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REVIEW ARTICLE

Innovation in Alloplastic and Biological Materials in Modern Rhinoplasty: From Volume Augmentation to Predictability

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ABSTRACT

Rhinoplasty has undergone a major transformation over the past decade. The concentration has shifted from simple volume augmentation towards long term structural predictability and functional stability. Traditional alloplastic materials, mainly silicone implants, remain commonly used in Asian rhinoplasty because of their affordability and ease of use, but they are associated with many commonly documented complications such as extrusion, infection, translucency like the shiny nose and late calcification. Recent innovations in implant engineering, including surface texturing and flexible hinge designs, targets to overcome most of these limitations. At the same time, biological alternatives such as the RAGO strut(Reinforced Autologous Graft from the Osteo septal complex) introduce hybrid autologous solutions that decrease morbidity while maintaining strength and durability. Additional methods and techniques like residual hyaluronic acid fillers and the use of 3D simulation systems, plays a crucial role in planning the surgery and outcome predictability of the surgery.Most importantly, the modern rhinoplasty gradually highlights the nasal septum as a key craniofacial growth and functional unit with direct connection for maxillary development, occlusion and dentofacial harmony, thereby expanding the relevance of rhinoplasty into the domains of dentistry and orthodontics.This review synthesises current clinical evidence on implant design, autologous bone reinforcement, long term failure mechanisms, preoperative filler management, and digital planning tools, highlighting a shift in rhinoplasty from volume change toward predictable structural design.

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Introduction

Rhinoplasty is one of the most technically demanding procedures in facial plastic surgery. Unlike fixed skeletal structures, the nose is a dynamic organ that moves with facial expression, speech, mastication, and respiration. This dynamic behaviour also interacts with oral functions like mastication and breathing patterns which are closely linked to dentofacial growth and occlusion.This continuous motion makes long term predictability challenging, particularly when foreign materials like implants are introduced.

In Asian rhinoplasty, silicone implants have historically been favored for dorsal augmentation because they are biocompatible, affordable, and easily carved intraoperatively. Despite these advantages, long term clinical experience has revealed consistent limitations, including infection, extrusion, translucency like a shiny nose, and delayed structural changes. Autologous options, while biologically favorable, often require additional donor site morbidity.

Recent developments suggest that the field is no longer divided into synthetic versus natural. Instead, modern rhinoplasty increasingly focuses on predictability, achieved through engineered biomaterials, refined autologous techniques, and digital planning tools.

Although nasal septum deviation is classically corrected through septoplasty, modern rhinoplasty practice frequently includes septoplasty as a part of an integrated septorhinoplasty procedure. Because the nasal septum serves as the central structural support of the nose its role extends beyond airway function to influence nasal shape, facial balance and adjacent Dentofacial structures [1].

This article is a narrative review based on published clinical studies, long-term outcome analyses, failure reports, and consensus guidelines examined from dental and orthodontic perspective. Literature was selected to focus on how nasal septal defects altered breathing patterns and their implications for Dentofacial growth maxillary development and occlusal stability. In parallel, recent evolving trends in implant engineering, autologous graft innovation, complication mechanisms, and their impact on craniofacial balance and functional stability along with nasal aesthetics, preoperative optimization. No systematic search or metaanalysis was performed.

Evolution of Silicone Implants: Engineered Solutions to Historical Problems

Silicone remains the most widely used alloplastic material in Asian rhinoplasty because of its biocompatibility, affordability, clinically easy to carve and intraoperative adaptability.

However, traditional smooth silicone implant has a long list of potential complications like extrusion infection and the smooth surface resulting in aesthetic failure is translucency, the shiny nose mostly because of optics.

This phenomenon results from direct light reflection off the smooth implant surface which acts like a mirror, producing an unnatural look with a whitish glow under the skin. In contrast, the natural bone and cartilage absorb and scatter light but do not reflect it like a mirror. So that brings us to the YUSHA implant.

The YUSHA implant represents a newer generation of silicone implants designed to address all these limitations through surface and structural modification [2]. Its surface incorporates micro-textured particle outbursts instead of being smooth, that scatter light rather than reflect it, mimicking the optical behavior of natural bone and cartilage and eliminating unnatural shine.

