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The nasal length is defined as the distance from the nasion to the tip-defining point (TDP), and, accordingly, a short nose means a short distance from nasion to TDP. When evaluating the short nose, one considers the ratio of the nasal length to the facial length to be more important than the actual length of the nose in centimeters because “short” is defined and judged in relation with the facial length, which is highly variable. In addition, other anthropometric parameters such as nasal tip projection (NTP), nasofrontal angle (NFA), or nasobasial angle (NLA) are also commonly used to evaluate and define a short nose. While many studies have been published that describe aesthetic rhinoplasty techniques for lengthening the short nose, with corresponding claims of success, there is a paucity of literature that includes objective data and discrete measurements to accurately assess the success of the touted procedure.

Short-nose deformity can be congenital or acquired secondary to trauma or nasal surgery. In white patients, over-section of the nasal dorsum, caudal septum, or lateral crus of the lower lateral cartilages in primary rhinoplasty is a frequent preceding factor of short-nose deformity. Deficiency in the supporting structures of the nose with resultant saddle and tip retraction causes a short-nose deformity. Thus, revision rhinoplasty focuses on replacing and rebuilding the framework of the nasal tip and septum. In Asians, the cause of short-nose deformity after primary rhinoplasty is somewhat different. Instead of resection, reduction, or refinement, the addition of grafts or implants for augmentation is rather common in Asian rhinoplasty. Alloplastic material is also commonly used for dorsal augmentation, and the need for subsequent removal owing to infection or other complications is not rare. Removal of the alloplast causes scar contracture of already injured, thick dorsal and tip soft tissue with resultant cephalic rotation of the tip. A weak lower lateral cartilage and septum that do not resist the scar contracture also contribute to the development of deformity.

Aggressive augmentation of a tip that was already in slightly cephalically rotated position is another common cause of short-nose deformity. A very low dorsum, which is a frequent finding in Asian noses, also gives the look of a short nose in relation to the rest of the face. Thus, secondary short-nose deformity in Asians has a different cause from that in whites, and the treatment poses a more difficult challenge for rhinoplasty surgeons. They have to deal with thick scar and skin and weak lower lateral and septal cartilage to lengthen the nose. In addition, they also have to augment the dorsum and tip, which were usually low before the primary surgery.

The purpose of this study is to present the authors’ experience in treating the primary and secondary short-nose deformities of Asians and to report the surgical results with anthropometric measurement.

Methods

Patients
Thirty-six patients who underwent rhinoseptoplasty for correction of short-nose deformity between December 2003 and November 2011 at Seoul Metropolitan Government–Seoul National University Boramae Medical Center were included. All operations were performed by one surgeon (H.-R.J.).

The short-nose deformity included in our study had 3 common characteristics: (1) the chief complaint of the patient was a short-looking nose; (2) the nose to facial length ratio was less than one-third; and (3) the patient’s nose had an abnormally increased visibility of the nostril from a frontal view and a cephalically rotated tip with larger-than-normal NLA on profile view.

We reviewed the medical charts and operative records of 36 patients retrospectively. Twenty-two of the patients were male (61%); 14 were female (39%); and their mean (SD) age was 30.6 (12.6) years. The cause of the short-nose deformity, methods and materials for lengthening, surgical results, and complications were reviewed. Patient photographs were taken with a digital camera (Canon EOS 40D) using standardized lighting, background, and patient positioning. All photographs were taken by a single senior surgeon. Each patient was asked to stand 2 meters away from the camera, and the visual axis was set parallel to the floor of the room for the frontal, lateral, and three-quarter views. The camera height was adjusted according to the patient’s height so that the subject’s head was horizontal to the camera lens. Patients were seated in a fixed position and asked to gaze directly at designated points for different views. Patients were asked to keep eyes fully open with direct gaze and lips closed with no smile.

Surgical results were analyzed by anthropometric measurements of preoperative photographs and postoperative photographs taken at least 6 months after surgery, mostly taken 1 year after surgery. For objective evaluation of the aesthetic results, the serial photographs were reviewed by 2 plastic surgeons who were blinded to the purpose of this study. The postoperative result was graded on a 4-point scale (1 indicating worse; 2, no change; 3, improved; and 4, much improved). Patients’ subjective aesthetic satisfaction was also evaluated by chart review and telephone survey by the same grading method. This study was approved by the institutional review board of Seoul National University Boramae Medical Center. Written informed consents for publication of photographs and participation in the study were provided by all patients.

