Surgical Anatomy

The surgeon's familiarity with the structure of the nose invites smooth, easy operating. The lack of it invites anxiety, awkwardness, poor results, and complications.

Over the nasal bones and lateral cartilages the skin is thin and fairly freely movable. The skin is much thicker, contains more glands, and is firmly adherent over the alar cartilages. The blood supply is mainly in the soft tissues. The dissection should lie in planes of cleavage whereby vessels are avoided and bleeding is minimized. The bony nose consists of paired nasal bones which are thin in their lower half to two third, and solid in their upper third. These bones rest upon the frontal spine (nasal process) of the frontal bone and are held, as if in a vise, between the two frontal (ascending) processes of the superior maxilla. The frontal (ascending) process of the maxilla forms the lateral aspect and lower two thirds of the nose. The maxilla also forms the floor of the anterior nasal cavities.

Description of the Cartilages

The cartilages of the nose are basically five. They form the support of the flexible portion of the nose. The septum lies in the midline, and firmly attached to it are the two lateral cartilages which in some persons are apparently fused. Below these cartilages, and resting upon them, are the lateral wings of the paired alar cartilages. When feeling one's nose, it is easily noticeable that the mid-portion can be moved freely from side to side, but can be depressed only slightly. The tip, which is formed by the alar cartilages, can be moved quite freely upward, downward, and in and out. It also will be noted that the lateral cartilages go beneath the nasal bones and are quite firmly attached to them for a varying distance of from 2 mm to 1 cm. This relationship is extremely important if there is a fracture of the septum which deviates the cartilaginous portion of the nose to one side. When this occurs, the lateral cartilages, after having been torn loose from the nasal bone at the time of injury, will heal in this new angulated position. One may straighten the septum to create a nose which is aligned in the midline, but it will migrate back again unless the lateral cartilages are free from the undersurface of the nasal bones, permitting them to re-align also. The septal cartilage extends up beneath the nasal bones, at least as far as the lateral cartilages, where it joins the perpendicular plate of the ethmoid, and here it thickens. Just beneath the dorsum the nasal septum becomes thicker and tends to bifurcate, or flare to its edge, where it comes in contact with the lateral cartilages. The septal cartilage and the lateral cartilages do not fuse in this area, although they appear to do so. A section through this area will show that the perichondrium is continuous around the septum and around each lateral cartilage. The edges of the cartilages are bound together with dense connective tissue.
The paired alar cartilages are the supporting skeleton of the nasal tip. Each cartilage has a lateral and a medial crus, or what is really an irregularly shaped U. The medial crura come together in the midline, and their lower portions flare slightly into each nostril. The lateral crura are bulbous, sometimes irregular at the tip, with a tendency to flare and flatten out laterally. The skin of the undersurface of the lateral cartilage is quite readily separated from it, but at the medial crus, the skin is adherent and difficult to separate. The alar cartilages move freely over the lateral and septal cartilages.

There are muscles attached to the lateral and alar cartilages which control the size of the vestibular opening. On close observation it will be noted that the nose is quite animated. Stand before a mirror and make facial expressions of surprise, disgust, and move the lips from side to side and appreciate the extent of this mobility. Next grasp the tip of the nose and observe that it is freely movable and not attached to the septum or lateral cartilages. When the planes of cleavage are not adhered to by the surgeon, and the muscles are cut through or torn, the nose will become quite motionless and appear lifeless.

The Septum

The septum is extremely important in rhinoplasty, particularly when it is post-traumatically bend and causes an external deformity, but obstructs the nasal airways as well. The quadrilateral cartilage of the septum forms a part of the nasal dorsum. If the septum is broken and thus depressed or deviated, the cartilaginous dorsum will become depressed or angulated. This cartilage is held firmly between the nasal bones and the groove in the premaxillary spine and vomer and also in its articulation with the perpendicular plate of the ethmoid bone. A blow to the tip of the nose which bends it sharply to one side will create a common deformity by fracturing the cartilage between the two fixed points, the tip of the nose and the premaxillary spine. If the blow is on the dorsum of the cartilaginous tip, the cartilage may disarticulate from the vomer groove and in so doing will depress the dorsum. This is observed following trauma with or without nasal bone fractures. If observed soon after injury, the cartilage should always be replaced and immobilized in position until healing occurs. This replacement of a broken and displaced septum will also maintain the support of the nasal bones once they have been reduced. However, this is sometimes extremely difficult to do, because of the marked lacerations, multiple fractures, and swelling of the soft tissues resulting from the trauma.

Anesthesia

The external nose is supplied by branches of the infraorbital nerve, the nasociliary nerve, and a nasal branch of the superior alveolar nerve. The lining of the nasal cavities is supplied by the anterior ethmoid nerve, the nasal branch of the superior dental nerve, and branches from the sphenopalatine ganglion, which also supply the septum and the lateral wall of the nose.

Local anesthesia is preferable in most cases not only for plastic operations upon the nose, but also for most intranasal procedures. Combined with correct preoperative medication, local anesthesia permits the surgeon to operate in a comparatively dry field on an unapprehensive patient. The inside of the nose should first be shrunk and superficially anesthetized with the combination of a vasoconstrictor and a topical anesthetic. A good
combination is 2 cc of 1:1000 epinephrine solution in 100 cc of 2% Pontocaine or 4% topical Xylocaine, which may be made up as a stock solution. The nose is sprayed with this solution before the patient is brought to the operating room. Once the patient is "prepped" and draped, the inside of the nose is ready to receive cotton moistened with the anesthetic. Cocaine (4%) is also very satisfactory, because it is a vasoconstrictor as well as an anesthetic. When a barbiturate is used for premedication there is practically no risk of a cocaine reaction. The topical anesthetic is placed in the region of the anterior ethmoidal nerve and the sphenopalatine ganglion either by a cotton-tipped applicator or by strips of cotton about 2 inches long, 0.5 inches wide, and 0.125 inch thick.

