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Point of View

The Epistemology of Wrinkles: From Geology and Anatomy to Physiology

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Abstract

The author studies the geometry and physics of wrinkling – drawing from geology and animal biology. The general principles behind tension and compression wrinkles are the same in geology or dermatology. But what is the structure in the subcutaneous tissue that marks every overlying wrinkle? Given we now know wrinkles have both anatomical and pathological correlations considering wrinkles as pure anatomic lines is fallacious and the article offers a unique perspective of skin creases and also avenues for further research. **(Int J Biomed. 2016;6(3):237-239.)**.

Key Words: wrinkles • surgery • geology • anatomy • physiology • ageing • skin

Discussion

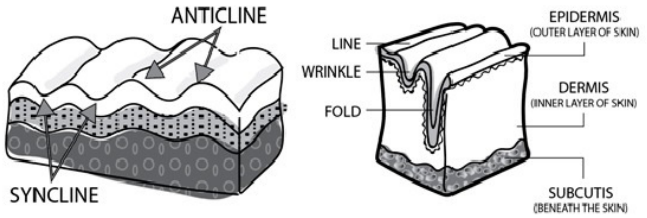
In 2003, Cerda and Mahadevan[1] studied the physics and geometry of membrane wrinkling – they took a food-grade plastic sheet, cut ribbons from the middle and stretched the sheet. They noted that wrinkles appeared parallel to the ribbon, and the wavelength (λ) was proportional to the square root of the sample size. They then extrapolated their research to human skin. They noted that human wrinkling is generally more notable where there is excess skin (such as back of hands) or where skin is close to bone (such as forehead or crow's feet).

If human skin is viewed as a mere physical membrane, wrinkles fundamentally occur because a keratinocyte-stiffened epidermis drapes a softer and thicker dermis. Of course, anatomical sites like knees and elbows have wrinkles that can be considered 'tension' wrinkles (two-dimensional, due to geometry, pre-tension and joint action) and in other areas like forehead, muscle action causes 'compression' wrinkles (one-dimensional due to muscle action only).

The author has been fascinated by the concept of wrinkles and relaxed skin tension lines being used as surgical guidelines, given these have become widely adopted with no conclusive scientific basis – and both types of lines differ in direction, yet are considered acceptable for surgical incisions. In animals such as pigs, for example, with age and fat deposition skin tension lines begin to run transversely, whereas in thinner animals, skin tension lines run more obliquely.[2] To get a better understanding of any condition, it is better to study its loss or excess. In 2010,[3] there was a report of a Japanese baby with Michelin Tire Baby Syndrome, a condition that causes folding of excess skin. However, as was noted in this case report, in some babies with this syndrome spontaneous recovery occurs i.e. wrinkles simply disappear. Most notably, skin fold biopsies from these babies showed no epidermal, dermal or subcutaneous tissue abnormalities. Surely, there must be an underlying anatomical reason why wrinkles occur?

Geologically speaking, folds occur in the Earth's 'skin' are conceptually no different to wrinkles on any multi-layered surface. These geological folds occur when flat and stacked planar surfaces, such as sedimentary strata, are bent or curved as a result of permanent deformations. To the author, geological folds seem epistemologically related to cutaneous folds, as illustrated in the figure. Berg [4] proposed a model for anticline formation -- showing that ranges became raised along a partially listric, sub-horizontal thrust fault. However, this model showed the down-dip portion of the fault plunging at depth, which was only possible if basement rocks were plastic -- and therefore this theory was later discredited.[5] Later, geologists adopted the model of 'balanceable cross sections'.[5] On observing the anticline formations in old rocks, it appears that it is the resistance to forward movement of the layers in front causes the rocks to bend upward in asymmetric fashion, causing wrinkling. Anticlines occur

in old rocks just as wrinkling occurs in aging skin. These geological 'compression' wrinkles gives rise to shortening of the beds across the structure as the area becomes horizontally compressed, not dissimilar conceptually to the formation of cutaneous wrinkles with age. However, there was one matter unresolved – geologically there are differences notable in the underlying strata, -- but histologically, as we discussed in the Michelin Tire Baby case above, there was no underlying differences noted on anatomic pathology examination.



Pessa[6] and others set out to answer this question – is there an underlying anatomical basis for wrinkles – can biology follow geology? Pessa studied both creases such as crow's feet, and forehead wrinkles. They found that each and every wrinkle they studied occurred within ±1 mm of a major lymphatic vessel and its surrounding tube of adipose tissue. They concluded that an anatomical basis for wrinkles does exist and these are lymphatic vessels, along with the surrounding distinct peri-lymphatic fat, which are present directly beneath wrinkles and creases. This may have implications for surgery. Until recently, incisions were planned in wrinkle or crease lines with the theory being as collagen runs parallel to wrinkle lines, collagen will be laid down in the same direction as is normal within wrinkle lines and the septa between skin and muscle -- leaving to the best possible scars. However, the author's group recently noted that incisional and excisional lines are different i.e. when skin is excised and tension created, as is done after skin cancer surgery, different dynamics apply and wrinkle lines no longer have the least wound tension.[7]

More recently, it has come to light that wrinkles can be caused due to aging and oxidative stress – and indeed increased wrinkling may be a sign of impending heart disease, metabolic disorders, osteoporosis or degenerative disorders.[8] And, while photo-damage from sunlight is one of the most common causes in Caucasian skin, recent studies have shown that UV light also damages lymphatic channels.[9] Some of the genetic mechanisms behind wrinkling are disturbed lipid metabolism, altered insulin and STAT3 signaling, up regulation of apoptotic genes partly due to the deregulation of FOXO1, down regulation of members of the jun and fos family, differential expression of cytoskeletal proteins (e.g., keratin 2A, 6A, and 16A), extracellular matrix components (e.g., PI3, S100A2, A7, A9, SPRR2B), and proteins involved in cell-cycle control (e.g., CDKs, GOS2).[10]

The direct finding of an anatomical relationship between lymphatic channels and wrinkles is a good direction for new research. This has implications for not only surgical lines, but also in understanding why chronic illness or cancer often accelerates the aging process. Tybjærg-Hansen and others studied over 10,000 Danes and found that ear lobe creases indicated the body's biological age, and was an indicator for heart disease.[11] Studies on Shar Pei dogs suggests that these animals have mucinosis – high hyaluronic acid levels are found in both cutaneous tissues and the blood stream -- and these high amounts are due to an excess in the activity (overexpression) of the HAS2 enzyme.[12] Such research avenues are promising as they can shed more light on processes such as cell recognition and ageing.

Conclusion

In surgery and medicine, thus far, wrinkles have been considered purely as a surface anatomical phenomenon -- with the main purpose in surgery being the concealment of skin incision scars. However, given we now can see that below each such crease, there exists an anatomical correlation to a lymphatic vessel, the implications are still poorly understood. For example closing a wound in a fashion that creates compression of the lymphatic vessels may be less than desirable. Further, we now know that wrinkles in certain locations indicate both the body's biologic age, as well as a risk for heart disease. We also know that high hyaluronic acid levels due to enzymatic dysfunction can cause deep wrinkling in animals – and therefore when it comes to wrinkles beauty may indeed be more than skin-deep. The author's perspective is that until now we have been viewing wrinkles purely as fault lines of skin i.e. using a geological or anatomical approach -- when what is needed is more research behind the physiology of wrinkles.

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Author contributions

S.P was the sole author and conceptualized and conducted this study.

Competing financial interests

Nil.

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