

Tip Droop Prevention in Rhinoplasty: Dynamic Effect of Strut Graft on Smiling versus Depressor Muscle Release

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Background: Aesthetic rhinoplasty is one of the most challenging procedures performed by aesthetic surgeons. Tip droop, especially on smiling, may not be noted by the surgeon postoperatively but can be concerning to patients. Our aim was to determine if the division of the depressor septi nasi or its combination with a columellar strut graft during rhinoplasty produce a measurable reduction in nasal tip droop on smiling.

Methods: A retrospective casenote and photograph review was conducted on patients who had undergone aesthetic endonasal rhinoplasty, performed by a single surgeon between 2015 and 2019. In total, 29 patients had release of the depressor septi nasi muscle, whilst 11 had release of the muscle along with a strut graft. Lateral smiling photographs were taken postoperatively. Tip droop was measured as a variation of the nasolabial angle from rest to smiling using the Frankfurt line.

Results: Photographs were taken at a mean of 14 months postoperatively. In the group who had muscle release only, a mean increase in nasolabial angle of 3.66 degrees was seen when smiling when compared with rest. In the group who had muscle release combined with strut graft, a mean increase of 2.27 degrees was seen. When using a columellar strut along with muscle release, tip droop on smiling was reduced.

Conclusions: This study demonstrates that columellar strut grafting in combination with muscle release can alleviate drooping of the tip better than muscle division alone after rhinoplasty. The columellar strut graft provides tip stability and can therefore be used to enhance dynamic outcomes after rhinoplasty. (*Plast Reconstr Surg Glob Open* 2021;9:e3462; doi: [10.1097/GOX.0000000000003462](https://doi.org/10.1097/GOX.0000000000003462); Published online 15 April 2021.)

INTRODUCTION

Aesthetic rhinoplasty is a complex procedure that aims to modify the structure of the nose to improve its static and dynamic appearance. This is defined by the patient's goals, realistic expectations, and aesthetic ideals held by rhinoplasty surgeons. The process by which this is achieved has evolved significantly over the last few decades, with alterations to the procedure aiming to improve postoperative patient satisfaction.¹ It is essential to understand

that whilst the surgeon may be pleased with the results on table, this does not necessarily provide all the information needed to ensure patient satisfaction. There is good evidence that there are significant psychological aspects to patient satisfaction.²

The nasal structures are surrounded by soft tissues, which will of course alter the appearance of the nose, either statically or dynamically. The dynamic factors cannot be appreciated intraoperatively and so must be considered during detailed preoperative planning.³

One such dynamic factor is smiling. When a patient smiles, the tip of the nose appears to drop.⁴ In a scenario where patients are seeking cosmetic improvement, this may be distressing to them following rhinoplasty. Two muscles contribute to this: depressor septi nasi and levator labii superioris.⁵ The depressor septi nasi muscle is a

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paired structure, with one muscle on either side of the nasal septum.⁶ The muscle takes its origin from the nasal spine and inserts into the orbicularis oris muscle.⁷ This is seen in [Figure 1](#).

The combination of the actions of orbicularis oris and depressor septi nasi during smiling can both accentuate aesthetic smiling deformity and result in nasal tip droop following rhinoplasty.⁸⁻⁹ They can cause both the nasal tip to descend and the upper lip to shorten and so worsen the aesthetic result if not addressed or identified. The effect that the depressor septi nasi muscle has on the drooping of the nasal tip has led some to suggest that a “smile test” should be performed on all patients undergoing aesthetic rhinoplasty to allow a decision to be made on whether this muscle should be divided intraoperatively.⁶

In preventing tip droop following rhinoplasty, 2 techniques have been popularized, which will be compared in this study. One method works to structurally reinforce the columella and so prevent movement of the tip on smiling, the other seeks to prevent dynamic changes of the nasal tip during smiling by reducing animation. A columellar strut graft can be formed from septal cartilage, auricular cartilage, rib, or even bone.¹⁰

The purpose of the graft is to create greater nasal tip definition whilst strengthening the columella and lower lateral cartilages to allow them to better resist the pull of dynamic forces such as depressor septi nasi.⁹ The

soft-tissue envelope of the nose, consisting of skin, muscles, cartilages and ligaments, can all act independently and play a significant part in the dynamic outcome following rhinoplasty. Modifying the depressor septi nasi muscle is well known to improve the results of rhinoplasty.⁶ The exact method of altering this muscle to improve results is debated within the literature. Sinno et al’s systematic review demonstrated no evidence to show which method was superior, ranging from excision of the muscle to simply dividing it at its insertion.³ These 2 methods can of course be combined to provide both static and dynamic improvements to nasal tip droop following rhinoplasty.