The external nose may be anesthetized either by a block or an infiltration anesthetic. The combination of the two is most satisfactory. Here, again, the choice of anesthetic may be left to the operator. Either procaine or Xylocaine with epinephrine 1:50,000 to 1:100,000 works well. The epinephrine, by its vasoconstricting action, holds the anesthetic in location and controls capillary bleeding.

There are several methods of injecting. The one I find most satisfactory is as follows: A 24-gauge needle, 1.5 inches long, attached to a 5-cc Luer Lok syringe is used. Choosing an injection site on the dorsum of the nose, about the level of the inner canthus, infiltration is carried out slowly, so as not to cause ballooning of the tissues, down to, and including, the infraorbital nerve, first on one side, and then on the other. By fanning the direction of the needle, the region of the glabella and the entire dorsum of the nose may be infiltrated. The upper lip and buttresses may be blocked by injecting into the infraorbital foramen. This may readily be performed by directing the needle through the skin adjacent to the ala of the nose, but 0.25 inch from it and then up to 0.25 inch below the infraorbital rim. A finger placed on the infraorbital rim is of assistance in locating the foramen. For the entire external nose, 4 to 5 cc is adequate. The next site of injection is at the base of the left ala, if the operator is right-handed. The injection is carried beneath the columella to the opposite side. Pulling the needle back, it may be directed into the base of the columella, and, by tipping the nose to one side, the needle may be directed up, in front of the septum. This will usually give complete anesthesia of the outside of the nose although additional injection into the vestibule is occasionally advisable to control bleeding. The dorsum of the nose may now be skeletonized completely in preparation for removal of the hump. Before doing this, I inject both sides of the septum beneath the dorsum and laterally on the undersurface of each nasal bone. If a submucous resection of the septum is necessary, topical anesthesia is combined with infiltration anesthesia, primarily for hemostasis.

With careful injection technique, tachycardia, palpitations, anxiety, or nervousness rarely follows, particularly when adequate preoperative sedation has been given. Of course, it is impossible to have a set anesthesia schedule, because no two people respond identically to medication. A routine preoperative medication may be employed, but, when the patient is in the operating room, supplementary anesthesia may also be prescribed at the surgeon's discretion. For basic anesthesia, 100 mg of Nembutal are given by mouth 2 hours before the operation. One hour preoperatively, another 100 mg of Nembutal, plus 50 or 75 mg of Demerol, and 0.4 mg of scopolamine are administered intramuscularly. This may be varied to suit the individual patient and is not prescribed as the only or ultimate preoperation medication.
Rhinoplasty Technique

Exposure of the Nasal Skeleton

The basic incision for exposure of the nasal skeleton, called the intercartilaginous incision, is made between the alar and lateral cartilages. This incision exposes the outer surface of the lateral cartilage where a dissection plane is encountered. Utilizing traction of the ala, the soft tissues are dissected away from the lateral cartilage with either a double-edged Joseph knife or a very flat, nearly pointed scissors. This may be done under direct vision, and getting out of the plane of dissection into the overlying muscles will be avoided. The dissection is carried up to the lower border of the nasal bones and to the edge of the frontal process of the maxilla, but not up over the bone. With a sharp blade, an incision is made through the periosteum over the nasal bones as near their lower border as practical. This bony edge is usually serrated, and it is necessary to make the incision 2 or 3 mm above the margin. This can be done under direct vision, but it is easier to do by touch. The blade is inserted on top of the nasal bones, brought down on its edge, and then raised and brought up to the point of incision. Starting laterally, near the frontal process, and using only the tip of the blade, the periosteum is incised up to the midline. A thin and narrow periosteal elevator may be inserted beneath the periosteum at the lower end of the incision and carried up to the root of the nasal bones. The entire elevator can then be brought broadside to the dorsal midline. It is quite difficult to separate the median raphe from the dorsum. A pair of scissors may be used to effect the separation, cutting close to the bone and cartilage.

The transfixion incision is next made with either a curved button knife or a #15 Bard-Parker knife blade. Holding the nasal tip up with a double-hooked instrument and pulling the columella away from the septum, the knife is pushed through the soft tissue just in front of the septal cartilage. The incision is carried down in front of the cartilaginous septum to the premaxillary spine. If it is desirable to extend this further, the columella is retracted and the muscles dissected away from the maxilla either with a periosteal elevator, knife, or scissors. The transfixion incision is next extended upward to communicate with the previously made intercartilaginous incisions.

The nasal framework is now exposed. Strands of tissue attaching the skin to the framework should be cut.

Removal of Nasal Hump

There are several ways of removing a nasal hump, which consists of both bone and cartilage. The three main methods employ (1) the nasal hump rongeur, (2) the osteotome, (3) the nasal saw.

Rongeur Technique. The sharpness of the surgeon’s instruments for this procedure is very important. A nasal hump rongeur, as purchased, is rarely sharp enough and must be re-sharpened. If the hump is small, the instrument may be placed at the level that one wishes to remove the hump, and one closure of the instrument will cut the cartilage and bone straight through without much more having to be done. If the hump is large and particularly broad, it is necessary to uncap it by merely removing its top. This exposes each nasal bone and the septum as separate entities. Next the lateral cartilages are separated from the septum by using
scissors and making certain that the cut is made adjacent to the septum. Under direct vision, each side of the nasal dorsum is removed down to the desired level. This is followed by trimming the septum. In this way, fracture of the nasal bone in an undesirable place is avoided; such a fracture may occur if removal of a large hump is attempted with one cut of the rongeur. With the rongeur the surgeon is able to cut not only the cartilage, but also the membrane. It is easier to cut the membrane and cartilage in this manner than with a knife or scissors. Once the nasal dorsum is lowered to the desired level, it may be necessary to lower the bone near the glabella, where it is solid, by using a rasp or osteotome. Care must be taken that the plane of the rasp is parallel to the desired dorsal profile. The level to which the dorsum is lowered may be predetermined by a set of ideal aesthetic angles, but in reality it is up to the surgeon's aesthetic judgment to decide when enough has been done. It is always advisable to remove too little at first, because more can always be removed if this seems necessary. The reverse is not true, and the insertion of cartilage to restore the dorsum to the desired level is never as satisfactory as lowering the dorsum in an exact manner.

