Correlation of Age Related Changes of Nasal Tip Support Mechanisms with Anthropometric Measurements

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ABSTRACT
Background: age-related changes of the face have been an area of intense interest and the focus of considerable researches. The facial skeleton and overlying soft tissue undergo a gradual transformation throughout the aging process and there are several consistent age-associated changes of the nose. **Aim of the Work:** this study aimed to evaluate the age related cellular and architectural changes of nasal tip support mechanisms, in correlation to its anthropometric measurements. **Patients and Methods:** this prospective study was conducted in Plastic and Reconstructive Surgery and Histology Departments, Ain-Shams University Hospitals, Cairo, Egypt. Forty-five patients were included in this study. They had undergone aesthetic rhinoplasty operations, 10 males (25%) and 30 females (75%) with mean age 35.42±15.15 years and age range 19–60 years. **Results:** LLC is the most nasal tip support mechanism affected by aging as every 1 year increase in age; correspond to weakness in LLC by percent **-**1.077 followed by ULC, SC, SCA, IDA, ICA, NLA, and projection respectively (P value <0.001). **Conclusion:** aging patients present unique technical challenges in rhinoplasty that warrant a comprehensive approach to restore and preserve tip support. **Recommendations:** medial crural septal suture should be performed in all elderly patients undergoing aesthetic rhinoplasty, both to prevent further exaggeration of the already existed acute nasolabial angle and to maintain the nasal tip projection and rotation.
Keywords: age, nasal tip support, anthropometric measurement.

INTRODUCTION

The nose is the center of the face and it has a central role in the harmony of the facial features. It can cause serious impacts with the facial image. This alone makes it clear that it is commonly believed that changes to the nose have psychological and social impact on the person [(1)].

The unique anatomy of the nose is reflected by the complex nomenclature used to describe it as well as the efforts made to characterize the geometric proportions of the ideal nose. The lobule can be defined as an area including the tip of the nose and bounded by a line connecting the upper edge of the nostrils, the supratip breakpoint, and the anterior half of the lateral alar wall. The lobule is subdivided into the tip, supratip and infratip segments [(2)]. The tip of the nose is the apex of the lobule and ideally the most defined element on the profile. The infratip lobule lies inbetween the tip and the apex of the nostrils. The configuration of the infratip lobule depends on the shape, size, and angulation of the medial and middle crura of the alar cartilage. The supratip lobule lies inbetween the pronasalae and the supratip breakpoint [(3)]. The nasal tip is a dynamic structure, hinged by the upper lateral cartilages and by the recurvature of the lower lateral cartilages. It is evaluated for projection, definition, rotation, symmetry and support. Tip projection can be evaluated by drawing a line from the alar-cheek junction to the tip of the nose and another vertical line is drawn adjacent to the most projecting part of upper lip. To achieve adequate tip projection, 50-60% of the horizontal line should lie anterior to the vertical line. The nasolabial angle is defined as the angle formed by a line drawn from the anterior to the posterior nostril apices and that intersects with the vertical facial plane. It determines the amount of cephalic rotation of the tip [(4)]. In an aesthetically pleasing nose, the columella projects as a gentle curve below the alar margin as seen on lateral view. The columella and infratip lobule projection are influenced by the configuration of the medial and middle crura. Because of the thin and adherent skin; asymmetries or prominences in these structures are easily visible in external configuration [(5)]. Tip support mechanisms play a central role in tip stability and positioning. **Janeke and Wright** [(6)] demonstrated the most crucial factor in nasal tip support mechanisms and they published hypothesis that fibrous connection between the upper and lower lateral cartilages play a vital r ole in the nasal tip support mechanism. **Ghavami and his colleagues** [(7)] stated that the lower lateral cartilages together with the ligamentous attachments between these paired structures (Interdomal sling) are critical in supporting the nasal tip, while **Xavier** [(8)] mentioned that the scroll area is mandatory and should be preserved to prevent weakening of tip support. **Quatela and Pearson** [(9)] mentioned that the medial crural footplates play an important role

Received: 17/10/2017
Accepted: 27/10/2017
DOI: 10.12816/0043813

in nasal tip support and projection, while **Shomouelian and his colleagues** [(10)] added that disruption of the scroll area attachment in addition to the attachment of the medial crura to the caudal septum could result in loss of the nasal tip support. Macroscopic changes showed the nasal tip included: downward migration of the lateral crura of the lower lateral cartilages and an unfurling of the scroll area, leading to drooping of the nasal tip. In addition, maxillary alveolar bone resorption causes posterior displacement of the pyriform aperture and divergence of the medial crura, reducing tip projection further and exaggerating the already acute nasolabial angle [(3)]**.** Not only is the overall effect aesthetically unacceptable to some patients, but the sagging tip diverts airflow superiorly into the narrow vestibule area, causing obstructive symptoms that may be aggravated by internal or external valve collapse due to degenerative loss of cartilage support, or a pre-existing septal deviation [(4)].