Anthropometric Measurement
Image analysis was performed using Adobe Photoshop CS5 (Adobe Systems Inc) (Figure 1). The frontal and lateral photographs in the Frankfort horizontal plane were analyzed for anthropometric measurement, which included nasal length, columellar-facial angle (CFA), NTP, and NFA. Nasal length was measured as a distance between nasion and tip-defining point (N-TDP). Because there was variability in the size of each photograph, object distance, and magnification, ratio of nasal length to a reference length (distance from pupil to anguli oris on the lateral photograph) was calculated. The CFA was measured as an angle by the line drawn from the anterior columella to the subnasale and the line perpendicular to the Frankfort horizontal. The NTP was measured by the Goode method: the length of a horizontal line drawn from the TDP to the alar line (a line drawn through the alar crease, perpendicular to the
Frankfurt plane) was divided by the nasal length. The NFA was measured as an angle formed by the intersection at the nasion of lines tangent to glabella and the TDP.

To discern the value of the anthropometric measurements in the Korean population, we took profile photographs in the Frankfort horizontal plane of 40 age-matched healthy volunteers (24 male and 16 female). The volunteers had normal-looking noses, as evaluated by two otorhinolaryngologists. They were all satisfied with their facial appearance and were not considering any aesthetic facial surgery. Individuals with previous nasal trauma or nasal surgery were excluded.

**Surgical Procedure**

We used the open transcolumellar approach through an inverted-V incision and applied the standard rhinoplasty procedures. The mean operative time was 2 to 4 hours; 3 components of the nose were all released and elongated, including the skin–soft-tissue envelope, the central cartilaginous framework, and the mucosal lining. If there was any previously inserted alloplastic implant, it was removed with surrounding capsules and granulation tissues. Removing the capsules, especially the underlying capsule, is important to facilitate the stability of the new graft on the dorsum. The skin–soft-tissue envelope was released with careful dissection along the subprerichondrial and supraperiosteal plane to preserve the supplying arteries and subdermal plexus through the whole dorsal skin. Lower lateral cartilages, often damaged and weak especially in revision cases, were also released from the scar tissue and upper lateral cartilage.

Graft material was obtained from septal cartilage, conchal cartilage, autogenous rib (sixth or seventh ribs), and irradiated homologous costal cartilage (IHCC, AlloCartilage, CG-
Bio Co). To effectively elongate the central component, the septal framework was elongated using a septal extension graft (SEG) (Figure 2A) designed so that the superior edge was longer than the inferior edge to effectively counterrotate the tip. In patients with a severely deformed or deficient caudal septum, a severe deficiency in tip support, and a deficient premaxilla, a caudal septal replacement graft was used instead of an SEG. To stabilize the SEG, an extended spreader graft was applied either bilaterally or unilaterally according to the stability of the SEG (Figure 2B). Both ends of the extended spreader graft were tapered to prevent nasal airway obstruction and to tuck the grafts under the nasal bones. The released lower lateral cartilage was secured to a new caudal septum with 5-0 polydioxanone suture (Figure 2C). Additional tip grafts such as shield grafts, cap grafts, or lateral crusal-only grafts were added for additional lengthening and final control of the tip shape (Figure 2D). In all cases, a dorsal onlay graft was added for a more aesthetic result. In severe dorsal deficiency caused by concurrent or previous removal of the alloplastic implant, rib cartilage was used for the dorsal graft. The dorsal graft was carefully carved so that the concave surface of the graft fit the dorsum. Perichondrium placed on the undersurface of the graft, as suggested by Toriumi and Pero, helped to immobilize the graft at the radix. If there was shortage of mucosal or skin lining at the vestibule to match the released outer skin, conchal composite grafts harvested from cymba concha were used bilaterally to fill the gaps (Figure 2E).

**Statistical Analysis**

The Wilcoxon signed-rank test was used to analyze the differences between preoperative and postoperative anthropometric measurements. The Mann-Whitney U test was used to compare the 2 groups (primary surgery vs revision surgery; costal cartilage group vs other cartilage group).
were performed using SPSS for Windows, version 12.0 (International Business Machines Corp [IBM]). The criterion for statistical significance was set at \( P < .05 \).

