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Trimartani Koento
Mirta Hediyati Reksodiputro
Mikhael Yosia

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REVIEW

The Best Cut: Evaluating Block, Sliced, and Diced Cartilage in Dorsal Augmentation Rhinoplasty

Trimartani Koento, Mirta Hediyati Reksodiputro, Mikhael Yosia *

Department of Otorhinolaryngology-Head and Neck Surgery, Faculty of Medicine Universitas Indonesia – Dr. Cipto Mangunkusumo General Hospital, Jakarta, Indonesia

ABSTRACT

Rhinoplasty is a surgical procedure aimed at improving the nasal shape and function, with dorsal augmentation playing a crucial role in nasal reconstruction. Autologous cartilage grafts, particularly from the rib, are widely used due to their structural integrity but pose challenges such as postoperative warping, graft shifting, and resorption. The evolution of cartilage grafting techniques has progressed from block to sliced and diced cartilage to enhance long-term stability and aesthetic outcomes. Block cartilage provides excellent structural support but is prone to warping due to intrinsic stress. Sliced cartilage reduces warping risk while offering greater flexibility, whereas diced cartilage allows for precise contour adaptation but has a higher risk of resorption. Modifications such as autologous fascia wrapping and fibrin glue application have been introduced to improve graft integration and stability. This study evaluates the effectiveness of each technique based on key parameters, including warping incidence, graft shifting, resorption, and aesthetic success. Literature review findings indicate that diced cartilage offers a more natural contour with minimal warping, while sliced cartilage provides a balance between structural support and flexibility. Block cartilage remains the preferred choice for major reconstruction requiring maximum strength. The selection of the grafting technique should be tailored to the patient's specific needs to optimize surgical outcomes and minimize complications.

Keywords: Rhinoplasty, Dorsal augmentation, Block cartilage, Sliced cartilage, Diced cartilage

1. Introduction

Rhinoplasty frequently necessitates dorsal augmentation to restore nasal height, contour, and overall structural harmony. Among available grafting materials, autologous rib cartilage remains widely regarded as the gold standard for substantial dorsal augmentation due to its abundant availability and superior mechanical strength. However, despite these advantages, traditional use of block cartilage grafts has been challenged by well-documented complications such as postoperative warping, graft shifting, resorption, and contour irregularities. Warping, in particular, results from intrinsic stresses within the cartilage matrix that manifest after carving and implantation, leading to distortion of the nasal dorsum that can undermine both functional and aesthetic outcomes and often require revision intervention [1]. Reported warping rates for block cartilage range from 0.9% to 26.1%, depending on carving method, cartilage quality, and stabilization strategy [2, 3]. Sliced cartilage techniques have reduced this incidence to approximately 2–5% [4, 5], while diced cartilage, when properly stabilized, demonstrates negligible warping but may face resorption rates up to 25–30% in certain containment methods such as Surgicel wrapping [6]. This recognition of inherent biomechanical limitations has prompted ongoing efforts to modify grafting approaches to improve stability and predictability.

In response to these challenges, surgeons introduced slicing techniques that involve creating thin lamellae from costal cartilage to reduce internal stress

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* Corresponding author.
E-mail address: mikhael.yosia@gmail.com (M. Yosia).

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and mitigate warping risk while preserving sufficient rigidity to support nasal contouring [7, 8]. Building upon this strategy, diced cartilage grafting was subsequently developed to maximize malleability and virtually eliminate warping by finely fragmenting cartilage into small particles that can be shaped into a paste-like construct for precise dorsal contouring [7]. However, the increased surface area and fragmented nature of diced cartilage accelerate enzymatic degradation and inflammatory breakdown, reducing long-term volume retention, while the absence of rigid structural continuity facilitates migration within the soft tissue envelope if not adequately contained.

To address these issues, various containment and stabilization methods were developed, each aiming to optimize integration and minimize complications. Notably, Erol's "Turkish Delight" technique employed oxidized cellulose (Surgicel) to wrap diced cartilage, an approach designed to facilitate shaping and reduce warping but later scrutinized for potential inflammatory responses and accelerated resorption [9, 10]. Subsequent studies reported resorption rates as high as 25–30% with Surgicel-wrapped cartilage in some series, underscoring the need for alternative containment methods [6]. Later adaptations favored the use of autologous fascia as a biocompatible wrap to enhance graft survival and reduce chronic inflammation. Parallel innovations included the diced cartilage glue graft, or "Tasman technique," which utilized fibrin sealants to bind cartilage particles into a stable construct, as well as the autogenous control augmentation system (ACAS), which sought to improve predictability in maintaining dorsal height and shape by refining glue-based stabilization strategies [1, 11, 12]. These iterative modifications reflect a collective surgical pursuit of an optimal balance between structural support, contour adaptability, and long-term graft viability.