The end result of these changes is a long nose with an under-projected, caudally rotated tip, dorsal pseudo-hump, and functional internal and/or external valve obstruction. These are the issues that could be considered and addressed during rhinoplasty in the older patient [(9)]**.**

Microscopically, there was a reduction in dermal collagen synthesis and increased number of disorganised elastic fibres, resulting in thinner, less elastic skin, particularly over the dorsum and columella; meanwhile, despite an overall reduction in sebum production, the size of sebaceous glands in the nasal tip increases, making it heavy and bulbous. This causes sagging of the tip complex, while the thinner areas of skin showed up any underlying structural irregularities [(10)]**.** In spite of all the previous data regarding the aging nasal tip, the main factor in determining the major tip support mechanisms is still debatable.

Also there is no previous study compared the age related histological changes that occur in different components of nasal cartilages, and also the age related histological changes that occur in fibrous attachments of major nasal tip support.

AIM OF THE WORK

This study aimed to evaluate the age related cellular and architectural changes of nasal tip support mechanisms, in correlation to its anthropometric measurements.

PATIENTS AND METHODS

This was a prospective study to evaluate the age related cellular and architectural changes of nasal tip support mechanisms, in correlation to its anthropometric measurements. The study was conducted in Plastic and Reconstructive Surgery and Histology Departments, Ain-Shams University Hospitals, Cairo, Egypt. Forty five patients were included in this study. They had undergone aesthetic rhinoplasty operations, 10 males (25%) and 30 females (75%) with mean age (35.42±15.15) years and age range (19–60 years).

Inclusion criteria

- Adult patient above 18 years
- No history of previous surgeries
- Long humpy nose
- Nasal and septal deformity

Exclusion criteria

- Previous nasal or septal surgery
- Previous history of nasal trauma
- Patients were admitted to the study after being instructed properly, and signing their own consent to be included in this study

-Patients were categorized into 3 groups:

Group 1: included 15 patients, 2 male and 13 females and age range were 19-30 years with mean age 23.26.

Group 2: included 15 patients, 5 males and 10 females and age range were 31-45 years with mean age 35.4.

Group 3: included 10 patients**,** 3 males and 7 females and age range were 50-60 years with mean age 52.7.

METHODS

(A) Preoperative assessment:

All patients were subjected to preoperative assessment which included full medical history, drug history for anticoagulant drugs, general and targeted examination to evaluate the nasal deformity, routine laboratory investigations including: P.T, P.T.T, CBC, kidney and liver function tests and standard endonasal examination by nasal speculum to detect excessive hypertrophied inferior turbinates, any intra nasal masses and anterior end enlargement of middle turbinate. For all patients, full face photographs: frontal, lateral, oblique lateral and basal views were used in preoperative assessment. The photos were taken by Nikon digital camera D5200. These photos were used for clinical use during the surgical procedure and also in our study. As regard anthropometric measurements of photographs, nasolabial angle and tip projection were assessed. Tip projection was evaluated in our study by measuring the ratio of the nasal length to tip projection which should be approximately 1:0.67 [(11)]. As regard the nasolabial angle, it is used to determine the degree of tip rotation. In our study, the nasolabial angle was measured by drawing a straight line through the most anterior and posterior points of the nostrils as seen on the lateral view. This line with a perpendicular line to the natural horizontal facial plane forms the nasolabial angle. The preferable angle is 95-100 degree in women and 90-95 degree in men **(Figs 1,2)** [(11)].

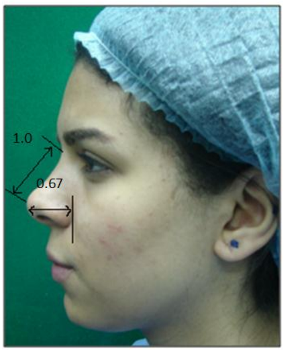

Fig. 1: nasal tip projection

Fig. 2: naso-labial angle

(B) Histological assessment:

As regard the study samples, they were taken through the usual steps of rhinoplasty procedure.They were preserved in formalin 10% for 3 days, then in ethanol 70% for 1 day, then in ethanol 90% for 6 hours, then in ethanol 100% for another 6 hours. After that they were put in Xylene for 6 hours, then in paraffin at temperature 60 c for 4 hours to make a block.Then cutting the block with thickness 5 micron were done followed by staining with H&E, Mallory's and safranin stains.

(C) Surgical Procedure:

All patients were operated upon using open septorhinoplasty technique. Dorsal reduction, osteotomy, excision of the cephalic part of the lower lateral cartilage, cartilage graft and nostril reduction were done according to patient's needs independent of this study. When necessary, septoplasty and turbinectomy were performed. The type of the operation was not be modified for this study. The standard of rhinoplasty care was performed to optimize aesthetic outcome.