The purpose of this study is to examine the difference in outcome following aesthetic rhinoplasty between patients having muscle division alone compared with those who underwent alteration to depressor septi nasi along with strut grafting. We present our findings in relation to postoperative nasolabial angles and therefore tip droop on smiling postoperatively.

METHODS

A retrospective casenote and photograph review was performed of patients who had undergone closed rhinoplasty between 2015 and 2019, all performed by a single plastic surgeon (RU). Patients preoperative and postoperative photographs were reviewed with informed consent. Both smiling and neutral photographs were taken of these patients before and after their procedures ([Fig. 2](#)). The principles outlined in the declaration of Helsinki have been followed.

Smile Analysis

All patients had undergone either release of depressor septi nasi alone or release with a columellar strut graft. All patients underwent endonasal primary rhinoplasty using the preservation technique as described by Daniel.¹¹ Patients who underwent muscle modification had intra-nasal division of depressor septi nasi. In both sets of patients, photographs were analyzed using Adobe Photoshop by one of the authors. Nasolabial angle was measured by the same observer in both smiling and neutral positions. The Nasolabial angle was defined as the angle between the line drawn through the midpoint of the nasal aperture and a line drawn perpendicular to the Frankfurt horizontal whilst intersecting the subnasale.^{12,13} This is demonstrated in [Figure 3](#).

Tip droop was defined as the variation in nasolabial angle from neutral to smiling. This is demonstrated in [Figure 4](#). Patients were followed up by the operating surgeon over the course of 1 year.

As can be seen in [Figure 4](#), a positive change in nasolabial angle translates to the degree of nasal tip droop. In [Figures 3](#) and [4](#), this change of +3degrees means that the patient has experienced 3degrees of nasal tip droop on smiling.

Surgical Technique

This endonasal procedure is performed under general anesthetic with infiltration using local anesthetic (lidocaine 2% with adrenaline). Skin markings are then placed at the midline, mid-pupillary lines, and alar base line.



Fig. 1. Nasal dissection during rhinoplasty demonstrating insertion of depressor septi nasi muscle at the nasal spine.



Fig. 2. Example photographs taken for all patients pre and postoperatively. In addition to the standard set of 6 views, we always take a “maximum smile” view. A gentle smile is insufficient to assess dynamic tip movement. Patients are asked to smile and grit their teeth to achieve maximum smile impact of all muscles acting on the tip. The top image shows a droop of 3.1 degrees on maximum smiling, and the bottom image shows a droop of 3.8 degrees. A, Gentle smile view. B, Maximum smile view. C, Gentle smile view. D, Maximum smile view.

Intra-cartilagenous incisions are performed bilaterally. A cross-cartilaginous approach is used as previously described by the senior author.¹⁴ Dissection then proceeds along a submucosal plane. This continues along a sub-perichondrial and sub-periosteal dissection plane along the dorsum of the nose to the radix. Any obstruction of the airway by the septum or turbinates is identified and noted. Mucosal flaps are raised on either side to expose the septum. Diligent dissection is required to avoid mucosal perforation, which can cause secondary changes and fibrosis. In the columellar strut group, the septum is identified to the vomer. A resection of the septal cartilage is performed measuring 3-mm wide by 12-mm long. This allows harvesting a septal cartilage graft for a columellar strut and improving any septal deviation. If there is inadequate septum for a columellar strut or the quality of the cartilage is not strong enough for a strut support, then cartilage graft harvest is performed from an alternative site. A functional assessment of the airway is essential, including the inferior turbinates.