Despite these refinements, there remains no consensus on the optimal stabilization method for diced cartilage. Advocates of autologous fascia wrapping cite superior biocompatibility and long-term volume preservation, while proponents of fibrin glue emphasize ease of use and elimination of donor site morbidity. Similarly, debate persists over whether diced constructs—despite eliminating warping—can match the long-term structural stability of block grafts in high-demand reconstructions. This scoping review aims to systematically map the existing literature on block, sliced, and diced cartilage grafts used in dorsal augmentation rhinoplasty. By cataloging the range of surgical techniques, modifications—including fascia wrapping, fibrin glue stabilization, and advanced containment systems—and reported complication profiles such as warping, shifting, resorption, and contour irregularities, this review seeks to provide a comprehensive overview of current practice patterns and evidence. Such mapping is intended to guide clinical decision-making and identify areas where further targeted research may refine surgical approaches and improve long-term patient outcomes.

2. Methods

This scoping review was conducted in accordance with the PRISMA-ScR (Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews) guidelines to ensure methodological transparency and reproducibility. The aim of this review was to map the existing literature on block, sliced, and diced cartilage grafts used in dorsal augmentation rhinoplasty.

A comprehensive online search was performed across PubMed, Scopus, Web of Science, and Google Scholar databases from database inception to 15 March 2025 (date last searched). The search strategy incorporated combinations of keywords and MeSH terms, including:

("rib cartilage graft" OR "costal cartilage" OR "block cartilage rhinoplasty" OR "sliced cartilage graft" OR "diced cartilage graft") AND ("dorsal augmentation" OR "cartilage warping" OR "cartilage resorption" OR "cartilage migration" OR "nasal contour irregularities"). Boolean operators ("AND," "OR") were used to refine results. Filters applied included English-language publications only, human subjects, and clinical studies. Reference lists of all included studies were manually screened to identify additional relevant literature.

Eligible studies included clinical trials, observational studies, case series, and comparative reports that described the use of autologous rib cartilage in block, sliced, or diced forms for dorsal augmentation rhinoplasty and reported outcomes such as warping, resorption, graft shifting, contour irregularities, or the use of adjunctive stabilization techniques (e.g., fascia wrapping, fibrin glue, or approaches like the Turkish Delight, Tasman technique, and ACAS). Studies focusing solely on synthetic implants or non-cartilaginous grafts, as well as articles lacking primary clinical data, were excluded. Two independent reviewers screened titles and abstracts for eligibility, followed by full-text review of potentially relevant studies. Discrepancies in study selection were resolved through discussion, and if consensus was not reached, a third reviewer acted as adjudicator.

Data extraction focused on charting key variables, including patient demographics, graft type and preparation method, stabilization strategies, follow-up duration, and reported complications or revisions. Findings were synthesized narratively and organized thematically to illustrate prevailing practices, surgical modifications, and complication patterns. This approach provides an overview of current evidence to support informed graft selection and highlights areas requiring further study in dorsal augmentation rhinoplasty. Data extraction included patient demographic variables such as age group (children <18 years, young adults 18–35 years, middle-aged adults 36–55 years, and older adults >55 years) and gender, where reported.

3. Results

3.1. Dorsum augmentation in rhinoplasty

Nasal dorsal augmentation in rhinoplasty demands a comprehensive understanding of the anatomical, physiological, and histological properties essential for graft viability, integration, and sustained functional and aesthetic outcomes. The nasal dorsum comprises a complex structural framework: the upper third is supported by the nasal bones, the middle third by the paired upper lateral cartilages connected to the dorsal septum, and the lower third by the alar cartilages, which contribute to tip support and mobility [7, 13]. Successful augmentation requires careful evaluation of these components to preserve nasal function, maintain structural harmony, and ensure long-term stability. For grafting, cartilage must withstand mechanical stresses while retaining structural integrity. Costal cartilage is widely favored for major nasal augmentation owing to its high tensile strength and load-bearing capacity; however, it is inherently predisposed to warping due to uneven contraction forces within its collagen and proteoglycan matrix, especially following harvest and carving [2, 14, 15]. Peripheral segments, with higher elastic fiber content, are more susceptible to asymmetric contraction over time, whereas centrally harvested portions demonstrate greater dimensional stability [15]. In contrast, septal cartilage exhibits minimal warping tendencies but is typically inadequate in volume for substantial dorsal reconstruction [16].