Surgical technique:

The procedure was almost exclusively performed with the patient under general anesthesia. The nose was injected with lidocaine containing 1:200,000 epinephrine circumferentially to ensure sufficient vasoconstriction. The soft tissues along the lateral and medial surface of the nasal bones were injected too. The columella and the dorsal portion of the septum were injected bilaterally. The septum was injected along the floor of the nose as far posteriorly and caudally as possible to reduce bleeding during the septoplasty.

A step-ladder incision was made in the columella that was continued along the caudal margin of the medial and lateral crura of the lower lateral cartilages. Using scissors and a spread and cut technique, the soft tissues overlying the medial crura and the domes were dissected. The dissection was continued cephalically to expose the lateral crura and along the dorsum until nasal bones were reached. (Fibrous attachment sample (1) was harvested after doing dissection between the two domes) **(Fig. 3).**

Fig. 3: harvesting of intradomal attachment

At this point, the periosteal elevator was used to maintain the dissection in the subperiosteal plane (Dual plane of dissection). After elevation of the soft tissue cover, the nasal framework and the tip cartilages are evaluated and correlated with the preoperative analysis. As it is a crucial step in the operative sequence is the assessment of adequate tip projection, because reduction or augmentation of the dorsum should be performed with the tip projection in mind

Regarding the dorsal hump, the true hump was reduced by rasping. The rasping was continued in a cephalocaudal direction until the bony dorsum appeared optimal. In patients with pseudohump, appropriate tip projection and rotation were done first because the appearance of a "pseudohump" may be alleviated and thus prevent unnecessary dorsal reduction.

Cephalic trimming of the lower lateral cartilages was perfomed, maintaining about 5 mm width of the lower lateral cartilage anteriorly and 6 mm or more posteriorly, the excess portion of the cartilage was harvested with an intact mucoperichondrium.

In patients needing septoplasty, the soft tissue overlying the caudal septum was removed to gain access to the caudal end of the upper lateral cartilages and the dorsum **(Fig. 4)**. The mucoperichondrium was separated from the nasal roof and a tunnel was created. The upper lateral cartilages were then divided from the dorsum, then septoplasty was performed by elevation of the mucoperichondrial flap and dissection was done between it and the septal cartilage (cartilage sample (2) was harvested by trimming of the upper lateral cartilage during the cartilaginous hump removal).

Next the sharp end of the septal elevator was used to incise the septal cartilage at one side, leaving an L-shaped strut for the dorsal and columellar support with at least 10 mm anteriorly, and then dissection was continued to the other side of the septal cartilage in the same plane until the full extent of this part of the septal frame was exposed. Freeing of this portion of the septal cartilage from maxillary crest and perpendicular plate of ethmoid bone was done followed by removal of the entire septum while preserving the forementioned L-shaped cartilage caudally and anteriorly. The anterior nasal spine was repositioned by an osteotomy if shifted or removed if protruded. In patients with long septa, removal of the excessive portion of the anterocaudal septum, with excision of the attachment in between the caudal septum and footplate of medial crura (cartilage sample (3) and fibrous attachment sample (3) were harvested) (**Fig. 5)**.

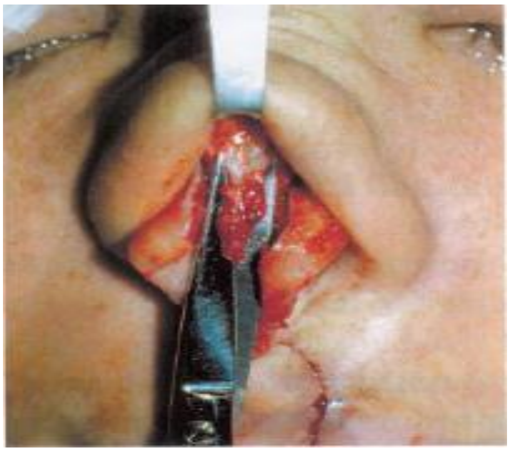

Figure 4: removal of the soft tissue overlying the caudal septum

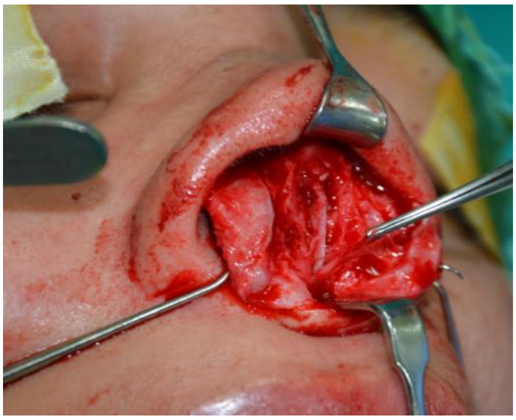

Fig. 5: harvesting of medial crural septal attachment

Next, a medial osteotomy was performed using a 4 or 6 mm osteotome. It was first placed medial to the nasal bones and then advanced cephalically with gentle tamping using a mallet. A wedge of bone could be removed medially to reposition the nasal bones, only if there was a significantly large distance between the nasal bones.Then external lateral osteotomy was carried out percutaneously using a 2 mm osteotome. It was inserted through a single puncture wound fairly anteriorly in lid cheek junction to avoid injury to the angular vessels. Then several interrupted osteotomies were done, then medialization of both nasal bones were performed by walsham.