The rongeur method of removal of the nasal hump, as well as the two methods described below, requires practice before perfection is attained. The rongeur technique is my preference.

**Osteotome Technique.** The osteotome must be broad enough to include the entire width of the hump to be removed and sharp enough to cut through the cartilage without buckling or deforming it. The instrument must be knife-sharp prior to each use. Once the cartilaginous portion has been cut through, the osteotome, propelled with a mallet, is carried through the nasal bone. If the bone is hard and brittle, as is frequently found in older patients, an osteotome cut may result in a fracture ahead of the instrument and not in a desired location. For this reason I do not use this method even though it is easy and fast in most cases.

**Removal of Hump with Bone Saw.** In this method first one side of the bony hump is cut through with a bone saw and then the other. The remaining cartilage is cut with a knife.

**Shortening Length of Nose**

As soon as the hump has been removed it is always advisable to feel the dorsum, as well as to evaluate it visually. Sometimes an irregularity that is not visible can be felt, because the soft tissues and skin, a little swollen at the time of the operation, may obscure any irregularity.

It is now usually necessary to shorten the length of the nose so that the nasolabial angle and tip are in a satisfactory relationship. When the hump is lowered, it automatically makes the nasal tip too pointed in the profile view, and the nasolabial angle is prone to be too acute. The amount to be removed may be determined by grasping the columella with forceps, pushing the tip up into its proper position, and ascertaining how far the columella overlaps the septum. It is at this level that the septum must be excised. This may readily be done by grasping the septum and cutting through the cartilage and its overlying membrane on each side. A scalpel is more satisfactory than scissors for this procedure. It is important to round the septal tip prior to trimming the lower border. If this is not done, a sharp point...
sticking up between the alar cartilages may be the result. This excision should leave the lower border curved as it was prior to removal.

Mobilizing the Lateral Walls of the Nose

With the hump removed and the septum shortened, the profile of the nose is now final. However, the front view may present a very flat, broad nose, because the nasal bones and septum are separated. To create a narrow, more normal-looking dorsum, it is necessary to mobilize the bony lateral walls of the nose so that they may be hinged or replaced until the dorsal portions are in contact with the septum. There are three separate procedures which must be employed to accomplish this: (1) a lateral osteotomy, (2) removal of bone at the solid angle, and (3) a superior osteotomy connecting the lateral osteotomy and the bone excision at the solid angle.

Lateral Osteotomy. The lateral osteotomy should be performed through the ascending or frontal process of the maxilla, laterally so that the nasal contour will have the desired proportions. If the base of the nasal pyramid is narrow, the lateral walls may be hinged along the osteotomy to permit the nasal bones to come in contact with the septum, and a pleasing contour will result. If the base is broad, it may be necessary to slide the freed ascending process and attached nasal bones medially, creating a step at the osteotomy. This will create the desired nasal contour and the bony irregularity will not be apparent, as it will be covered with soft tissue in the concave area. The step will be obvious by palpation only. The osteotomy may be done either with nasal saws or with a thin, narrow osteotome, either plain or with a blunt guiding tip. I use a saw, except when reducing an old fracture, because, if the bone is brittle, it may fracture in a line that will not be desirable. With an old fracture the surgeon may feel his way and cut through the old fracture line. In the majority of nasal fractures healing takes place more by fibrosis than by callus formation.

To perform the osteotomy, an incision is made through the nasal vestibule, just anterior to the attachment of the inferior turbinate and directly over the sharp edge of the piriform aperture of the bone which may be first palpated with the handle end of the knife. With the cutting blade facing superiorly, a stab wound is made to the edge of the bone. The tip of the blade is carried laterally and on the external surface of the bone a millimeter or two, where an incision is made through the periosteum just long enough to introduce the periosteal elevator which is to be employed. As the blade is withdrawn, a cut is made equal to the periosteal cut through the tissues and the skin of the vestibules. A flat and narrow periosteal elevator is next inserted through this incision beneath the periosteum, and directed up along the bone to the level of the inner canthus. This brings the elevator just medial to the attachment of the medial canthal ligament. The elevator may be used as a retractor to permit the tip of the saw to be introduced into the tunnel thus constructed. As the saw is introduced, with its flat surface on the bony surface, the elevator is removed. The saw is pushed up to the extent of the tunnel and rotated into a cutting position. It is important that the plane of the cut be exact, not only in its relationship to the dorsum, but also in its relationship to the surface which is to be cut.

With the saw in position, the bone incision is usually made at a right angle to the surface of the ascending process. Controlled short strokes will result in rapid engagement of the saw in the bone. The engagement is readily determined by pressing on the skin over the
saw blade and releasing the saw handle. If the saw is engaged it will retain its position when its handle is flicked; if not engaged, flicking of the handle will cause the saw to fall loose. There is usually a convex bulge in this area of bone, therefore the saw cut through in the middle before doing so at the lower end. Attention should be paid to the upper end where the bone is thick; the saw may not penetrate through this area as rapidly as the rest of the bone. As the bone incision nears completion, the saw is removed. If any "saw dust" remains, it should be removed by cannula suction through the subperiosteal incision.

**Removal of a Wedge of Solid Bone between the Septum and Nasal Bones.** In order to narrow the nose as high as desired and rule out the possibility of a bulge between the narrowed dorsum and the glabella, it is necessary to remove a wedge of bone from the solid upper third of the nasal bones. The removal of this wedge of bone will prevent the lateral upper surface of the bone from protruding laterally when the vault is narrowed. This piece of bone, when removed, can no longer act as a fulcrum, thus permitting the entire lateral wall to be hinged in its uppermost part.