Histologically, cartilage is composed of chondrocytes situated within lacunae and embedded in an extracellular matrix rich in type II collagen and proteoglycans, conferring elasticity and mechanical resilience (Fig. 1) [17, 18]. These lacunae safeguard chondrocyte viability by mitigating direct mechanical stress, while the avascular nature of cartilage necessitates nutrient and oxygen diffusion from adjacent tissues, factors that significantly influence postoperative healing and long-term graft survival [19]. The initial ischemic phase post-transplantation diminishes chondrocyte activity; excessive manipulation, crushing, or desiccation exacerbates apoptosis and matrix degradation, elevating the risk of graft resorption [20]. Dorsal augmentation is typically indicated to restore nasal height, contour, and symmetry in cases of congenital underdevelopment, trauma-related deformities, or revisions following over-reduction [14]. Autologous cartilage remains the material of choice, preferred over alloplastic or homologous implants due to its minimal risks of infection, rejection, and extrusion [16]. Among autologous options, rib cartilage is especially valued for its ample availability and robust structural characteristics, making it suitable for extensive augmentation [13]. Nevertheless, the long-term success of dorsal reconstruction is intricately tied to the selected graft type and processing technique, which must balance mechanical strength, flexibility, and contour adaptability to mitigate complications such as warping, resorption, and surface irregularities [7]. An appreciation of these considerations is critical for surgical planning and minimizing postoperative challenges in nasal augmentation rhinoplasty.

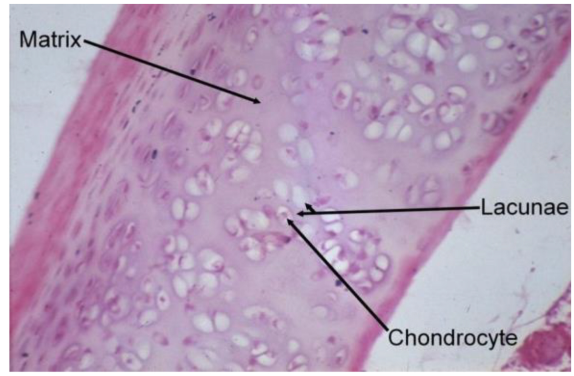

Fig. 1. Histological section of cartilage showing chondrocytes within lacunae, surrounded by a matrix rich in type II collagen and proteoglycans, providing elasticity and mechanical resistance (Image from Holland JC, 2012) [16].

3.2. Biomechanical challenges: Resorption, warping, and irregularities in dorsal augmentation

Cartilage resorption and warping represent principal biomechanical obstacles in dorsal augmentation rhinoplasty. Resorption is particularly relevant in diced cartilage grafts, where increased surface area accelerates enzymatic degradation and inflammatory breakdown, compromising long-term volume retention [11, 21]. Smaller fragments are especially vulnerable, prompting techniques such as fascia wrapping or fibrin glue application to limit inflammatory exposure and promote vascular integration, thereby improving graft stability and survival [6, 10].

Histologically, manipulation and ischemia reduce chondrocyte viability, elevating resorption risks by disrupting the extracellular matrix critical for structural integrity [20].

Warping remains the most recognized complication of costal cartilage grafts, largely attributable to intrinsic anisotropy in collagen and proteoglycan arrangements that establish uneven residual stresses unmasked by carving [18]. Peripheral rib segments, with lower mineral content and higher elastic fiber composition, are more prone to asymmetric contraction than centrally harvested sections, resulting in greater warping tendencies [15, 22]. This deformation may occur immediately due to osmotic shifts from intraoperative hydration (direct warping) or develop gradually as residual stresses equilibrate over weeks to months (delayed warping), with younger patients exhibiting higher rates due to increased cartilage elasticity and metabolic activity [23]. The perichondrium also plays a stabilizing role, as differential contraction across covered versus uncovered surfaces influences postoperative dimensional changes [24].

To address these mechanical liabilities, several intraoperative strategies have been employed. Concentric carving redistributes internal stresses, while rest periods post-carving allow early stabilization before fixation [23]. Superficial scoring can release residual tension but risks weakening structural integrity if overapplied. K-wire reinforcement offers mechanical constraint at the expense of potential extrusion or infection [5]. Contemporary techniques such as diced cartilage combined with fibrin glue or fascial wrapping aim to eliminate intrinsic stresses entirely, trading warping susceptibility for higher risks of resorption and migration inherent to fragmented grafts [25].

Soft tissue characteristics further modulate outcomes. Patients with thick nasal skin can better conceal minor contour irregularities, whereas thin-skinned individuals are more prone to visible dorsal inconsistencies even with subtle graft deviations [5]. Proper fixation and containment, such as with fascial-wrapped diced grafts, enhance graft integration and minimize displacement or long-term volume loss [25]. The intricate interplay between cartilage biomechanics, histological resilience, and patient-specific variables ultimately underscores the complexity of achieving durable, symmetric results in dorsal augmentation rhinoplasty.