If there is excess mucosa or prominence of the inferior turbinates that is reducing the airway, these are treated at this time. Outfracture of the inferior turbinate is done if required. It is important to maintain sufficient nasal support with an appropriate L-shaped septal support with a width of at least 11 mm. In the strut group, a hemitransfixion (Killian) incision is performed as shown in Figure 5. The septal angle is dissected and exposed in a sub-mucosal plane. The height of the septal angle is reduced by 3 mm or as needed. A slight supra-tip break allows for any tip retraction. The caudal end of the septal angle is reduced by 2 mm to reduce columella show. Columellar dissection of the medial crura of the lower lateral cartilages is performed to improve columellar show and to create a pocket for a graft. A medial crural suspension suture is then applied to the septum 5/0 PDS to reduce tip retraction and maintain tip support. A tongue-in-groove approach aids stability and improvement in the columella outcome. A release of the depressor nasi septi is performed at this stage in all patients



Fig. 3. Measurement of nasolabial angle. The nasolabial angle was measured by the same observer in both smiling and neutral positions. The nasolabial angle was defined as the angle between the line drawn through the midpoint of the nasal aperture and a line drawn perpendicular to the Frankfurt horizontal whilst intersecting the subnasale.

down to the periosteum of the maxilla. Intra-oral access is not required for this maneuver to reduce patient morbidity.

Osteotomies are then performed using a guarded osteotome with an endonasal technique. An in-fracture is performed to close the open roof after the bony bump removal. A rasp is used to smooth any irregularities. The upper laterals are not disarticulated from the septum to avoid compromise of the internal valve. The lower lateral cartilages are identified, and a conservative cephalic trim is performed measuring 2–4 mm in width. A rim of



Fig. 5. Marking of hemi-transfixion incision. This endonasal approach preserves Pitanguy ligament and allows access for a pocket to be created in the midline between the medial crura for the strut. It also allows access for division of the depressor nasi muscle.

support of at least 6 mm in width is left behind. The vestibular mucosa is preserved to protect the internal valve. A delivery technique is used to apply inter-domal sutures using 5/0 PDS for support and tip definition. In the strut group, a columellar strut is then prepared by cutting the graft into the correct shape and length of approximately 12 mm. This is inserted into a pocket in between the medial crura. The strut is fixed to the septum via a hemi-transfixion incision using 5/0 PDS. Good tip support is achieved. This is shown in [Figures 6 and 7](#). (See [Video \[online\]](#), which displays the inset of the columellar strut via an endonasal incision for tip support.)

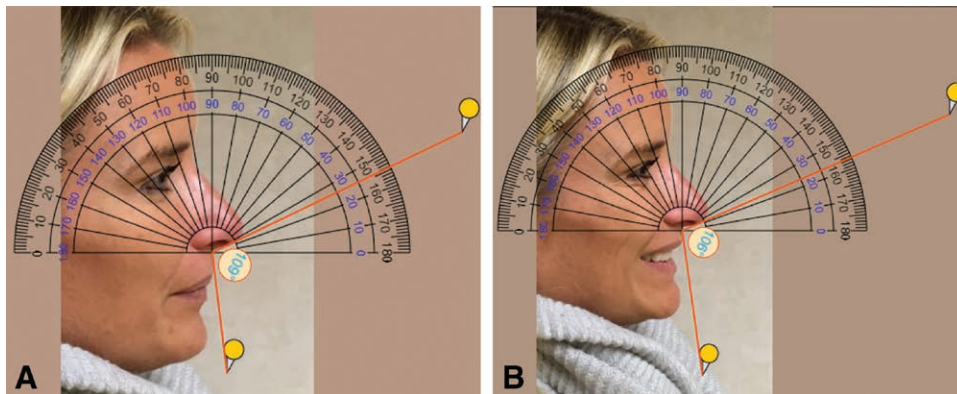


Fig. 4. Protractor measurements of nasolabial angle showing angle at rest and during smiling. As the tip drooped on smiling, the angle was reduced. The smaller the angle, the more the tip droop became apparent. The smaller the angle, the more the patient sensed that they did not like their tip when they smiled in photographs. As a result, some patients avoided smiling in photographs. The images demonstrate a change of +3 degrees of droop on smiling. A, nasolabial angle measured with gentle smile; B, nasolabial angle measured with maximum smile.



Fig. 6. Dissection before columellar strut insertion. The medial and lateral crura are fully exposed to allow intra-domal sutures to be placed. The pocket for strut placement can also be measured accurately in realtime as the skin envelope is intact. During open rhinoplasty, the skin tension can distort the final tip position after skin closure.