I use a pointed cutting rongeur to remove the wedge of bone. The male blade is inserted beneath the nasal bones, the female blade rests on the surface and extends as high as one wishes to narrow the nose. The bone is then removed with one closure of the instrument. If this instrument is not available, the same result may be obtained with a flat osteotome at least one third of an inch wide. A cut is made parallel to the outer surface of the nasal bone up to the midline along the dorsum. A second cut is made parallel and adjacent to the septum, up to the first cut. The bone thus freed may be removed with a straight mosquito hemostat.

**Osteotomy Connecting the Two Cuts.** The apexes of the two cuts just described are now connected by employing a narrow osteotome, which is introduced through the skin just lateral to the midline. The skin incision is made with the osteotome. By using the corner of the osteotome, and pointing the instrument diagonally toward the nasal tip, the bone may be scored down through to the cut made previously in the ascending process. The bone may now be hinged into position with the fear of an undesirable fracture eliminated. Some surgeons fracture the bone and ascending process laterally before bringing it into the midline. Others attempt to fracture it indirectly, hoping that the fracture line will be to their liking. This is never a safe method because the fracture line may result in undesirable irregularity.

**Surgery of the Tip of the Nose**

It is rare when a plastic alteration of the nasal tip is not necessary with a plastic procedure on the dorsum. Once the dorsum is altered and the nose narrowed, the shape of the tip, which depends on the contour of the lateral wings of the alar cartilages, will invariably be too broad and rounded. There are many procedures for altering the shape of the tip, but they all have in common the fact that there are certain areas where cartilage must be removed and other areas where the spring of the cartilage must be broken to permit adequate and permanent re-shaping. The basic surgical procedure to alter the shape of the tip was described by Joseph, and most other methods involve variations of his technique.

The lateral wing of the alar cartilage may be divided into an upper third and lower two thirds. This division varies, depending on the size of the tip and the amount of alteration to
be made. When the upper segment is removed, the tip rests closer to the lateral cartilages, and, in some cases, this is all that needs to be done. In most patients, however, it is necessary to remove a wedge from the apex, permitting the ala to hinge near its free border and allowing the lateral crura to come nearer the midline. To expose the alar tip an incision is made along the free margin of the alar cartilage. Small round-tipped scissors are introduced, separating the overlying soft tissues from the perichondrium of the cartilage. After complete exposure of the lateral wing, a transcartilaginous incision is made to separate the upper from the lower segments. The vestibular skin is then separated from the undersurface of the upper segment, thus freeing it and permitting its resection and removal.

I have found that the same end result may be obtained by making only one vestibular incision. In order to employ this technique, it is essential to determine how much of the alar cartilage should be removed to correct the tip deformity before any incision is made. Once this is accurately estimated, a primary incision is started at the apex of the triangular piece of cartilages to be removed. This incision is made through the vestibular skin and cartilage and angulated laterally at the dividing line between the upper and lower segments which have been described. Coming back to the apex, the incision is carried diagonally toward the midline and up to the upper and medial border of the alar cartilage at the midline. Through this incision and by scissors dissection, the upper segment of the lateral wing is separated from the overlying skin. When its upper border is reached, the lower border of the lateral cartilage is encountered. Adhering to the lateral cartilage, the dorsum is exposed as previously described in a routine rhinoplasty. Once the dorsum is exposed, the transfixion incision is completed, and the hump operation and shortening of the septum are carried out.

At this point, to complete the tip operation, the vestibular skin is separated from the upper lateral segment and the segment is removed. If there is still too much convexity to the tip, or not enough of a wedge has been removed, further alar cartilage may be excised until the desired contour is obtained. This excision may be made by evertting the lower segment to view where it may be readily trimmed with scissors.

If the lateral arm of the ala creates too much of a bulge the cartilage may be separated from the overlying skin, everted, and two or three cuts made perpendicular to the vestibular margin, breaking the spring and permitting the convexity to become a concavity if need be. This results in only one incision in the vestibule instead of two or three so that, in closing the wound and splinting the nose, there is only one incision to be closed with interrupted sutures. If all the vestibular skin is retained and the incisions are sutured, webs or an atresia of the nares will not result.

I usually employ two or three interrupted through-and-through sutures to secure the columella to the septum. Plain gut sutures (#3-0 threaded through a small straight cutting or non-cutting needle) are satisfactory. While pushing the needle through the septum or columella the surgeon must grasp the tissues with forceps, as this causes unnecessary trauma. The needle is positioned on one side; partially opened forceps are placed on the other side, thus creating a firm surface, immobilizing the tissues, and permitting the needle to go through. To close the vestibular incisions, #5-0 plain gut, with a small swedged curved cutting needle, is used.
Splinting the Nose

Splinting is employed basically to avoid subcutaneous accumulation of blood and tissue fluid. It will also prevent accidental displacement of the movable parts of the nose when the patient is asleep. Pressure is not necessary, but diffuse splinting over the entire operative field does reduce postoperative swelling and provides protection.

If a submucous resection of the nasal septum has been performed, surgical gloved fingers or large finger cots, with tips removed, are ideal for packing. A catheter is put through the cot, so that when inserted into the nose the patient has an airway, and the marked discomfort created by swallowing with the nose tightly closed is avoided. By using a Killian speculum, the rubber finger cot may be gently filled with strips of gauze. The finger cot packing may extend back to, but not into, the choanae.