3.3. Evolution of cartilage processing techniques

The evolution of cartilage graft processing techniques in dorsal augmentation rhinoplasty reflects an ongoing effort to reconcile the need for robust structural support with the demand for long-term stability and precise contouring. Early reliance on block cartilage capitalized on its inherent mechanical strength, making it indispensable for substantial dorsal reconstruction. However, challenges such as warping and conspicuous edges, especially in thin-skinned patients, highlighted its limitations. This drove the development of sliced cartilage methods, designed to reduce internal stress while preserving the load-bearing properties necessary for nasal framework support. The progression ultimately culminated in diced cartilage techniques, offering unparalleled malleability for detailed contouring but introducing new considerations, particularly regarding graft cohesion and resorption. These iterative refinements illustrate how surgical innovation has continually adapted cartilage handling to optimize outcomes and minimize complications.

3.3.1. Block cartilage grafts

Block cartilage remains foundational for achieving significant dorsal height and projection, particularly in reconstructive cases. Costal cartilage harvested from the 6th to 8th ribs is favored for its dimensional bulk and tensile strength [13]. Precise carving is critical, as warping arises from differential contraction between perichondrium-covered and denuded surfaces, with reported rates varying widely based on technique and tissue quality [5]. Preservation of the perichondrium and balanced carving patterns aim to minimize intrinsic stress, while additional methods such as core hollowing or internal K-wire fixation (Fig. 2) offer further stabilization [26, 27]. Despite these strategies, block grafts can pose challenges in patients with thin soft tissue envelopes, where rigid contours or graft edges may become prominent. Considerations of donor site morbidity, including postoperative discomfort and rare but serious complications like pneumothorax, also inform patient selection and preoperative planning [28].

3.3.2. Sliced cartilage grafts

Slicing techniques were introduced to address the propensity of block grafts to warp while enhancing integration with recipient tissues. By creating lamellar sheets from costal cartilage, internal stress is distributed across thinner sections, significantly lowering deformation risks [29, 30]. This makes sliced cartilage particularly useful in patients requiring modest augmentation or subtle contour adjustments, as in secondary or revision cases where scar tissue complicates graft placement [13, 16]. However, thinner grafts increase the surface area exposed to enzymatic activity, heightening susceptibility to

Fig. 2. The "I" cartilage block grafts, reinforced with internal K-wires (left) [24]. An "L" cartilage block graft prepared for grafting (right).

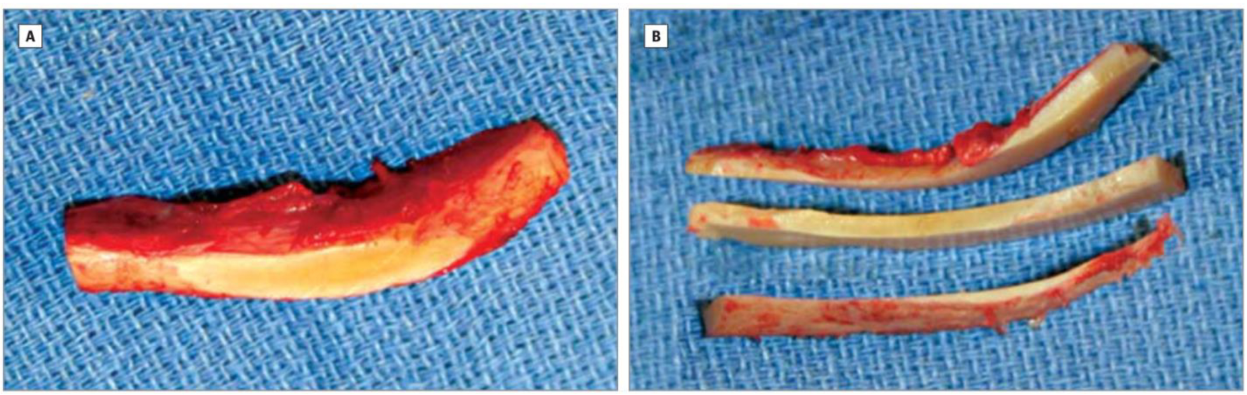

Fig. 3. (A) Harvested rib cartilage graft. (B) Rib cartilage sliced into thin layers for grafting.

resorption, especially in poorly vascularized tissue beds [9]. Techniques such as maintaining perichondrial coverage and employing fascia wraps bolster graft durability [28]. The oblique split method by Taştan et al. provides an additional refinement, preserving the outer cortical layer to maintain graft straightness and reduce long-term dimensional changes (Fig. 3) [31, 32].