The ends of the spreader grafts were beveled, and then they were placed and fixed in position using a double-armed 4-0 proline stitch. Two sutures at least were used to fix the graft and avoid rotation or dislodgement and to firmly approximate the cartilage graft to the septum. Two mattress sutures were then placed to approximate the upper lateral cartilage to the septum after trimming of the upper lateral cartilages.

The columellar strut, if needed, was placed into position and tattooed across the columella using a 25-guage needle to guide placement of the medial crural sutures. Typically two to three sutures were used to fix and secure the strut in position by 4-0 proline sutures. The strut is then trimmed to its desired shape to alter or refine the infratip lobular area

If indicated, a wedge of the anterocaudal septum was removed to allow rotation of the nasal tip. Tip rotation was obtained by using medial crural septal suture; a 4-0 proline suture was passed through the cephalic edge of the medial crura to the dorsal septum near the septal angle and tied. The needle was then passed between the medial crura and then the anterocaudal septum and brought back between the medial crura.

If indicated, the alar base was narrowed. The incision was designed to maintain the lateral portion of the nostril sill and provide a graceful transition from the alar base to the nostril sill, the alar base muscles were released, the excess tissues were excised and then the incision was closed by 6-0 proline sutures

A nasal dressing consisting of paper tape and splint is placed for 5-7 days. Intranasal support by packing is helpful to support the brittle nasal bones after osteotomies because of their tendency to collapse inward.

(B) Post operative assessment:

The post operative follow up was done as follows;

- The patient was monitored for blood pressure, pulse, breathing, and any bleeding tendency
- Intra nasal packs were removed after 2 days
- Stitches and external splint (if indicated) were removed after 1 week, and internal splint (if indicated) after 8-10 days

Statistical analysis

Data were analyzed using Statistical Program for Social Science (SPSS) version 20.0. Quantitative data were expressed as mean± standard deviation (SD). Qualitative data were expressed as frequency and percentage.

The following tests were done:

- ^ANOVA test with post hoc Tukey's test
- Pearson's correlation coefficient (r) test was used for correlating data.
- The confidence interval was set to 95% and the margin of error accepted was set to 5%. So, the p-value was considered significant as the following:
- Probability (P-value)
  - P-value <0.05 was considered significant.
  - P-value <0.001 was considered as highly significant.
  - P-value >0.05 was considered insignificant.

The study was approved by the Ethics Board of Ain Shams University.

RESULTS

In our study, 40 patients, 10 males (25%) and 30 females (75%) were seeking aesthetic primary rhinoplasty surgery with mean age (35.2±11.8) years and age range (19–60 years).

Table 1: age of the studied cases (N=40)

		Mean± SD	Range
Age (years)		35.2±11.8	19.0–60.0
		N	**%**
Age categories (years)	**Group I: (19-30)**	15	37.5%
	Group II: (30-50)	15	37.5%
	Group III: (50-60)	10	25.0%

This table showed that the group I (37.5%), group II (37.5%) and group III (25%) of age (years).

We correlated the celluar changes by aging that occurred in nasal cartilages LLC, ULC and SC and in soft tissue attachment ICA, IDA, and SCA with the anthropometry including both projection and nasolabial angle (NLA).

HISTOLOGICAL RESULTS

(A) Histology of the nasal cartilages:

Examination of section of cartilage taken from **Group I** showed that the cartilage was covered by perichondrium which is formed of outer fibrous layer and inner chondrogenic layer.The outer fibrous layer is formed of irregular connective tissue containing high number of fibroblast.The inner chondrogenic layer is avascular and formed of chondrogenic cells and chondroblasts. The cartilage matrix was seen basophilic due to its high contents of proteoglycans.

Changes that occur with aging process in Groups II and III:

There was a minimal change in cell types, but there was a decrease in their number, in addition to low number of blood vessels and decrease of the percentage of collagen bundles.

By the histological assessment of these nasal cartilages and soft tissue attachment, we found that:

Lower scores by modified Mankin score-indicating good cartilage- and maximum cellularity in soft tissue attachments were found in Group I (LLC=4 and SCA =70 cell/HPF) followed by Group II (SC=5 and SCA = 60 cell/HPF).While, higher scores-indicating weak cartilage- and lower cellularity in soft tissue attachments were found in **Group III** (LLC=15 and SCA= 50 cell/HPF).The projection was highest in **Group I** (0.68) and decreased in **Group II** (0.66) and became the least in Group III (0.41).

The nasolabial angle was measured the highest in **Group I** then **II** and **III**, giving values 105, 95 and 75 respectively.

Table 2: nasal tip supports mechanisms of the studied cases.