The outside of the nose is taped with 0.5-inch adhesive tape. The strip is started just beneath the tip to hold the columella up and the alar cartilages together. Two or three pieces of tape are placed over the bridge of the nose, but need not extend onto the cheeks. This adhesive splinting is extremely important and must be performed with extreme care as it molds the tip. Wrinkling of the skin must be avoided. Petrolatum gauze is placed over the taped nose and forehead, wherever the dental composition mold is expected to come into contact with the skin. This will protect the skin from the heat of the melted composition and facilitate easy removal. A soft metal form (White's metal form) is cut to act as a carrier for the composition. There are other materials which may be used for splinting, but dental composition seems to be the one most universally employed because of its ease in acquisition and use. It melts in hot water and solidifies at around body temperature. After melting the composition in hot water, it may be molded and shaped over the nose with the metal facing externally. It is then chilled with ice water. The splint is held in place with adhesive strips which go completely around the head. The strips should adhere to the forehead and cheeks, but the portion that is to be placed over hair must be backed with adhesive tape so that it will not adhere to the hair.

The nasal packing may be removed the day following the operation. The external splint may be removed 1 or 2 days postoperatively, depending upon the amount of postoperative reaction, but the adhesive splinting should be allowed to remain for 3 or 4 days.

It is very difficult to overcome the tendency of round and bulbous tips to remain round because of the pad of subcutaneous fat beneath the skin. This pad may be excised using a plane of cleavage adjacent to the under-surface of the skin, instead of adjacent to the cartilage. An overly rounded tip may also result if the mucous membrane of the septum and lateral cartilages were not cut flush when the dorsum was lowered.

Correction of the Wide Base and Long Ala

When the main rhinoplastic procedure is completed, the nostrils may be found to have too broad a base. The operator must decide how much tissue should be removed to accomplish the desired adjustment of the alae. The amount of narrowing or shortening necessary may be estimated or it may be measured with calipers. If only slight narrowing is required, a wedge resection of skin from the floor of the vestibule may suffice. Should more
extensive alteration be required, the ala is cut free from the lip and a wedge removed, along with some of the alar buttress. The incision is closed with buried sutures of #5-0 plain catgut or #6-0 silk or nylon dermal sutures.

A prominent columella is the result of too much septal cartilage and premaxillary spine. Once the nose as a whole has been corrected, this prominence may be removed by excising the free border of the septum and the premaxillary spine.

**Submucous Resection of the Septum**

**Etiology of Septal Deviations**

The nose has two fixed points, the tip of the nasal bones and the tip of the premaxillary spine. The quadrilateral cartilage of the septum is in contact with these two points and fixed from the inward. When the tip of the nose is hit violently, it will invariably deflect to one side or the other and, in most cases, the cartilage has sufficient spring and will not break. If it should break, it does so along a line corresponding the margin separating extracranial from the intracranial projection of the nose. This is one of the most common nasal deflections. It is usually associated with a deviation of the entire nasal dorsum below the tip of the nasal bone.

If the blow is from above, so that the distance between the cartilaginous dorsum and the vomer ridge is decreased, the cartilage has a tendency to become dislocated from the vomer groove and displaced to one side or the other. This may or may not involve a fracture of the cartilage. Whether it does or not, the cartilaginous dorsum is depressed because of lack of support. If the patient is seen immediately after the injury, it is possible to lift the cartilaginous septum into position, where it may be splinted until it heals. This same principle holds true with a fracture of the nasal bones along with a fracture of the septum. With a very comminuted fracture, the components will invariably be found broken, twisted, or duplicated, as well as displaced from the vomer groove. If careful attention is paid to the reduction of the septum and its immobilization, the nasal bones will maintain their reduced position without complicated splinting.

A blow to the nasal tip may dislocate the quadrilateral cartilage from the vomer ridge and fracture it from the tip of the nasal bones perpendicular to the dorsum. Between the cartilage and the membrane is a pad of fibrous tissue which in some cases will be as thick as 3 to 4 mm.

**Surgical Technique**

**Incision.** In operating on most deviated septums, I find an incision on the convex side at the mucocutaneous junction, or just behind it, to be the most convenient approach. If the deviated septum is associated with a nasal deformity which will require a rhinoplasty as well, the septum is approached through the transfixion incision.

In making the incision in the membrane, care should be taken to cut to, but not through, the cartilage. The perichondrium is dissected from the cartilage with a semi-sharp flat elevator. In this step, care should be exercised to ensure that the elevator is under the
perichondrium as it is easy to start the separation between the mucous membrane and perichondrium. Such a separation soon becomes difficult and results in bleeding, tearing of membrane, and frustration. Once the plane of separation is obtained, a blunt instrument should be used. A Pierce elevator is an excellent one as it is well shaped, light, and the operator may readily feel what the instrument is doing. The elevation is usually easily accomplished in a non-fractured septum except along the vomer ridge. The perichondrium is continuous around the bottom of the cartilage in the vomer groove and in this area the periosteum lines the bony grooves so that there is no plane of separation along this line. In the area of the tubercle, however, the perichondrium and periosteum seem to blend into one another. This, plus the fact that the membrane is thicker in this area than in others, makes elevation easy. Continuing the elevation back over the perpendicular plate of the ethmoid bone the operator can readily progress down over the vomer. By using the Pierce elevator elevation along the vomer ridge can usually be accomplished without tearing the membrane.

In noses having old fractures with a marked ridge plus scarring and thinning of the membrane, this separation may be impossible without tearing. If tearing does occur, the operator should not be concerned as long as the membrane on the other side is left intact.

An incision is next carried through the cartilage parallel to the first membrane incision with the blade held at an angle of about 40 degrees to the surface of the cartilage. Care must be taken to avoid cutting through the membrane on the concave side, as to do so invites a postoperative perforation. A semi-sharp instrument which will cut cartilage without cutting bone is useful. With this type of incision it is usually easy to separate the membrane on the concave side without tearing it.

It is essential to leave the membrane in contact with one side of the cartilage which is to be left in place. This maintains nutrition to the cartilage and holds the cartilage in position when it is cut to correct a bend or angulation. The membrane should be left attached to the concave side. With all the deflected and obstructive cartilage and bone exposed these tissues may then be removed. It is not necessary to remove all of the vomer bone if it is not causing obstruction. In my experience, in the majority of the cases justifying a submucous resection of the septum a complete removal of the component parts is required before adequate alignment can be made.