3.3.3. Diced cartilage grafts

Most series involving diced cartilage grafting were conducted in adult populations, with mean ages ranging from 25 to 42 years and female predominance of approximately 60–70% [1, 25]. No study directly compared outcomes by gender, although some authors noted lower revision rates in younger patients, possibly reflecting better tissue healing and integration. Diced cartilage represents the most flexible evolution in graft processing, fragmenting cartilage into 0.5–1 mm particles to disperse intrinsic stresses entirely and thus eliminate warping [33]. This high degree of malleability allows surgeons to fine-tune dorsal contours intraoperatively, an advantage in addressing complex irregularities or performing delicate adjustments in secondary rhinoplasty [13].

However, diced grafts inherently face increased risks of migration and accelerated resorption due to their expansive surface area [34]. Stabilization techniques have evolved to counter these issues: Erol's Turkish Delight method uses Surgicel wrapping to contain diced fragments (Fig. 4), though concerns over inflammatory responses prompted a shift toward autologous fascia, which better preserves volume and minimizes chronic inflammation [6, 9, 10]. The diced cartilage glue approach (Fig. 5) binds particles into a cohesive matrix with fibrin sealants, promoting neovascularization and reducing migration, while the ACAS refinement further stabilizes dorsal height and shape [1, 11]. These adjuncts underscore the adaptability of diced cartilage, though achieving long-term volume retention often necessitates slight overcorrection or employing reinforced wraps to counter expected resorption [10].

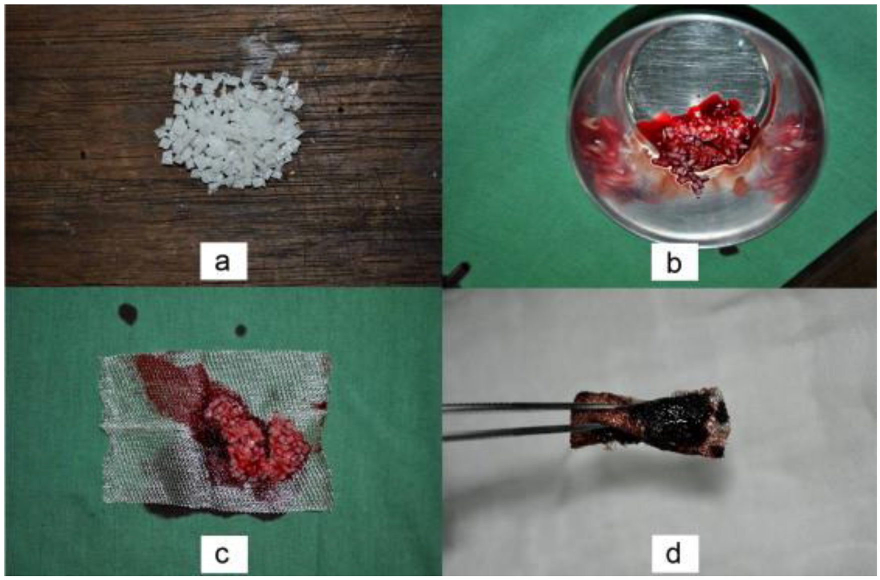

Fig. 4. Illustration of the "Turkish Delight" method [9].

Fig. 5. Administration of fibrin glue in the preparation of diced cartilage grafts. The crushed septal cartilage-covered diced cartilage glue graft technique aims to enhance graft integration and minimize surface irregularities, improving postoperative contour stability.

3.4. Prognosis of different cartilage processing techniques

Comparative analysis of block, sliced, and diced cartilage grafts in dorsal augmentation rhinoplasty highlights distinct performance profiles, each with characteristic benefits and limitations (Table 1). Prognostic concerns primarily revolve around warping, graft shifting, and contour irregularities, which collectively influence long-term structural integrity and aesthetic outcomes.

Block cartilage remains indispensable for extensive dorsal reconstruction due to its substantial mechanical strength and generally low resorption rates. However, it is also the most susceptible to warping, with reported incidences ranging from 0.9% to 26.1%, depending on carving methods, fixation strategies, and inherent cartilage quality [2, 30, 41]. Techniques such as balanced or concentric carving and core hollowing have shown promise in reducing deformation, while K-wire reinforcement offers mechanical stabilization at the expense of risks like extrusion or infection [5, 24]. Although rigid enough to resist migration, block grafts can produce visible contour irregularities, particularly under thin soft tissue coverage. Allogeneic block grafts, meanwhile, have demonstrated stable integration without deformation or migration, positioning them as potential alternatives when autologous donor sites are unsuitable [4, 37].