A final assessment is made and dissection is performed to smooth the outline and remove any irregularities. The mucosa is closed using 5/0 Rapide. Steristrips are used to mold the shape, and a thermoplastic splint is applied for 7 days.

Preoperative and postoperative photographs are taken for all patients, including a maximal smile view. This allows appreciation of the dynamic changes of the nose on smiling (Figs. 8 and 9).

Patient satisfaction was judged by patients on a 5-point Likert scale from very good to very unsatisfied.

RESULTS

During the 4-year period, 40 patients were identified who had undergone modifications to their rhinoplasty to prevent tip droop. All patients underwent primary rhinoplasty for aesthetic indications within the private sector. Twenty-nine patients underwent modification to the depressor septi nasi muscle alone and the following 11 patients underwent modification to the muscle along with the use of a columellar strut graft (Figs. 9 and 10). The Demographic data for these patients are demonstrated in Table 1. All strut grafts utilized septal cartilage harvested intraoperatively. There were no major complications resulting in acute secondary surgical interventions in any of the patients. All patients reported some restricted lip movement and upper lip numbness postoperatively but this resolved within 1–3 weeks. Patient satisfaction data were collected, showing that 87% of patients rated their satisfaction as good or above in the strut group and 82% in the muscle division group ($P < 0.5$). Two patients requested revision for small surface irregularities.

For the group undergoing muscle modification alone, the nasolabial was found to increase on smiling. Individual results are seen in Table 2 with a mean increase of 3.66 degrees when compared with photographs taken at rest. For the group undergoing muscle modification in addition to columellar strut insertion, the nasolabial was also found to increase on smiling, but to a lesser degree. Individual results are seen in Table 3 with a mean increase of 2.27 degrees when compared with photographs taken at rest.

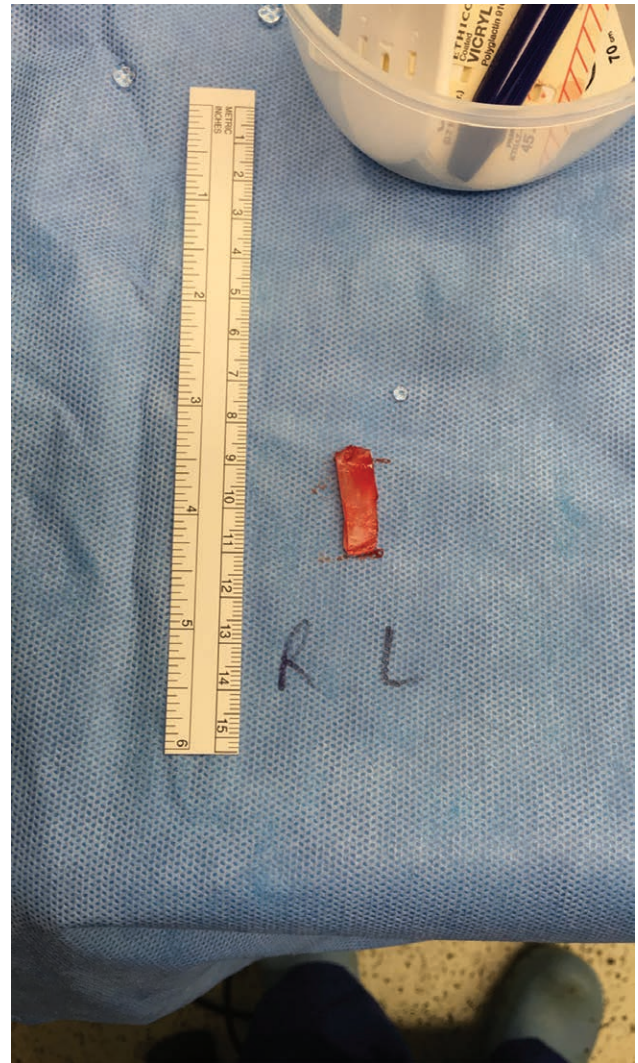


Fig. 7. Columellar strut. This image shows the typical size and shape of the strut. The precise length and shape is adjusted for each patient. It is placed between the medial crura and sutured in place with 5/0 PDS. The strut should ideally sit on the maxilla for stability, although the sutures provide the greatest contribution to long-term stability. The septum is the ideal graft harvest site because the cartilage is stiff enough to provide support and the harvest site is easy to access. Rib cartilage is also of excellent quality, but many patients and surgeons prefer to avoid the donor site issues. Conchal cartilage from the ear is generally too soft to provide support unless reinforced with sutures.