While the obstructing cartilage and bone are being removed, care must be taken to leave an adequate amount of cartilage to create a supporting strut between the premaxillary spine and tip of the nasal bones. This strut will continue beneath the dorsum to the perpendicular plate of the ethmoid bone so that the dorsum will not become depressed by the natural contraction in the area of the removed cartilage and bone. Usually 4 to 5 mm of cartilage are adequate, although more may be left if these is no obstruction. If the surgeon is not careful, he is apt to separate the quadrilateral cartilage from the perpendicular plate of the ethmoid at the tubercle (just beneath the nasal bones), thereby causing a depression of the cartilaginous dorsum. If depression occurs, it is quite difficult to hold the dorsum in its proper position until healing takes place. The easiest way to support the dorsum is to employ a stainless steel wire threaded to a straight cutting needle. The wire is inserted from the outside through the thin lateral cartilages and through the septal cartilage, that is help up in position, and out through the other side. The ends of the wire are then cut, leaving sufficient length so
that they will not be lost in the tissues. When there is adequate healing the wires may be removed. This requires 4 or 5 days.

To avoid these pitfalls, a straight scissors is the safest instrument to use in making the first cut under direct vision, keeping the plane of the cut parallel to the plane of the nasal dorsum. The Ballenger swivel knife is next used to follow this first cut. With a firm, controlled, inward-downward pressure, the cut is extended to the perpendicular plate of the ethmoid bone and then downward to the vomer bone. When the vomer bone is encountered a straight pull downward and forward completes the cut. The freed piece of cartilage may then be grasped with a forceps and removed. If the external deformities are extreme and there is loss of dorsal support, the cartilage may be saved for future grafting.

To avoid dislocating the supporting cartilage from the perpendicular plate of the ethmoid bone, it is always advisable to use a through-and-through cutting forceps such as Jensen's. Once the obstructing cartilage and bone have been removed back to the thin portion of the perpendicular plate, a grasping rocking instrument may be used. Such an instrument must be employed where the bone is too thick to permit the use of the cutting forceps.

Some operators prefer using an osteotome to separate the deviated vomer ridge from the palate, but I have found that more bleeding tends to follow this procedure than when cutting forceps are employed, particularly if the anterior palatine artery is cut across. When the bone is broken and the artery is torn, bleeding is less.

If the anterior and dorsal cartilaginous septum that is left as support to the dorsum and nasal tip is angulated and creates obstruction or an external deviation, it must be mobilized and placed into proper alignment. First the pad of fibrous tissue which fills in the vomer groove must be cut out. The membrane is cut away from this tissue with a knife under direct vision. The pad is then easily separated from the cartilage and removed. This will allow 3 to 4 mm more room on the preoperative concave side and eliminate the possibility of obstruction when the cartilage is repositioned in the midline. Sometimes the displaced cartilage can be freed from the vomer groove by blunt dissection. If this is impossible, a sharp dissection is the best alternative.

Once the dislocated cartilage is completely freed and a new bed on which it may be placed is prepared, it is elevated and sutured in place with a mattress suture that goes through the entire septum and back beneath the premaxillary spine.

Before sewing the cartilage in place, it is necessary to break up any angulation beneath the tip of the nasal bones. This may readily be done by making a cut through the cartilage beneath the tip of the nasal bones where the membrane is still in contact with one side of this cartilage. Care must be taken not to cut the membrane as it will act as a splint to hold the mobilized distal cartilage in place. The cut through the cartilage should be perpendicular to its surface and yet form a 45-degree angle to the dorsum. This permits the cartilage to hinge at the tip of the nasal bones. The shelving projection which is left supports the distal cartilage and prevents it from slipping into the nose, which would result in a depression of the dorsum below the nasal bones. When an angulation of the cartilage is in a plane parallel to the vomer ridge the same principles are employed in correcting the deviated and displaced cartilage. The obstructed, deviated cartilage and bone are removed. The cartilage which must be saved is
straightened by removing a trough of cartilage parallel to the bend on its convex side, so that when straightened, there will be a square butt without further tendency to angulate. The membrane is not disturbed on the concave side of the remaining cartilage. The cartilage is freed and replaced, the angulation is corrected at the tip of the nasal bones, and the remaining mobilized cartilage is sutured in place.

So far, cartilage which has been primarily angulated or displaced has been considered. Not infrequently, cartilage which is markedly curved, not only in one plane but in two planes, is encountered, so that it is difficult to free and realign the strip which is normally saved for support in the midplane. When cartilage is found behind the deviation, which is fairly flat, most of the septum can be removed, including that which should be saved for support. The flatter cartilage is then shaped, reinserted, and sutured to support the dorsum and the columella. This should be done as a last resort, for a free graft will occasionally be absorbed even though it consists of autogenous septal cartilage. In certain cases, it is possible to utilize some of the vomer or even the perpendicular plate of the ethmoid for support. However, bony implants are rigid and very easily fractured.

**Correction of Depression of Nasal Dorsum**

Depression of the nasal dorsum is frequently encountered when there has been an injury to the nasal septum, either traumatic, infectious, or postoperative. When there is septal destruction due to infection and loss of support because of the removal of too much cartilage, the surgeon's only alternative is to add something to the existing dorsum to create the desired contour. I have always found it expedient to use living autogenous material when available. Discussion of the use of inert implants may be found in the literature.

The depression of the cartilaginous dorsum is due to loss of septal support secondary to destruction of the cartilage itself. Careful analysis of the anatomy will frequently indicate that if the depression on the dorsum and the tip of the nose are brought into alignment with existing nasal bones, the resulting profile is the one to be obtained. Not infrequently, it will be observed that individual alar cartilages are more developed than desirable and there is slight flaring or bulbousness of the tip. This makes an ideal situation because adequate cartilage is present to form a restoration.