Sliced cartilage was developed to mitigate the warping tendencies of block grafts by distributing internal stresses across thinner lamellae, yielding significantly lower warping rates, typically between 2.5% and 4.7% [4, 22]. This improved dimensional

Table 1. Summary of comparative analysis between block, sliced, diced cartilage.

Authors (Year)	Type of Cartilage Graft	Warping	Graft Shifting	Contour Irregularities
Gunter et al. (2008) [24]	Block (reinforced with K-wire)	None – K-wire stabilization prevents graft warping	N/A	N/A
Lopes et al. (2011) [35]	Block (L-shaped carved graft)	None – no post-op cartilage deformity observed	None – grafts remained stable (no displacement)	None – smooth dorsum/tip achieved (no irregularities)
Moon et al. (2012) [3]	Block	1 case (0.9%) of warping noted	N/A	2 cases of visible graft contour irregularity
Moretti & Sciuto (2013) [36]	Block	3/54 patients (5.6%) had warping (dorsal graft distortion)	None – 0% extrusion (no graft migration noted)	N/A
Balaji (2013) [2]	Block	41/157 cases (26.1%) with warping requiring revision	N/A	N/A
Rajbhandari & Kao (2019) [30]	Block (fusiform carved onlay graft)	Minimized – balanced carving + 15 min pre-placement wait	Minimized – graft secured with multiple sutures (no shift)	Minimized – graft smoothed; minor irregularities masked by thick skin
Namgoong et al. (2020) [4]	Block (one-piece carved graft)	15.4% of cases	5.1% of cases (graft displacement)	7.7% of cases (visible graft margins)
Harutyunyan & Hakobyan (2025) [37]	Block (allogeneic donor graft; some crushed with PRF)	None – no deformation noted in any case	None – no graft extrusion or migration	N/A
Namgoong et al. (2020) [4]	Block (one-block concentric carving)	15.4% (warp observed)	5.1% (displacement)	7.7% (visible graft edges)
Wang et al. (2018) [22]	Sliced (peripheral rib segment)	Dorsal graft warping in 3 patients (2.5%)	N/A	N/A
Teshima et al. (2016) [38]	Sliced (transversely sliced graft)	No warping observed; grafts remained straight long-term	N/A	N/A
Farouk & Ibrahiem (2015) [39]	Sliced (thin sliced ≈1 mm, layered stack)	Not observed – thin slices used to neutralize warping	N/A	N/A
Namgoong et al. (2020) [4]	Sliced (multilayered graft technique)	4.7% of cases	2.3% of cases (graft displacement)	7.0% of cases (visible graft margins)
Tasman et al. (2013) [11]	Diced (glue, Tasman technique)	N/A	N/A	Minor dorsal irregularities: palpable in 15 cases (not visible); visible in 5 cases (2 required minor revision)
Tasman (2017) [25]	Diced (glue)	N/A	Yes – graft displacement in ∼7 patients (≈6.5%) requiring repositioning (digital manipulation or surgical revision)	Minor irregularities noted: 2 patients needed trimming of a graft edge; "cobblestone" dorsal contour in 2 patients (smoothed in revision)
Swaroop et al. (2018) [1]	Diced (glue, ACAS refined technique)	None observed (dorsal profile remained straight in all cases)	N/A	None observed
Shafik et al. (2020) [21]	Diced (free, unwrapped septal cartilage)	N/A	N/A	No visible irregularities (all patients satisfied; no revisions needed)
Al-Jorani et al. (2022) [40]	Diced (unwrapped; septal, auricular, or costal source)	None – no warping observed	N/A	Visible graft bulging at rhinion in 3 patients (∼6% of cases)

stability comes with trade-offs; precise intraoperative alignment is critical, as misplacement can result in step-offs or palpable irregularities, especially in patients with thin skin [39]. Techniques such as fascial wrapping or suturing slices together enhance integration and minimize secondary displacement, supporting long-term contour preservation [38]. While sliced grafts reduce the risk of pronounced warping, they still rely on meticulous handling to maintain predictable outcomes.

Diced cartilage represents the most refined evolution in graft processing, eliminating intrinsic warping entirely by fragmenting the matrix into small particles, thus achieving exceptional contour adaptability. However, this approach introduces heightened concerns over resorption and migration. Early stabilization techniques like Erol's "Turkish Delight," which used Surgicel, were later tempered by evidence of inflammatory responses accelerating resorption [9, 10]. Subsequent modifications, including fascia wrapping and fibrin glue stabilization, have demonstrated markedly improved volume retention and contour reliability [6, 11]. Fibrin glue not only binds diced particles into a cohesive implant but also promotes neovascularization, although uneven distribution can occasionally lead to localized clumping requiring minor revision [25]. More recently, platelet-rich fibrin has been explored as an alternative biological scaffold, showing potential benefits in enhancing chondrocyte viability and long-term graft stability [40, 42]. Free diced cartilage, while highly versatile, is generally less favored due to unpredictable absorption and greater risk of postoperative shifting.