**Results**

The mean (SD) postoperative follow-up duration was 29.8 (23.3) months. The cause of the short-nose deformity was primary (congenital) in 18 patients and secondary after previous rhinoplasty in 18 patients. In revision patients, the number of previous nasal surgical procedures was 2.1 on the average, ranging from 1 to 4. In 16 of the 18 revision patients, development of the short-nose deformity was associated with an alloplastic implant. In 12 patients, previously implanted alloplastic materials (11 silicone, 1 Silitex [Silitex Purification Inc]) were removed with the surrounding capsule or granulation tissue at the time of surgery. Another 4 patients with multiple previous rhinoplasties had already undergone alloplast removal owing to infection or cosmetic problems. In only 2 patients was there no relationship between the alloplast and the development of the short-nose deformity.

Septal, conchal, or costal cartilage (either autogenous or homologous) and composite graft were used as graft materials (Table 1). Autogenous costal cartilage was used in 11 cases (31%); IHCC was used in 20 cases (55%); and both were used in 3 cases (8%). The key procedures for lengthening included release of skin–soft-tissue envelope and lower lateral cartilage, SEG with or without extended spreader graft, dorsal onlay/radix graft, and tip grafts (Table 2). In 33 of 36 patients, both SEG and extended spreader graft were used. The extended spreader graft was placed bilaterally in 25 cases and unilaterally in 9 cases. A conchal composite graft was used in 3 cases to fill the gap between lengthened skin and vestibular lining in extreme short-nose cases. No immediate complications such as infection, flap necrosis, or hematoma formation were noted. There was no pneumothorax or significant donor site pain in patients using autologous costal cartilage.

Objective aesthetic evaluation was much improved in 10 patients, improved in 23 patients, and no change in 3 patients, with an average score of 3.2. Subjective aesthetic evaluation was much improved in 17 patients, improved in 18 patients, and no change in 1 patient, with an average score of 3.4.

**Anthropometric Measurement**

Changes in anthropometric measurements are summarized in Table 3. The postoperative nasal length (N-TDP) increased by 11.2% on average \( (P < .001) \) (8.1% in primary cases, 14.9% in revision cases) without any statistically significant difference between 2 groups \( (P = .82) \). The mean (SD) increase of N-TDP was greater in patients using costal cartilage than in patients using sepal or conchal cartilage \( (13.4\% \pm 10.2\%) \) vs \( 4.3\% \pm 1.9\%) \) \( (P = .001) \). The N-TDP/reference length increased from 0.48 to 0.53, which was statistically significant \( (P < .001) \).

The CFA decreased from 122.6° to 111.1°, which was statistically significant \( (P < .001) \). The CFA showed a slightly greater decrease in primary cases than in revision cases \( (12.3° \pm 10.5°) \), but the difference was not statistically significant \( (P = .41) \). The mean CFA measured in the normal population was 108.1° in male subjects, 111.6° in female subjects, and 109.7° on average. The preoperative CFA in study patients was much larger than that of the normal population \( (P = .01) \), while the postoperative CFA was similar \( (P = .50) \). The decrease of CFA did not differ significantly between the group using rib cartilage and the groups using other cartilage \( (P = .80) \).

The NTP measured by the Goode method decreased from 0.53 to 0.50 \( (P = .12) \). The NFA changed from 148.9° to 148.5°.
A 27-year-old woman visited our clinic seeking a revision rhinoplasty. She had undergone 4 rhinoplasties previously. The first 2 were augmentation rhinoplasties using GORE-TEX (W. L. Gore & Associates Inc) performed 9 and 4 years previously, respectively. At the third operation, the GORE-TEX implant was removed, and dorsal augmentation and tip surgery were performed using autologous costal cartilage. Both lateral crural onlay grafts were also used to lower the alar rim. Shield grafts and cap grafts were added for additional lengthening of the tip. A more superiorly positioned nasion with a caudally rotated nasal tip gave a longer, more natural appearance 1 year after surgery (Figure 3).