Mechanisms	Mean±SD	Range
NLA (degrees)	90.5±7.9	75.0–105.0
ICA (cell/HPF)	40.4±11.1	20.0–61.0
IDA (cell/HPF)	40.4±11.4	19.0–60.0
SCA (cell/HPF)	39.0±11.9	19.0–60.0
Projection	0.58±0.07	0.41–0.68
LLC (MM score)	8.68±3.41	4-15
ULC (MM score)	9.03±3.43	5-15
SC (MM score)	8.35±3.24	5-14

Quantitative data were expressed as mean± standard deviation (SD)

Table 3: comparison between aging and soft tissue attachment (ICA, IDA and SCA)

Findings	Group I (N=15)	Group II (N=15)	Group III (N=10)	^P
ICA (cell/HPF)	45.3±9.8 A	42.0±10.1 A	30.3±8.2 B	**<0.001***
IDA (cell/HPF)	45.8±9.4 A	41.3±11.6 A	30.4±7.7 B	**0.002***
SCA (cell/HPF)	47.1±9.5 A	37.7±9.8 B	28.0±6.6 C	**<0.001***

^ANOVA test with post hoc Tukey's test (homogenous groups had similar letters), *Significant

This table indicated high accuracy of the histological assessment of the soft tissue attachment done through image analyze (Leica Q 500 MC program) for its quantitative analysis.This table showed that any increase in age correspond to decrease in these soft tissue attachment cellularity, vascularity and strength, which was most statistically significant between groups only in SCA. While other attachments (ICA, IDA) showed minmal changes with aging in group I & II with marked changes in **group III.** Moreover, SCA has highest cellularity in **group I** and the least one in **group III.**While, in **group II**, the most one of soft tissue attachment that has high cellularity was ICA.

Table 4: relation between projection and soft tissue attachment (ICA, IDA and SCA)

Findings	Group I (N=15)	Group II (N=15)	Group III (N=10)	^P
Projection	0.61±0.06	0.59±0.06	0.51±0.07	**<0.001***
ICA (cell/HPF)	45.3±9.8	42.0±10.1	30.3±8.2	**<0.001***
IDA (cell/HPF)	45.8±9.4	41.3±11.6	30.4±7.7	**0.002***
SCA (cell/HPF)	47.1±9.5	37.7±9.8	28.0±6.6	**<0.001***

This table showed highly statistically significant relation between groups according to projection and soft tissue attachment. Also, this table illustrated the effects of aging that lead to decrease in projection and all soft tissue attachment being more statistically significant (P <0.001) in SCA and ICA.

Table 5: correlation between projection and soft tissue attachments, using Pearson Correlation Coefficient.

Projection		All (N=40)	Group I (N=15)	Group II (N=15)	Group III (N=10)
ICA (cell/HPF)	**r**	0.678	0.740	0.473	0.353
	p	**<0.001***	**0.001***	0.075	0.318
IDA (cell/HPF)	**r**	0.660	0.689	0.436	0.466
	p	**<0.001***	**0.003***	0.104	0.174
SCA (cell/HPF)	**r**	0.706	0.616	0.588	0.584
	p	**<0.001***	**0.011***	**0.021***	0.076

Pearson correlation, *Significant

Positive correlation was detected and significance between projection and soft tissue attahcments in the study group. As well as the most important SCA, ICA and IDA (r= 0.706, 0.678 and 0.660) of respectively.

In this table, **ICA** was the most significant soft tissue attachment affecting projection in Group I **(P = 0.001).** While, the **SCA** was the most significant one affecting the projection in groups II and III. **(**P = 0.021 and = 0.076 respectively)

Table 6: relation between projection and cartilages (LLC, ULC and SC).

Findings	Group I (N=15)	Group II (N=15)	Group III (N=10)	^P
Projection	0.61±0.06	0.59±0.06	0.51±0.07	**<0.001***
LLC (MM score)	5.73±1.58	8.47±2.00	13.70±0.97	**<0.001***
ULC (MM score)	5.80±1.32	9.13±1.92	13.40±0.95	**<0.001***
SC (MM score)	5.53±1.06	8.07±1.91	13.00±0.82	**<0.001***

This table showed highly statistically significant relation between groups according to projection and cartilages. Also, this table illustrated the decrease in projection and all cartilages (which have higher scores by modified Mankin grading system) being statistically significant (P <0.001) in all cartilages (ULC, LLC, and SC) that occur with aging.

Table 7: correlation between projection and cartilages, using Pearson Correlation Coefficient

Cartilages	Measures	All (N=40)	Group I (N=15)	Group II (N=15)	Group III (N=10)
LLC (MM score)	**R**	-0.441	-0.393	-0.285	-0.190
	P	**0.004***	0.490	0.929	**0.049***
ULC (MM score)	**R**	-0.433	-0.359	-0.211	-0.288
	P	**0.005***	**0.034***	**0.026**	0.917
SC (MM score)	**r**	-0.431	-0.198	-0.338	-0.311
	p	**0.005***	**0.029***	**0.034***	0.761

Pearson correlation, *Significant

Negative correlation was realized and significance between projection and cartilages in the study group. Higher scores of the cartilage (denoting its weakness) correspond to low nasal projection, while low scores correspond to high projection.As well as the most important one affecting projection were SC, ULC and LLC (r= -0.431, -0.433 and -0.441) of respectively.