Each technique offers unique advantages suited to specific anatomical demands and patient considerations. Block cartilage remains essential for robust structural augmentation but carries the highest warping liability. Sliced cartilage balances reduced deformation with retained support, contingent on careful placement. Diced cartilage achieves unparalleled contour precision without warping but requires adjunctive measures like fascia or bioadhesives to maintain long-term stability. Collectively, these processing options reflect a continuum of surgical adaptation, underscoring the importance of individualized graft selection and technique refinement to achieve durable, symmetric rhinoplasty outcomes.

4. Discussion

When comparing block, sliced, and diced cartilage grafts for dorsal augmentation rhinoplasty, it is evident that each technique evolved to address specific biomechanical and aesthetic challenges, with distinct advantages and inherent trade-offs. Block cartilage, typically harvested from the 6th to 8th ribs, remains the mainstay for major structural augmentation due to its robust mechanical properties. However, its primary vulnerability lies in postoperative warping caused by residual internal stresses within the collagen-proteoglycan matrix [2]. This phenomenon can result in dorsum asymmetry or visible deformities, with reported warping rates ranging up to 26.1% depending on the carving technique and graft handling [36]. Despite meticulous approaches such as balanced or concentric carving, peripheral core removal, and even K-wire fixation to distribute or mechanically constrain forces, block grafts inherently retain a degree of rigidity that can translate into visible edges or step-offs, especially in thin-skinned patients [4, 5, 24]. Moreover, while block grafts rarely shift due to their mass and stiffness, they are susceptible to contour irregularities if poorly sculpted or if subtle warping manifests over time.

The introduction of sliced cartilage techniques sought to mitigate these issues by segmenting rib cartilage into thinner lamellae, effectively dispersing internal tensions and significantly reducing warping risk to as low as ∼2–5% in published series [4]. This method preserves a composite structure capable of providing dorsal support, while simultaneously increasing flexibility for intraoperative shaping. The slices are often secured together through sutures or enclosed in a thin fascial wrap, which maintains their alignment and helps integrate with surrounding tissues [38]. Such constructs have proven particularly valuable in cases requiring moderate augmentation or in revisions where existing scar planes complicate graft placement. Nonetheless, sliced cartilage still demands precise intraoperative orientation; misalignment can produce contour irregularities or subtle step-offs, most evident in patients with delicate soft tissue coverage [39]. Additionally, the process of thinning inherently expands the graft's surface area, increasing susceptibility to enzymatic resorption, especially if local vascularization is compromised [32]. Techniques like preserving the perichondrium or employing fascia wrapping have been advocated to counteract these tendencies and prolong graft viability [28, 31, 32].

Diced cartilage represents the most advanced conceptual departure from traditional monolithic grafts, addressing warping by fragmenting cartilage into tiny particles, effectively eliminating internal stress [9]. This method allows the graft to be molded like a paste, achieving highly customized dorsal contours ideal for correcting subtle irregularities or in thin-skinned patients prone to visible transitions [10] However, this innovation introduced new challenges, chiefly the risks of postoperative migration and accelerated resorption due to the vastly increased surface area of the diced fragments [34]. Early stabilization efforts such as Erol's Turkish Delight method involved wrapping diced cartilage in Surgicel, but concerns over inflammatory responses and rapid volume loss led to a transition toward autologous fascia wrapping, which demonstrated superior integration and reduced chronic inflammation [6, 9, 10]. Fibrin glue has further refined the approach, binding diced particles into a cohesive implant that promotes neovascularization and maintains dorsal projection, though uneven distribution of glue can occasionally produce localized clumping necessitating minor revision [25]. The ACAS technique represents an additional step in this evolution, enhancing predictability by controlling dorsal height and contour through customized molds and glue matrices [43]. More recent exploration into platelet-rich fibrin (PRF) offers an autologous scaffold rich in growth factors that may both stabilize diced cartilage and support chondrocyte viability, potentially slowing resorption [42].

