there is more than one way to treat a specific ageing related characteristic specifying one method of correcting the change is not advised.

Non-Surgical Treatment

There is a wide range of techniques available for non-surgical treatment for ageing. Though they may be used as solitary procedures they are generally combined with other techniques both surgical and non-surgical to provide optimal results.

Botulinum Neurotoxin

Botulinum neurotoxins are produced by Clostridium botulinum. Two serotypes, A and B are used for treatment in medicine, although type A is by far the most common serotype used in facial plastic procedures. Botox (Botox Cosmetic; Allergan, Inc., Irvine, Calif.) is a formula of botulinum toxin type A used extensively in facial rejuvenation. The main action of Botox is to treat rhytids formed by muscular contraction or dynamic rhytids. It functions by paralyzing the muscles from 6 weeks to 6 months. Common uses of Botox include:
- glabellar furrows
- horizontal forehead rhytids
- crows feet
- platysmal horizontal rhytids

Research into the use of Botox has also shown that the use of Botox when introducing fillers or performing resurfacing enhances the results.18

Fillers

Fillers as the name implies are substances used to fill in the irregularities that form during the ageing process. As ageing produces an uneven distribution of facial fat creating the bumpy surface of the ageing face and convexities become concavities there comes the need to recreate these features. In the case of fillers this is accomplished by injecting material that can be used to efface wrinkles or create a fuller mid face to reappropriate the youthful face.
- Areas of use for fillers include:
  - To fill in the nasolabial and labiomandibular crease
  - Treatment of wrinkles
  - To volumize the face and create aesthetically pleasing curves
  - Filling of acne scars
  - Filling of facial scars due to trauma or surgery

There is a wide range of fillers from autologous fat to nonbiodegradable material that differ in their course of action and the duration of acceptable results from the time of injection. This makes the choice of the “perfect filler” considerably difficult for both the surgeon and the patient. Although semi-permanent and permanent filler require no or fewer further injections they posses the risk of long-term complications and the risk of a permanently unsatisfied patient. Temporary fillers have the advantage of being able to be re-introduced after a period of time, and as the ageing process continues, this may aid in correction of changes that occur after the first injection. Although initially used to correct rhytids, fillers are now commonly used to restore volume to ageing face and recreate the youthful curves.8

Resurfacing

Resurfacing is the name given to procedures that destroy the superficial layer of epidermis and upper portions of the dermis and activate reproduction of a new layer of skin resulting in a smoother and less wrinkled appearance.

Resurfacing is performed with the use of a laser or a chemical, to effectively strip the face of it’s’ most superior layer. Both techniques can be utilized for the following conditions:
- Effacement of wrinkles
- To treat damage caused by solar exposure
- To treat scars produced by acne or trauma
- To create a smoother and firmer appearance to facial skin

The most commonly used lasers are the carbon dioxide laser and the erbium: YAG laser.19 Although neither is accepted universally to be of more use than the other there are major differences between the effects they have on the skin though their method of action is initially the same. They utilize the use of light to penetrate the skin and create thermal damage removing the superficial layers of skin.

Chemical resurfacing or chemical peels use chemical agents to create partial thickness skin injury as in the laser. The most
commonly used chemical peeling agent is Trichloroacetic acid used in various concentrations or mixtures. Other agents such as alpha-hydroxy acid and phenol are also used to create similar destruction.

**Surgical Treatment**

Surgical management of ageing face is not only mechanically lifting and relocating the ptotic soft tissues, the main goals of these operations are bringing out the beauty in the face that existed during youth. Although good results are possible through a variety of techniques, all techniques have advantages, disadvantages, and limitations, with the ultimate result often dependent on underlying skeletal support and the quality of facial soft tissues for a particular patient. The key to consistent results is not the particular technique utilized but rather the preoperative aesthetic analysis and how the operative plan is individualized according to the aesthetic needs and desires of the patient.

**Upper one third**

**Forehead and Eyebrow lift**

Eyebrow ptosis is an important aspect of ageing and the correction of this drooping is essential in creating a youthful appearance. The main techniques in correction of this problem are the coronal, trichophytic and endoscopic brow-lifts. With advantages such as small incisions placed within the hair-bearing scalp with minimal scarring and less alopecia, numbness, bleeding, postoperative ecchymosis, and swelling, leading to a more rapid patient recovery the endoscopic brow-lift has become the treatment of choice for many surgeons. Although brow-lifting can be used as a single procedure it is commonly combined with an upper eyelid blepharoplasty in creating a younger peri-orbital and forehead region. Eyebrow lifting also has the advantage of effacing horizontal wrinkles on the forehead and during the procedure incision of the corrugator muscles aids in correcting the glabellar furrows.

**Upper eyelid blepharoplasty**

The upper eyelids are one of the first sites to succumb to the effects of ageing and many younger patients are now seeking an upper eyelid blepharoplasty procedure. This procedure includes the excision of skin, orbicularis oculi muscle, fat or a combination of these components. Some surgeons prefer to remove the skin and muscle together while others prefer to remove a layer of skin before removing the underlying muscle. Fat pads are removed as required by the surgeon. By performing an upper eyelid blepharoplasty problems such as dermatochalasis, hernation of fat pads and lateral hooding may be corrected. Lateral hooding in the eye is also caused by the descent of the brow and when performing a blepharoplasty this must be taken into consideration as not to exacerbate the problem by shortening the distance between the lash line and the eyebrow creating more inferior pull.