Case 2: A Foreshortened, Contracted Nose After Multiple Rhinoplasties
A 27-year-old woman visited our clinic seeking a revision rhinoplasty. She had undergone 4 rhinoplasties previously. The first 2 were augmentation rhinoplasties using GORE-TEX (W. L. Gore & Associates Inc) performed 9 and 4 years previously, respectively. At the third operation, the GORE-TEX implant was changed to a silicone implant. One month after the third operation, erythema with infection developed, which did not improve with antibiotics. At the fourth operation, performed 1 year prior to the present study, the silicone implant was removed, and dorsal augmentation and tip surgery were performed using autologous costal cartilage.

At the time of her visit for the present study, a typical contracted, short-looking nose was observed. Her nasal dorsum was low, and the tip was upturned with an exaggerated nasal ala and an exaggerated nasolabial angle from the lateral view (Figure 4).

Because she did not want to use rib cartilage again, we used IHCC as graft material. Using an open approach, we performed typical procedures, including extensive undermining of the skin-soft-tissue envelope; removal of previously grafted cartilage; and placement of an SEG and extended spreader grafts bilaterally, a dorsal onlay graft, multiple tip grafts, and bilateral conchal composite grafts (Figure 2). Sufficient dorsal augmentation and lengthening with improved facial proportions could be observed 2 years after surgery (Figure 4).

**Table 3. Changes in Anthropometric Measurements After Surgery**

<table>
<thead>
<tr>
<th>Anthropometric Measurement</th>
<th>All Procedures (n = 36)</th>
<th>Primary (n = 18)</th>
<th>Revision (n = 18)</th>
<th>Normal (n = 40)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change in N-TDP, mean (SD), %</td>
<td>11.2 (1.2)*</td>
<td>8.1 (5.1)*</td>
<td>14.9 (12.7)*</td>
<td>NA</td>
</tr>
<tr>
<td>N-TDP/reference length</td>
<td>0.50</td>
<td>0.50</td>
<td>0.51</td>
<td>0.60</td>
</tr>
<tr>
<td>Preoperative</td>
<td>0.50</td>
<td>0.50</td>
<td>0.51</td>
<td>NA</td>
</tr>
<tr>
<td>Postoperative</td>
<td>0.03</td>
<td>0.00</td>
<td>0.00</td>
<td>NA</td>
</tr>
<tr>
<td>Postoperative–preoperative</td>
<td>0.03</td>
<td>0.00</td>
<td>0.00</td>
<td>NA</td>
</tr>
<tr>
<td>CFA, °</td>
<td>122.6</td>
<td>124.5</td>
<td>120.3</td>
<td>109.7</td>
</tr>
<tr>
<td>Preoperative</td>
<td>111.1*</td>
<td>112.2*</td>
<td>109.8*</td>
<td>NA</td>
</tr>
<tr>
<td>Postoperative–preoperative</td>
<td>-11.5</td>
<td>-12.3</td>
<td>-10.5</td>
<td>NA</td>
</tr>
<tr>
<td>NTP ratio (Goode method)</td>
<td>0.53*</td>
<td>0.51</td>
<td>0.55</td>
<td>0.51</td>
</tr>
<tr>
<td>Preoperative</td>
<td>0.53</td>
<td>0.51</td>
<td>0.55</td>
<td>0.51</td>
</tr>
<tr>
<td>Postoperative</td>
<td>-0.03</td>
<td>-0.01</td>
<td>-0.04</td>
<td>NA</td>
</tr>
<tr>
<td>Postoperative–preoperative</td>
<td>0.03</td>
<td>0.01</td>
<td>0.04</td>
<td>NA</td>
</tr>
<tr>
<td>NFA, °</td>
<td>148.9</td>
<td>145.4</td>
<td>153.3</td>
<td>136.7</td>
</tr>
<tr>
<td>Preoperative</td>
<td>148.5</td>
<td>144.9</td>
<td>153.4</td>
<td>NA</td>
</tr>
<tr>
<td>Postoperative</td>
<td>111.1 a</td>
<td>112.2 a</td>
<td>109.8 a</td>
<td>NA</td>
</tr>
<tr>
<td>Postoperative–preoperative</td>
<td>-11.5</td>
<td>-12.3</td>
<td>-10.5</td>
<td>NA</td>
</tr>
</tbody>
</table>

Abbreviations: CFA, columellar-facial angle; NA, not applicable; NFA, nasofrontal angle; N-TDP, distance between nasion and tip-defining point; NTP, nasal tip projection; reference length, length between pupil and anguli oris on lateral photograph.