Comparative data across these techniques reinforce these mechanistic insights. Warping remains predominantly a complication of block grafts, seen in approximately 5–10% of modern series even with optimized carving, whereas sliced cartilage lowers this risk substantially and diced cartilage effectively abolishes it [4, 36]. Conversely, diced cartilage—while free from intrinsic deformation—faces heightened resorption and migration risks if not adequately stabilized. Studies of fascia-wrapped or fibrin-stabilized diced grafts show excellent long-term contour preservation, with some reports noting less than 0.5% partial volume loss over decades and minimal need for revision [40]. Free diced cartilage, by contrast, is prone to unpredictable absorption and positional changes [21]. Graft shifting overall was infrequent across all techniques when proper fixation was applied, though monolithic block grafts carried slightly higher instances of minor displacement requiring supplemental anchoring [24]. In terms of surface outcomes, block grafts had a greater tendency toward palpable edges, especially if carved aggressively, while diced cartilage provided the smoothest dorsum profiles, with only isolated reports of minor nodularity under very thin skin [25]. Sliced grafts largely bridged these extremes, generally maintaining a stable contour but requiring scrupulous layer alignment to avoid step-offs.

The emergence of adjunctive strategies has further expanded the reconstructive toolkit. The diced cartilage glue technique introduced by Tasman et al. effectively eliminates the need for fascial harvest, creating stable grafts through bioabsorbable fibrin matrices that simplify implantation and reduce operative morbidity [25]. The ACAS refinement allows even greater control of dorsal architecture by shaping the glue-cartilage composite within a mold prior to placement. Beyond adhesive scaffolds, PRF represents a compelling bioengineering advancement, offering a biologically active matrix that supports cellular viability and may attenuate long-term resorption, although larger comparative studies are warranted to confirm these benefits [42]. Hybrid constructs—such as combining diced cartilage cores wrapped in thin perichondrial sheets or layering crushed cartilage over block bases—reflect creative attempts to exploit the strengths of multiple techniques simultaneously, aiming to optimize contour smoothness while maintaining structural elevation. Similarly, investigations into integrating calcium hydroxyapatite into diced grafts suggest a potential pathway toward further stabilizing cartilage matrices and stimulating chondrocyte proliferation, though such approaches remain largely experimental [12].

Collectively, these refinements emphasize how the historical progression from block to sliced to diced cartilage—and now toward composite and biologically enhanced constructs—reflects a fundamental surgical objective: to maximize structural support and aesthetic precision while minimizing complications like warping, shifting, and resorption. Each technique carries a distinct complication profile and is best selected based on individual anatomical demands, skin characteristics, and the degree of augmentation required. Modern dorsal augmentation rhinoplasty increasingly involves blending these methods, tailoring graft strategies to each patient's unique needs. This nuanced approach, coupled with advances such as fibrin-based scaffolds and PRF, continues to elevate the predictability and durability of rhinoplasty outcomes, ensuring both structural integrity and patient satisfaction over the long term.

This scoping review has several limitations. First, the included studies exhibited considerable heterogeneity in patient populations, surgical techniques, follow-up durations, and outcome measures, which precludes direct comparisons and limits the generalizability of findings. Second, the reliance on published literature introduces a potential risk of publication bias, as studies with favorable outcomes may be overrepresented. Third, because this is a scoping review rather than a systematic review with meta-analysis, no pooled quantitative synthesis was performed, and effect sizes could not be statistically compared across techniques. Future research employing standardized outcome measures and prospective comparative designs is needed to strengthen the evidence base for optimal graft selection in dorsal augmentation rhinoplasty.

5. Conclusion

The choice of cartilage grafting technique in dorsal augmentation rhinoplasty hinges on balancing structural strength, contour adaptability, and long-term stability. Block cartilage provides unmatched support for major reconstruction but carries a substantial warping risk, reported between 5% and 26%, necessitating precise carving and stabilization. Sliced cartilage reduces warping to around 2–5% by distributing internal stresses, yet its thinner structure increases susceptibility to enzymatic resorption. Diced cartilage entirely eliminates intrinsic warping and offers superior contour precision, particularly in thin-skinned patients, though its fragmented nature elevates risks of migration and absorption, often requiring fascia or fibrin-based containment. Each method presents distinct advantages and trade-offs: block grafts assure robust frameworks with careful anti-warping measures, sliced grafts balance flexibility with structural integrity under vigilant vascular support, and diced grafts yield the smoothest profiles when properly stabilized. The progressive evolution from block to sliced and diced techniques underscores a continual effort to optimize rhinoplasty outcomes, with emerging bioengineering approaches poised to further enhance predictability, longevity, and patient satisfaction.

Conflict of interest

The authors declare no conflict of interest.

Ethical approval

Not applicable.

Data availability

The data that support the findings of this study are available on request from the corresponding author.

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Author contributions

Trimartani: Conceptualization, Methodology, Supervision, Project administration. Mirta: Data curation, Formal analysis, Validation, Writing review & editing. Mikhael Yosia: Investigation, Resources, Writing original draft, Visualization.

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