Functionally, traditional L-shaped implants behave as rigid units, transferring force from the tip to the dorsum. The YUSHA implant incorporates a narrowed junction known as the “mantis neck,” the biggest innovation which functions as a mechanical hinge. This allows independent tip mobility, closely mimicking natural nasal biomechanics [2].

Clinical data demonstrate a 95.6% success rate [2], with complications occurring only in revision cases and none in primary rhinoplasty. These findings suggest that modern silicone implants have evolved into actively engineered devices rather than passive

blocks.

Biological Innovation: The RAGO Strut As A Hybrid Autologous Solution

Certain populations, particularly those in Northeast India, present anatomical challenges such as a flat dorsum, thick skin, and weak septal cartilage. In these cases, conventional septal extension grafts may fail due to insufficient cartilage strength. And the YUSHA implant is still a foreign object but for some patients we must need autologous tissue, the body's own building blocks. This brings us to the RAGO strut. The Osteo-septal complex used in RAGO strut originates from a craniofacial region that also contributes to midfacial support, further strengthening the relevance of this technique from dentofacial stability standpoint.

Costal cartilage remains a reliable alternative but introduces additional morbidity i.e., going from local nasal surgery to full on thoracic procedure, involving a chest incision, harvesting a segment of rib cartilage, longer recovery and permanent chest scar. The RAGO strut provides a hybrid solution by repurposing the vomer ethmoid bone complex [3].

Using ultrasonic bone cutting technology, surgeons can harvest precise thin, intact bone strips without damaging surrounding soft tissue. Because bone cannot be sutured directly, microperforations may be a millimetre wide and are created along the graft to allow fixation to cartilage.

This approach avoids rib cartilage harvest, reducing donor-site morbidity, operative time, and scarring. Long-term follow-up demonstrates stable tip projection without clinically significant bone resorption with fully intact graft at eight years, challenging concerns regarding bone resorption [3].

Long Term Failures of Silicone Implants: Lessons from Explantation Studies

Despite advances in implant design, long term complications of alloplastic materials remain relevant. An explantation study of patients with an average implant duration exceeding a decade identified extensive calcification along implant surfaces [4].

Clinically this manifests as nasal rigidity, contour irregularities, and difficulty during revision surgery.

Calcification results from two main causes:

Cause 1: Chronic low-grade foreign body inflammation
Cause 2 : Repeated mechanical micro movement

The nasal tip and dorsum regions with the highest mobility were most affected. These findings support the rationale for textured and flexible implant designs like YUSHA implants, that reduce friction and stress concentration.

Digital Planning and 3D Simulation

3D simulation systems, specifically the crisalix system have demonstrated high clinical accuracy in predicting dorsal outcomes, with deviations of less than 2 to 3 degrees in key angular measurements [6].

Accuracy is lower at the nasal tip due to biological limits of skin elasticity i.e., biologically skin resists stretchability and postoperative tissue behavior which is the biological part. But studies suggest that surgeons might intentionally overshoot in the simulation to make sure the patient gets the message to agree on the direction of change rather than the exact millimetre which is a psychological part [6].

When combined with Cephalometrics and Occlusal analysis, 3D simulation may enhance interdisciplinary planning for precise treatment between rhinoplasty facial surgeons, dentists and orthodontists.

These tools are best used to align expectations rather than to promise exact millimeter outcomes, particularly in revision cases. Accuracy decreases in revision cases due to scarring.

Conclusion

Modern rhinoplasty is no longer defined by a choice between alloplastic materials and autologous materials. Instead, it is driven by the pursuit of predictability, not only in nasal contour but also in its surrounding craniofacial and dentofacial structures.

Recognition of nasal septum As a determinant of maxillary growth, occlusion and facial balance positions rhinoplasty at intersection of plastic surgery, dentistry, and orthodontics.

Engineered silicone implants such as the YUSHA implants(Y-shaped Unified Structural Harmony Augmentation implant) design address historical optical and mechanical drawbacks. Autologous innovations like the RAGO strut(Reinforced Autologous Graft from the Osteo septal complex) provide strong, biologically compatible support without any morbidity and together represent a shift from simple volume change towards long term structural reliability and in an innate dynamic organ and anatomical harmony.

Understanding implant calcification guides material selection, while mandatory standardized filler dissolution protocols establish safer surgical starting points. Finally, 3D simulation serves as a most important communication bridge between surgeon and patient.

Conflict of Interest

The author declares no conflict of interest.

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