* The differences between preoperative and postoperative values are statistically significant.

(P = .94). There was no significant difference in preoperative and postoperative NTP and NFA.

The analysis of profile photographs of normal Korean healthy volunteers revealed 109.7° for CFA (M/F, 108.1/111.6), 0.51 for NTP (M/F, 0.53/0.49), and 136.7° for NFA (M/F, 134.2/140.0) (Table 3).

**Discussion**

In noses of white patients, iatrogenic short-nose deformity develops from scar contracture with weakened cartilaginous support usually caused by overzealous resection of the lower lateral cartilages or resection of the caudal septum. However, in Asians, the short-nose deformity after rhinoplasty typically develops in association with alloplast implant used for dorsal or tip augmentation. It can develop with implant in situ or as a sequelae after implant removal.11,16,19 The contraction of the capsule formed around the silicone implant or progressive scar contraction after removal of the implant are the suggested mechanisms for short-nose deformity. Inherent weak lower lateral and septal cartilage and a thick skin-soft-tissue envelope
that is prone to scar contracture with inadvertent dissection during rhinoplasty increase the risk of short-nose deformity. The fact that 16 of 18 revision patients in our series had short-nose deformity associated with silicone implants supports this idea. Aggressively augmenting the already slightly upturned tip without considering the vector of augmentation is another possible source of short-looking nose.

The key procedures used in our series are not different from the techniques that are already known to be effective in lengthening the short nose.\(^2,3,7,14\) However, owing to the inherent anatomic differences in Asians, the already thick skin–soft-tissue envelope becomes scarred and inelastic due to implant-related reaction or surgical trauma. Therefore, the lateral crural strut grafts, which are known to be effective in repositioning
and lowering the alar component, are not as effective as they are in white patients. To further refine the tip, a cap graft is preferred because a shield graft protruding over the dome without proper posterior backup usually does not resist the contractile forces of the thick tip skin, and so the risk of cephalic rotation is increased. Weak and small cartilaginous framework in addition to the thick skin requires a rigid and strong structural support that is only provided by the rib cartilage. Rib cartilage provides ample supply of graft material that is necessary not only for structural support for tip rotation but also for augmentation of the dorsum and tip—a frequent request from Asian patients.

Anthropometric parameters are commonly considered important factors in the preoperative assessment of short-nose deformity. However, most articles about short-nose deformity report the surgical outcome in terms of subjective aesthetic evaluation or by measuring only limited anthropometric parameters.18-20 For the present study, we measured commonly used and easily repeatable anthropometric parameters such as N-TDP, CFA, NTP, and NFA from photographic review to objectively evaluate the surgical results. The validity of using photographs to analyze these parameters has been previously established in other studies.21-22 Although the variability noted in photograph size and object magnification caused by the retrospective nature of our study prevented an exact standardization of the N-TDP, relative values measured preoperatively and postoperatively were meaningful for evaluation of the surgical results.

An average increase of 11.2% in N-TDP after surgery indicates the effectiveness of our surgical techniques to lengthen the short nose. Significantly increased N-TDP to reference length ratio after surgery is another indicator of surgical success. Although revision patients had a slightly greater increase than primary patients (14.9% vs 8.1%), the difference was not significantly different. Superior results may be anticipated in primary patients considering the scar contracture of skin and deficient cartilaginous framework in revision patients. However, a more aggressive approach in revision patients in terms of operative time, graft materials, and surgeon’s attitude favors as good an outcome as in primary surgery. More frequently used rib cartilage and composite graft in revision patients prove this idea.

We used CFA instead of NLA for assessment of nasal tip rotation. In their study, Kim and Egan13 propose that the CFA compensates for the varying NLA yielded by different upper lip slopes despite equivalent nasal tip rotation, especially in patients with premaxillary deficiency or premaxillary excess.13 The CFA is a good substitute for evaluation of nasal tip rotation in Asians, who have frequent premaxillary deficiency. Significantly larger preoperative CFA (P = .01) and similar postoperative CFA (P = .50) compared with the normal population indicates the effectiveness of maneuvers used to caudally rotate the nasal tip in our study.