In this table, **SC** is the most significant cartilage affecting projection in **group I** (P = 0.029).
While, the **LLC** was the most significant one affecting the projection in **groups II and III.** (P = 0.049)

Table 8: relation between NLA and soft tissue attachment (ICA, IDA and SCA)

Findings	Group I (N=15)	Group II (N=15)	Group III (N=10)	^P
NLA (degrees)	97.8±10.3	88.6±4.2	81.6±5.1	**<0.001***
ICA (cell/HPF)	45.3±9.8	42.0±10.1	30.3±8.2	**<0.001***
IDA (cell/HPF)	45.8±9.4	41.3±11.6	30.4±7.7	**0.002***
SCA (cell/HPF)	47.1±9.5	37.7±9.8	28.0±6.6	**<0.001***

This table showed highly statistically significant relation between groups according to NLA and soft tissue attachment.Also, this table illustrated the cellular and architectural changes by aging that lead to decrease in nasolabial angle and all soft tissue attachment being more statistically significant (P <0.001) in SCA & ICA.

Table 9: correlation between NLA and soft tissue attachments, using Pearson Correlation Coefficient

Attachments	Measures	All (N=40)	Group I (N=15)	Group II (N=15)	Group III (N=10)
ICA (cell/HPF)	**r**	0.595	0.310	0.628	0.202
	p	**<0.001***	0.242	**0.012***	0.576
IDA (cell/HPF)	**r**	0.609	0.317	0.598	0.259
	p	**<0.001***	0.232	**0.018***	0.470
SCA (cell/HPF)	**r**	0.699	0.363	0.738	0.294
	p	**<0.001***	0.167	**0.002***	0.442

Pearson correlation, *Significant

Positive correlation was demonstrated and significant between NLA and soft tissue attachments in the study group. As well as the most important soft tissue attachment affecting NLA are SCA, IDA and ICA (r= 0.699, 0.609 and 0.595) of respectively.In this table, **SCA** was the most significant soft tissue attachment affecting the nasolabial angle in all groups (Group I, Group II, and Group III **(**P = 0.167, = 0.002 and = 0.442 respectively).

Table 10: relation between NLA and cartilages (LLC, ULC and SC)

Findings	Group I (N=15)	Group II (N=15)	Group III (N=10)	^P
NLA (degrees)	97.8±10.3	88.6±4.2	81.6±5.1	**<0.001***
LLC (MM score)	5.73±1.58	8.47±2.00	13.70±0.97	**<0.001***
ULC (MM score)	5.80±1.32	9.13±1.92	13.40±0.95	**<0.001***
SC (MM score)	5.53±1.06	8.07±1.91	13.00±0.82	**<0.001***

This table showed highly statistically significant relation between groups according to NLA and cartilages.

Also, this table illustrated the decrease in NLA and all cartilages (with high scores) being statistically significant (P <0.001) in all cartilages (ULC, LLC, and SC) that occur with aging.

Table 11: correlation between NLA and cartilages, using Pearson Correlation Coefficient

	Measures	All (N=40)	Group I (N=15)	Group II (N=15)	Group III (N=10)
LLC (MM score)	**R**	-0.727	-0.315	-0.194	-0.473
	P	**<0.001***	**0.025***	0.488	0.289
ULC (MM score)	**R**	-0.713	-0.360	-0.316	-0.385
	P	**<0.001***	**0.028***	**0.025***	0.160
SC (MM score)	**R**	-0.665	-0.411	-0.357	-0.323
	P	**<0.001***	**0.038***	**0.040***	**0.038***

Pearson correlation, *Significant

Negative correlation was observed and significant between NLA and cartilages in the study group. As low NLA corresponds to high score of the cartilage (denoting its weakness) and high NLA occurs with low cartilage score.

As well as the most important cartilage affecting NLA is SC, ULC and LLC (r= -0.665, -0.713 and -0.727) of respectively.