These changes in nasolabial angle indicate that the effect of nasal tip droop is reduced by 1.39 degrees ($P = 0.96$) when both muscle division and columellar strut grafting is used.

DISCUSSION

Achieving a satisfactory cosmetic result following rhinoplasty is challenging. It is clearly difficult to fully assess this intraoperatively, given the fact that the nose is a dynamic structure. Preoperative understanding of both the patient's expectations and the surgical goals are



Fig. 8. Dynamic smile outcome of a 41-year-old patient 15 months after division of depressor nasi muscle and columellar strut for support. The patient had required tip support on smile and therefore the strut was used. The combination of the strut and muscle division has helped prevent drooping of the tip related to activity of the SMAS and depressor muscles. The nasolabial angle droop has been reduced by 2.3 degrees. A preoperative assessment of dynamic smile changes is required to provide appropriate support during rhinoplasty. A, Preoperative gentle smile view. B, Preoperative maximum smile view. C, Postoperative gentle smile view. D, Postoperative maximum smile view.

therefore essential. Nasal tip droop after rhinoplasty is a recognized outcome, and patients must be counseled preoperatively. The physical and psychological aspects of the nose can be assessed in detail before surgery, but these parameters can all change postoperatively, making the patient unhappy.

Many techniques have been suggested to prevent or lessen the effect of muscle action on lowering the tip of the nose on smiling. These include dissecting the accessory cartilages via a transcartilaginous incision and releasing all the tissues around the lateral crura to rotate the domes cephalad.²⁰ In this study, the depressor muscle was resected or excised to varying degrees.

Patient satisfaction is related to the dynamic and the static position of the nose after rhinoplasty. Cachay-Velásquez cites that many defects become noticeable only on smiling.¹⁹ He calls this phenomenon the “rhinoginivolabial syndrome of the smile.” Previous work emphasizes the importance of the dynamic smile effect

on the nose but does not measure this objectively as in this study.

Brown and Guyuron defined the “ideal nasolabial angle” in both men and women.¹⁵ This was defined as 93.9–97.3 degrees in men and 96.8–100.2 degrees in women. Interestingly, the men in our series who underwent columellar strut achieved a mean postoperative angle of only 89 degrees on smiling; however, when combined with the depressor nasi division, this improved to 96.3 degrees, allowing them to achieve an “ideal nasolabial angle.” The female cohort’s postoperative nasolabial angle with just the columellar strut on smiling was 92 degrees, whereas, with muscle modification, the angle was 94 degrees. Although not within this “ideal” range, it is certainly closer. Of course, defining a goal with patients preoperatively is essential because an ideal nasolabial angle may differ between the surgeon and the patient.¹⁶

In discussing surgical options with patients, it is essential to make them aware of the risks and benefits of each



Fig. 9. Dynamic smile assessment for 38-year-old patient 19 months after rhinoplasty with the division of depressor nasi muscle alone. Although drooping of the end of the nose is improved by dividing the muscle alone, the effect is less than if a strut is used in addition for tip support. In this case, the reduction in nasolabial angle was only 2.9 degrees. Muscle division alone without strut support is 18% less effective in preventive dynamic tip droop when smiling. A, Preoperative gentle smile view. B, preoperative maximum smile view. C, Postoperative gentle smile view. D, Postoperative maximum smile view.

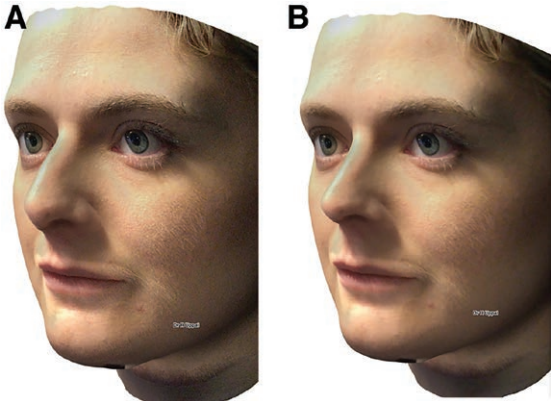


Fig. 10. Three-dimensional planning using surface laser rendering helps analyze the details of the tip with the greatest accuracy (Crisalix Software, Switzerland). The patients in this series found the images valuable in planning their operation and assessing the dynamic movements before and after surgery. However, the lack of accuracy is a drawback, as the 3D image does not always reflect the emotions of the patient nor the skin tone in different lighting. A, Preoperative appearance. B, Proposed results from rhinoplasty.