No significant change in NFA and significantly decreased CFA after surgery in primary patients may give the impression that the caudal rotation of the nasal tip, not dorsal augmentation, was a major contributor to the lengthening of the short nose. However, the tip was augmented together with the dorsum in most patients. As in primary patients, NFA did not change much in revision patients because preoperative dorsal height was maintained by the cartilage graft after removal of the dorsal implant. Thus, nasal lengthening in both primary and revision patients is attributed to the combined effect of dorsal augmentation and caudal rotation of the tip.

The NTP is a variable determined by the nasal length and tip projection. To effectively achieve nasal lengthening by caudal rotation of the tip, projection is often sacrificed. Maintaining or even increasing the tip projection with caudal rotation of the tip requires rigid cartilaginous framework to resist the skin contracture. Most patients in our series wanted to augment the tip projection in addition to nasal lengthening, which is not an easy task. Nonsignificant change in NTP together with significantly increased N-TDP indicates that the actual tip projection has been increased successfully in our series.

Comparison of costal cartilage with other cartilage in graft material showed a greater increase of measured N-TDP in the costal cartilage group. This is good evidence that rib cartilage gives robust strength and ample volume to effectively lengthen the short nose, especially in revision patients with depleted septal cartilage.23 It is still consistent with previous observations that a strong cartilage framework is necessary to counteract the deforming forces posed by the expected soft-tissue contraction process. Asians have a small, weak septum with thick skin; thus, rib cartilage is needed in most cases of nasal lengthening, especially in revision patients. The choice of costal cartilage in our series was affected by various factors, including patient age, desires, and calcification of the costal cartilage.

Although there was no significant difference in the parameters evaluating the lengthening effect between autogenous costal cartilage and IHCC, autogenous was our preferred material over IHCC. Our reasons for choosing IHCC despite our preferences were diverse, but they mostly followed our female patients’ wishes after failed efforts to persuade that an autogenous graft was the best option. Using autogenous costal cartilage is advantageous because it is not as brittle as IHCC and can be carved thin for SEGs and extended spreader grafts while holding enough strength to support. The resorption is also more predictable with autogenous grafts than with IHCC when used for dorsal onlay grafting. However, if well selected (IHCC has variation in quality) and used properly, IHCC is also a very useful material in lengthening the short nose.24 Although IHCC was used in 20 of the 36 cases in our series, it was not the only graft material used for lengthening. In many cases in our series, especially in primary cases, IHCC was not used as the sole material for grafts but rather was used as an adjunctive supporting material, such as an extended spreader graft, to hold the SEG fabricated from septal cartilage. In these cases, the main support for lengthening came from the SEG. If the shape of the lengthened nose is maintained for a year or more, the shape of the nose does not change substantially thereafter. We assume that a fibrotic change takes place, and the graft holds the strength and maintains the shape of the nose.

The structural stability of IHCC used as an SEG or an extended spreader graft in lengthening the short nose can only
be confirmed after a longer follow-up. The concern for resorption cannot be denied when the IHCC is used for major dorsal augmentation, and these cases require long-term follow-up, although we did not have many such cases in our series. While we made every effort to take standard photographs with standard head position and facial expression for accurate comparison and measurements, there remains the possibility of differences in the size, object distance, and magnification of the photographs. These limitations can be overcome if we measure the angles and distances directly on the patients, which is very difficult to do in actual clinical situations.

In conclusion, the development of short-nose deformity in Asian revision patients was mostly associated with alloplastic implants. The key maneuvers for lengthening the nose were septal extension grafts reinforced with extended spreader grafts for the caudal rotation and dorsal onlay grafts for increasing the dorsal height. Rib cartilage provided a superior lengthening effect compared with other cartilage.

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Study concept and design: Park, Jin.

Acquisition of data: Park, Mun, Kim, Jin.

Analysis and interpretation of data: Park, Mangoba, Mun, Kim, Jin.

Drafting of the manuscript: Park, Mangoba.

Critical revision of the manuscript for important intellectual content: Mangoba, Mun, Kim, Jin.

Statistical analysis: Park, Mun, Kim.

Administrative, technical, or material support: Mun, Kim, Jin.

Study supervision: Jin.

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REFERENCES