In this table, **LLC** was the most significant cartilage affecting the nasolabial angle in **groups I and II** (P =0.025 and =0.488) and the least one affecting the NLA in group III (P =0.289).
While the SC was the most significant cartilage affecting the NLA in Group III **(P =0.038)**

Table 12: effect of age on nasal tip support mechanisms (linear regression models)

Items	Factors	B	SE	P	95 % CI	R^2
NLA	**Constant**	109.324	2.393	**<0.001***	104.485–114.164	**0.638**
	Age	-0.535	0.065	**<0.001***	-0.666–-0.405	
ICA	**Constant**	61.266	4.308	**<0.001***	52.551–69.980	0.400
	Age	**-0.592**	0.116	**<0.001***	-0.827–-0.357	
IDA	**Constant**	62.693	4.313	**<0.001***	53.969–71.418	0.432
	Age	**-0.634**	0.116	**<0.001***	-0.869–-0.398	
SCA	**Constant**	63.833	4.019	**<0.001***	55.705–71.962	0.448
	Age	**-0.706**	0.108	**<0.001***	-0.925–-0.487	
Projection	**Constant**	0.697	0.031	**<0.001***	0.635–0.760	0.290
	Age	-0.0033	0.0008	**<0.001***	-0.0050–-0.0016	
SC	**Constant**	77.315	4.245	**<0.001***	68.730–85.901	**0.627**
	Age	**-0.927**	0.114	**<0.001***	-1.159–-0.696	
LLC	**Constant**	82.271	4.240	**<0.001***	73.694–90.484	**0.695**
	Age	**-1.077**	0.114	**<0.001***	-1.308–-0.846	
ULC	**Constant**	76.815	4.170	**<0.001***	68.381–85.249	**0.644**
	Age	**-0.943**	0.112	**<0.001***	-1.171–-0.716	

β: Regression coefficient, SE: Standard error, CI: Confidence inyterval, R^2: Coefficient of determination, *Significant

Age dependent models can best explain changes in the *cellularity* in **NLA** and cartilages measures (highest in **LLC)**, but worst explain changes in projection and soft tissue attachments**.**

In this table, β **(**Regression coefficient) illustrated that **LLC** was the most nasal tip support mechanism affected by aging; as every 1year increase in age, correspond to weakness in LLC by percent **-**1.077 followed by ULC, SC, SCA, IDA, ICA, NLA and projection respectively (P value <0.001).

DISCUSSION

Rhinoplasty in the older patients becomes more challenging, as there is an increase in the availability and acceptability of aesthetic surgery.

Thus thorough understanding of the relationship between the upper lateral, lower lateral and septal cartilages together with the nasal soft tissue attachments that evolve with age will facilitate proper assessment and counseling of the older patient in addition to achieve better and more consistent results [12].

With the loss of soft tissue support and the vertical realignment of the nasal tip cartilages that progressively develop with age, rhinoplasty in the older patients requires a predictable means of reorienting and stabilizing the nasal cartilages and soft tissue attachment so as to affect changes in tip rotation and projection [(13)].

As a part of the aging face, tip ptosis is the predominant feature of nasal aging. In addition, it is one of the most common findings in patients presenting for primary rhinoplasty. Also nasal tip ptosis is one of the most common findings in patients presenting for secondary rhinoplasty, and iatrogenic destruction of nasal tip support is a common finding in late development of tip ptosis following rhinoplasty [(4)].

Thus nasal tip position should be maintained in a secured and controlled way after rhinoplasty. The unpredictability of postoperative healing forces can confound the aesthetic results of many experienced rhinoplastic surgeons. Additional steps may be incorporated in rhinoplasty technique even in young patients to avoid the changes affecting the nasal tip support by aging process [(13)].

In our study we evaluated the effect of aging on the individual cartilage of the nose; ULC, LLC, and septal cartilage. Also we studied the aging process that occurs in different attachments of the nasal tip including ICA, IDA and SCA as a part of tip support mechanisms which was not previously evaluated in details in previous studies.

In our study we did the histological assessment and modified Mankin histologic grading as an objective method for assessing the cellular and architectural changes of nasal soft tissue attachments and cartilages through (cellularity, clusters formation, necrosis, fibrinoid degeneration, and perichondrial fibrosis and malorganization) respectively. This was done in correlation to its anthropometric measurements including nasolabial angle and projection.

Lotz and loeser [(3)] stated that downward migration of the lower lateral cartilages and an unfurling of the scroll area, leading to drooping of the nasal tip with reduction of its projection and exaggerating the already acute nasolabial angle. Also Rohrich and Hollier [(14)] mentioned that there is attenuation and ossification of the fibroelastic attachment between the upper and lower lateral cartilages.

In our study, we did histological quantitative assessment of the interdomal attachment which showed that there was a significant difference (P <0.001) between all age groups and the IDA in relation to projection and NLA. Moreover, it is the second most important attachment affecting NLA and the third one to affect projection with statistically significance **(**P <0.001). Also **Farahvash *et al*.** [(15)] measured the lower lateral cartilage in fresh cadavers using the it's morphological changes as size and shape of the cartilage so as to achieve appropriate preoperative planning for treating the nasal tip

Our study measured the lower lateral cartilage in living, using the modified Mankin grading scale. It showed a negative relation and statistically significance between LLC and projection and NLA. **(**P =0.004 and <0.001). We found that LLC was the most significant cartilage affecting the projection in group II and III.