Table 1. Demographic Data for Patients Undergoing Rhinoplasty

Procedure Performed	Age (Mean)	Sex (M:F)
Muscle modification (n = 29)	28.25	2:27
Muscle plus strut graft (n = 11)	35.25	3:9

The table shows that there was no bias in the distribution of the patients, as each was part of a consecutive series. The strut group is smaller, which has an impact on the *P* value of the data. However, the analysis of results shows a clear difference between the 2 groups, in that the strut group experience less dynamic tip droop compared with the muscle division alone group.

procedure. The risks of dividing the depressor septi nasi are small but can include local edema, upper lip numbness, and the sensation of restricted upper lip movement.¹⁷ Although these may be transient, it is still important that patients are made aware of this, given the relatively small gain in tip droop, which is achieved from performing it. Of course, to provide further data on the management of nasal tip droop, further large studies are needed. Future

Table 2. Nasal Tip Droop Data for Patients Undergoing Muscle Modification Only

Patient	Nasolabial Angle at Rest	Nasolabial Angle Smiling	Change in Nasolabial Angle (Tip Droop)
1	95	92	3
2	93	89	4
3	109	106	3
4	103	98	5
5	78	75	3
6	106	102	4
7	93	88	5
8	83	79	4
9	97	92	5
10	103	98	5
11	105	101	4
12	97	93	4
13	85	81	4
14	99	97	2
15	97	93	4
16	81	79	2
17	91	87	4
18	103	99	4
19	90	88	2
20	98	92	6
21	85	81	4
22	105	103	2
23	106	103	3
24	94	91	3
25	93	92	1
26	102	99	3
27	109	103	6
28	82	79	3
29	91	87	4
Mean	96	92	3.66

The mean displayed in boldface shows that the tip drooped on smiling by 3.6 degrees. This is more than the strut group.

studies may use new software with artificial intelligence, which is better at analyzing facial movement.¹⁸ These are currently used by the senior author and have proved very helpful to patients (Fig. 10).

Limitations

Rhinoplasty and the literature surrounding it is complex. Demonstrating superiority of 1 technique over another is challenging, as patient numbers are typically small and long-term patient follow-up is often not long enough to fully appreciate patient results. The limitations of this study are no exception to this. Small patient numbers in this and other studies often result in the inability to provide a significant *P* value; however, these studies can continue to form an important knowledge base that can improve the care of rhinoplasty patients.

CONCLUSIONS

An analysis of the changes to a nose when a patient smiles is essential in the preoperative assessment of Cosmetic rhinoplasty. A dynamic smile analysis can be performed formally using measurements of the Frankfurt line and the nasal labial angle. Drooping of the end of the nose can lead to patient dissatisfaction and, as such, this study demonstrates that using a columellar strut and muscle division reduces some of the deformation related to smiling. Patient satisfaction in this complex group of patients was higher in the strut

Table 3. Nasal Tip Droop Data for Patients Undergoing Muscle Modification and Columellar Strut

Patient	Nasolabial Angle at Rest	Nasolabial Angle Smiling	Change in Nasolabial Angle (Tip Droop)
1	87	85	2
2	103	101	2
3	83	80	3
4	99	96	3
5	82	80	2
6	94	93	1
7	86	83	3
8	105	102	3
9	105	103	2
10	98	96	2
11	120	118	2
Mean	97	94	2.27

The mean in boldface shows that the strut reduced the tip drooping more than muscle division alone. The strut added support to the tip as would be expected, making it stiffer and more resilient to dynamic change.

group, although it is clear that patient satisfaction following rhinoplasty is an area in which further research is required.

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PATIENT CONSENT

Patients provided written consent for the use of their images.

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