**Middle third**

**Lower eyelid blepharoplasty**

The two main incisions used in lower eyelid blepharoplasty are the subciliary incision or the conjunctival incision. Transconjunctival approach avoids the denervation of the pretarsal portion of the orbicularis oculi muscles which is the most common cause of ectropion of the lower eyelid. In younger patients who exhibit minimal aging changes or have no demonstrable lid laxity, transconjunctival blepharoplasty can be an effective technique as in the patient whom only complains of bagging under the eyes. The old lower eyelid blepharoplasty concept focused on fat removal, which were causing long-term "hollowed appearances". Now, natural appearing and fuller lower eyelids that blend with overall facial shape are preferred. This is accomplished by preserving fat and repositioning it over the lid-cheek junction and the tightening and re-draping of the orbicularis muscle thus creating a smooth transition between the two. Another important addition is the lateral canthal tightening technique which aids in both preventing ectropion of the lower lid and correcting dermatochalasis.

**Mid-face lift**

The mid-face lift, in particular the endoscopic mid-face lift has grown in popularity over the last decade as more patients seek less invasive procedures and surgeons have become more aware of the nasolabial fold as an important indicator of the aged face. A harmonious rejuvenation addressing the tear trough deformity, and correcting the perceived malposition of the malar fat pad can be best achieved when the infraorbital and upper midfacial tissues are elevated. This can be typically achieved with subperiosteal mid face lifting performed through a temporal incision or a blepharoplasty incision. Both techniques aid in repositioning ptotic cheeks, improving malar volume and improving the melo-labial fold.

**Lower third**

**Face lift**

The facelift is a procedure that is effective in treating the lower face and the neck. When performing a face-lift the surgeon must be familiar with the relationship of the SMAS to the skin, branches of the facial nerve and the underlying fat pads. The SMAS represents a discrete fascial layer that separates the overlying subcutaneous fat from the underlying parotidomasseteric fascia (deep fascia) and facial nerve branches. The relevance of SMAS to facial anatomy is extremely important: within the cheek, the facial nerve branches, and the parotid duct, lie deep to the parotidomasseteric fascia after exiting the parotid. The surgical significance of the parotidomasseteric fascia is that the facial nerve branches within the cheek are always deep to this anatomical layer. For this reason, when performing sub-SMAS dissection, if deep facial fascia is not violated, facial nerve injury will similarly be prevented. There are different procedures when performing a facelift and range from dissection of only a skin flap in the subcutaneous lift to dissection of skin, fascia, fat, muscle and peristeum in the subperiosteal lift. Face lifting, initially performed as a skin-tightening procedure since the early 1900s, has technically matured during the past quarter of a century. In an attempt to improve results with skin envelope tightening, surgeons have used SMAS plication or suture imbrication along the superficial surface of the SMAS to improve postoperative contour. Those techniques of SMAS surgery do not involve mobilization of a SMAS flap with the attendant surgical release of the areas of ligamentous fixation. The deep plane or composite rhytidectomy allows extensive mobilization of the superficial fascia from the retaining ligaments while providing excellent blood supply to the overlying skin. All in all the facelift acts in creating a younger looking face by improving the jawline.
and eradicating jowling, accentuating the cervicomandibular angle, repositioning fat pads and adjusting sagging skin. It is remarkable to review the literature on face lifting and see how many excellent results are obtainable through what appear to be extremely different surgical techniques.

**Sub-mentoplasty**
The correction of the submandibular area to create a more defined cervico-mental angle and address platysmal banding. Treatment ranges from simple liposuction for the neck with fat accumulation but no platysmal banding to liposuction combined with platysmal plication and suspension of the platysma to the mastoid periosteum. Although the neck may be operated on as a sole procedure it is generally part of the face-lift procedure and is addressed through the face lift incision. The more simple liposuction performed through a small submental incision can be coupled with skin excision at the incision site to create a tighter submental area.

### Conclusion
Our understanding of the ageing process and options in treatment are increasing everyday. The strive to produce a youthful face that is also natural looking is leading to new innovative techniques both surgical and non-surgical, and as we continue to better understand the process of ageing the approach to treating this condition is ever changing. A never changing important factor is that any surgeon attempting facial rejuvenation surgery must have a complete understanding of facial anatomy and physiology and should always keep in mind that ageing is not a constant process and is different for every human being. Following this rule it is understandable that every treatment should be tailored to the patients need.

### Conflict of Interest
All authors have no conflict of interest to declare. No extraneous funding was obtained.

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Table 1. summarizes the options in treatment of the ageing face.
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References


Erratum:
In Hughes EK, Hughes JP & Madani G. Interpretation of Computed Tomography of the Petrous Temporal Bone. The Otorhinolaryngologist 2013; 6(2): 91–98, text of the article contained a number of typographical errors. The correct information follows below.

Page 91, Pathology Checklist should read: “Acute mastoiditis with or without abscess”
Page 94, Figure 4 caption should read: “Otosclerosis”
Page 94, right column line 2 should read: “…flaccida cholesteatoma”
Page 94, right column last line should read: “cholealformis…”
Page 95, left column, second paragraph, line 8 should read: “blind spot where cholesteatoma may be overlooked”
Page 95, Figure 6 caption should read: “Necrotising otitis externa (NOE) versus EAC squamous cell carcinoma (SCC)”