Moreover, we found that LLC was the most important cartilage affecting NLA in **groups I and II**. In addition, it showed least cartilage that preserved the nasolabial angle in elderly (**Group III**). This can confirm the tripod theory of the lower lateral cartilage including both lateral and medial crura that preserve the projection in older persons mentioned by **Anderson** [(16)].

Ghavami and his colleagues [(7)] mentioned that the dorsal nasal septum plays an important role in supporting the nasal tip and should be preserved to prevent weakening of tip support. Also **Mihajlovic and his colleagues** [(4)] stated that the cartilaginous septum acts as a minor tip support mechanism.

In our study we found a negative relation between aging and septal cartrilage resulting in decrease in the cartilage cellularity and clusters, increased number of cellular necrosis and fibrinoid degeneration and perichondrial fibrosis that occur with aging.

In addition, SC is the most significant cartilage to have high clusters and cellularity in **group I** and it was the most significant cartilage that affects projection in younger group (**Group I).** Also, SC was the most crucial cartilage to preserve the nasolabial angle in **group III**.

Ashrafi [(17)] stated that the ULC has a major role in maintaining the dorsal aesthetic lines and the nasal functions. **Rohrich and his colleagues** [(18)] mentioned that the ULC was instrumental in obtaining aesthetic and functional rhinoplasty and it was a crucial malleable parameter of projection, nasal dorsal shape, width and tip rotation.

In our study, we found highly significant significance between the aging groups according to the ULC. Moreover, it was the weakest cartilage in **groups I and II** and the second weak one in **group III.**

Also, we found a significant negative relation between ULC and projection and NLA. **(**P **=0**.005 and <0.001) especially in group I and II. In addition ULC is the most significant cartilage affecting the projection in **group II.**

Lee and his colleagues [(19)] mentioned that age-related morphologic changes are the most dramatic in the lower third of the nose, with elongation of the lateral nasal walls and dropping of the nasal tip caused by thinning of the nasal skin envelope, separation of the attachments between the upper and lower lateral cartilages, and weakening of the nasal cartilages.

This was confirmed in our study by doing the quantitative assessment of nasal cartilages and soft tissue attachment which showed that there is significant difference (P <0.001) between all age groups as regard all nasal cartilages, and SCA. Also there is significant difference in projection, IDA, and ICA between **groups II and III.**

Our study confirmed the accuracy of our objective methods in the form of modified mankin scoring system and the image analyze program as it conducted the highly significant correlation between them in relation to the aging process in correlation with the anthropometric measurements (projection and nasolabial angle).

By correlation the data obtained from **groups I, II, III,** there were significant positive correlations between NLA and soft tissue attachments and significant negative correlation between NLA and cartilages (P <0.001).

In group I there was a strong correlation between NLA and SCA and LLC; **group II** showed positive strong correlation between NLA and SCA and LLC, **group III** showed strong correlation between NLA SCA and SC. There were significant positive correlations between **NLA** and **SCA** in all age groups, being the most crucial attachment affecting the nasolabial angle in all groups. In addition, by correlation the data obtained from groups I**, II, III** there were significant positive correlations between projection and soft tissue attachments (P <0.001) and significant negative correlation between projection and cartilages cartilages (P =0.004**).**

In **group I** there was strong correlation between projection and ICA and SC, **group II** showed strong correlation between projection and SCA and ULC, **group III** showed strong correlation between projection and SCA and LLC. There were significant positive correlations between projection and **SCA and LLC** in older group, being the most crucial one that preserve the projection elderly. Moreover by doing the linear regression model, the regression coefficient β variability showed that every one year increase in age corresponds to maximum affection in LLC **(**by **– 1.077)** and this confirm the weakness and elongation of lateral nasal wall, being the most affected one by aging process. Other cartilages affected by aging were ULC and SC respectively. Also SCA was the most affected soft tissue attachment by increase aging **(**β **-**0.706).

CONCLUSION

Aged patients present unique technical challenges in rhinoplasty that warrant a comprehensive approach to restore and preserve tip support. Soft tissue attachments and cartilages are reduced significantly together with projection and nasolabial angle in relation to the aging process.

These findings not only enhances our current understanding of the natural changes that occur in cartilage and attachments with aging, but may also affect surgical decision making when grafting or suturing are considered during rhinoplasty. So, the surgeon should develop a flexible operative approach and should be prepared to perform a combination of surgical maneuvers to maintain and preserve nasal tip support.

RECOMMENDATIONS

Medial crural septal suture should be performed in all elderly patients undergoing aesthetic rhinoplasty, both to prevent further exaggeration of the already existed acute nasolabial angle and to maintain the nasal tip projection and rotation. At least 5-6 mm of the lower lateral cartilages should be preserved to avoid its weakness and collapse. It is advisable to use lateral crural strut graft or alar batten grafts to stabilize the lateral crura of the lower lateral cartilage after cephalic trim. Septal cartilage has not affected extremely by aging, so it is a valuable source for cartilage grafting in elderly.

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