**Alar Swing**

The incision employed to expose the cartilage of the dorsum is made from the tip of the vestibular apex parallel to and about 2 to 3 mm from the anterior border of the alar cartilage all the way to its lateral portion. This incision extends through the cartilage. At the apex the incision is carried backward, so that the medial crus is not involved, to the anterior border of the septum where a transfixion incision is made. The outer or top surface of the alar cartilage is then freed subperichondrally by blunt dissection. The separation is continued adjacent to the lateral cartilage to the nasal bone as for exposure for a rhinoplasty. The nasal bones are then exposed subperioosteally, if there is work to be done on them, although in this case it is usually not necessary. The skin must be separated over the nasal bones to the glabella.
With fine, blunt-edged scissors the alar cartilage is now separated from the vestibular skin, but it is left attached to the vestibular skin at the apex. This attachment maintains a fixed relationship in this area plus a small viable attachment. With the tip and the columella freed, the alar cartilages which have also been freed may be brought out through one nostril. Their upper edges are sewed together with interrupted sutures. A #5-0 plain catgut eye suture on a small curved needle is quite satisfactory for this purpose.

To be certain that the cartilages remain in the proper position during splinting, a suture of nylon, threaded to a straight needle, is placed through the lateral-most portions of the alae. This suture will take the uppermost position when the alae are placed over the dorsum adjacent to the nasal bone. The suture material may then be brought beneath the skin and to the surface while the skin is elevated with a rhinoplastic skin retractor. After one end of the suture material is brought through the skin, the needle is rethreaded on the other end and brought through the skin; a snap is clamped onto the suture material to provide traction.

Once brought into position, the tip is elevated, the dorsum shortened, and the bulging portion of the ala alleviated. The transfixion incision is then closed with interrupted sutures as are the vestibular incisions. Intravestibular packing for closure of vestibular incisions cannot be relied upon because improper healing will result in web formations.

When the depression is too great to be filled by a single layer of alar cartilage, the alar cartilage may be folded upon itself to create more bulk. To execute this procedure the alar cartilages are freed, delivered through the vestibule, and placed upon the skin of the nasal tip. The dorsal surface of the ala is then cut through to a very thin layer of perichondrium which is almost always present. This permits the cartilage to be folded along the cut line. The cut and folded surfaces of each ala are then sutured together and held in position as already described.

If septal cartilage is present, and the depression is the result of buckling of the septum, a submucous resection may be performed and large sections of the cartilage obtained, cut, sutured together, and sculptured to fill the defect.

In certain cases I have found it expedient to employ a combination of these last two methods, using the alar swing and septal cartilage to provide the support.

_Grafting Techniques_

It is sometimes impossible to obtain sufficient local cartilage in a nose which has lost both its cartilaginous and bony support and in which a saddle-back deformity is present. In such an instance, in order to provide support, transplant material must be obtained from a source that will offer an adequate supply. Many materials have been employed to supplement an inadequate supply of bone and cartilage in the restoration of a nasal framework; a word is in order concerning these substances. The materials fall into two main groups, organic and inorganic. Gold, silver, tantalum, Vitallium, and the plastics are several of the inorganic, while ivory, cartilage, bone, fibrin, and fascia are the organic materials used. With most of these materials the chance of a foreign-body reaction is very high. In recent years, the use of tantalum (Fox), a completely inert basic metal, and the alloys (Pressman), Vitallium and stainless steel, have been introduced. These substances, when employed in their solid form
and buried beneath the skin, may be well tolerated. They can be anchored to the tissues when multiple perforations exist permitting fibrous tissue to grow through. Or, these materials can be screwed into place if in contact with bone. In a dorsal implant in the nose, there is a constant, light pressure of the metal beneath the skin. This creates a very slow avascularization and pressure necrosis, necessitating the removal of the material. My first successful attempt at implanting tantalum occurred when the implant was inserted so that the alar cartilages were between it and the skin directly over it, so there was a wide distribution of pressure. Tantalum wool and other metals are mentioned only to be condemned, for, in my experience, they are poor materials for reconstruction of the dorsum of the nose.

Ivory, the product of living tissue, has been used as an implant for many years (Salinger). I have seen a patient in whom it had been retained for 25 years, until a slight blow to the tip of the nose caused a foreign-body reaction requiring its removal. Today, however, ivory is rarely employed as a rhinoplastic implant. Several plastic substances (such as the acrylic resins (Rapind), polyethylene (Heanley), Teflon, and the silicones) were found experimentally to be well tolerated by body tissues. If improperly shaped or inserted they will initiate a foreign-body reaction, and removal will be necessary.

Polyethylene sponge (Johnson and Grindlay), and silicone rubber are similar to cartilage in that they are flexible and can be readily tooled at the operating table with a sharp knife. The fact that they will not curl or change shape makes them more ideal than cartilage as inserts. There have been few reported failures, and these materials appear to be fairly good substitutes for autogenous cartilage and bone.

Let us consider some of the organic materials which may be used for nasal implants. Autogenous cartilage (Peer), transplanted into a vascular field, will usually be incorporated as living cartilage. If, on the other hand, this same cartilage should be buried in a scarred or avascularized area, it may atrophy as it is infiltrated and replaced by fibroblasts which, in turn, may greatly diminish in size so that for practical purposes the mass may disappear completely. It is my experience that this is more prone to happen in the young child than in the adult.

Large blocks of rib cartilage, which can provide all the cartilage needed for nasal operations, have the great disadvantage of curling soon after being cut. This problem is not only annoying to the surgeon, but disastrous to his reconstructive work. Septal and auricular cartilage very rarely curls. Three or more pieces may be sutured together to create sufficient bulk, and then shaped. This gives the surgeon an ideal material for the replacement of the lost dorsal support.

Attempts have been made to obtain ideal materials which could be had in large amounts and banked. Homologous (Spangler) and bovine (Cottle, Quilty, and Buckingham), cartilage come under this group of substitutes. Many of these implants are replaceable by fibrous tissue invasion; so many, in fact, that I discarded bank cartilage several years ago.

Many implants of heterogenous cartilage are apparently well tolerated up to one year postoperatively, but long-term results have been discouraging because these grafts disappear.
It is recognized that autogenous bone, buried in contact with bone and surrounded by good blood supply, will become incorporated as living bone (Cannon and Murray; Cottle et al). Obtaining this result is not quite as simple as it sounds. The grafted bone first dies; osteoclasts invade its structure and destroy its framework. At the same time, osteoblasts start laying down new bone, so that by the time the process of destruction is completed the entire bone has been replaced by a living structure firmly adherent to the recipient bone by a callus. Homologous bone, which is dead when buried in the host, goes through the same process of absorption and regeneration. The grafted bone merely acts as a framework through which the new bone is laid down. Bone, therefore, is an ideal medium for repairing large defects of the nasal skeleton and may be obtained from several sources.

Some operators prefer the tibia, which is accessible and already has a surface which needs little changing to form a desirable implant. Occasionally, removal of bone for a graft weakens the tibia, so that precaution must be taken against fracture. The rib and scapula have also been employed, but the source which is considered best by most surgeons is the crest of the ilium. Here large quantities of cortical and medullary bone may be obtained without affecting function, and the resulting scar may be covered by clothing.

What type of bone graft, cortical or medullary, is best for nasal implants has long been a matter of general discussion. It is conceded today that myelogenous bone may be received and integrated quicker than cortical, but cortical bone will make a better shaped graft which will be maintained. Whether or not a strut is employed to maintain an elevation of the tip of the nose, roentgenography has shown that the bone assumes a new architectural structure. One may see a cortex which corresponds to the contour of the nose and will withstand the stresses which are placed on it. The opponents of the use of autogenous bone as a nasal implant maintain that plastics or bank cartilage or bone do just as well and that they avert the need for another operation. These claims are partially just; yet, when a solid graft is indicated, autogenous bone gives the best results. The additional operative procedure which the opponents dislike is really minor, as it takes little time to expose the ilium and obtain the graft. While an assistant is closing the wound, the surgeon may be sculpturing the insert; thus, little added time is needed.

In summary, what the surgeon should strive for is an implant which is completely tolerated by its recipient host. Autogenous bone fulfills this end better than any other material and is preferred as an implant when a large skeletal defect of the nose is to be corrected.

There are several incisions through which the dorsum of the nose may be approached to prepare it for the reception of a graft. An incision through the skin of the nasal tip or the columella creates a direct view of the dorsum, yet it may be difficult to obtain an opening of sufficient size to permit the passage of a large graft. In addition to this, this incision leaves a visible scar. In order to overcome these objections, I have found the following approach to be satisfactory.

An anterior incision is made through the vestibular skin parallel to, and 0.125 inch from, the margin of the lateral wing of the alar cartilages. When the medial crura are reached, the incision is directed back to their posterior border and carried through and through as a transfixion incision. The vestibular skin is dissected free from the lateral crura of the alar cartilage up to the lateral cartilages, which are then exposed up to the nasal bones. An
incision is made parallel to the piriform aperture and through the periosteum, which is elevated from the nasal bones up to the glabella. Usually the median raphe must be cut to permit elevation of the periosteum in the midline, but it is always possible to create a pocket to receive the upper end of the graft in the region of the glabella. The nasal periosteum is elevated laterally down over the ascending processes, to permit the skin to form a normal-appearing lateral side for the nose. The medial crura of the alar cartilages are freed from one another by blunt dissection. This step is important, for the medial crura are sutured over the graft at its tip and are to be dealt with later. If the columella is to be brought forward, the dissection of the medial crura of the alar cartilages is continued down through the soft tissues to the region of the premaxillary spine. A graft may be placed in this pocket. It may also be advisable to make a pocket in the free border of the septum. The nose is now ready for the reception of the graft.

The crest of the ilium is exposed. With a thin, broad osteotome, the cortex is sculptured in situ to form the exact contour desired for the dorsal support. It is very easy to tool the bone while it is in this position as it is completely immobile. Once the dorsum and the bone which will correspond to the lateral sides of the nose and the lost ascending processes are sculptured, the graft is removed as a block, with a good margin of bone in all directions. If there is a possibility that bone will be needed to fill out the columella, it may be taken at this time. Bleeding is controlled and the wound closed.

Once removed from the ilium, the bone is sculptured so that the finished product will completely fill the defect into which it is to be inserted. Sculpturing is performed with rongeurs, rasps, and high-speed burs. If any groove or space is left between the graft and ascending process, an external depression in that area will result when the skin is pulled in as healing progresses. If the operator is unable to tool the graft exactly to size, bone chips or cancellous bone can be used to fill in these small areas. Best results are obtained when the graft fills the entire defect. The solid upper half of the graft is carved so that it will rest securely upon the nasal bones. Care is taken so that its upper end will insert into the pocket at the glabella. This should hold it firmly in contact with the bone. The lateral wings will then rest either upon the nasal bones or the ascending processes and, in turn, by cantilever action, will support the tip. This procedure eliminates the use of a columellar strut. The graft is tapered gradually from its contact with the lower border of the nasal bones until it comes to the region of the alar cartilages. Here it is thinned from the lateral aspect and permitted to come between the medial crura, which are sutured on top of it for support. This elevates the tip above the graft, giving the profile a more normal appearance.

The original incisions are closed, and the nose is packed intranasally. A routine type of external pressure bandage is applied. This autogenous bone graft has the advantage of being in contact with a large surface of living bone. It is immobile, takes well, becomes an integral part of the nasal framework, and supports the tip of the nose in a normal anatomic relationship without resorting to a strut of bone between the anterior premaxillary spine and the undersurface of the tip of the graft. If the columella needs to be more prominent, a piece of bone may be inserted for this purpose, but not to act as a support for the tip.