ABCs in the Prevention of Filler-induced Ocular Complications

Won Lee, MD, PhD
Hyoung-Jin Moon, MD
Min-Ho Lee, MD
Min-Sueng Kim, MD
Wook Oh, MD

1Yonsei E1 Plastic Surgery Clinic, Anyang, Korea
2Beup Aesthetic Plastic Surgery Clinic, Seoul, Korea
3Bestop Clinic, Suwon, Korea
4Inee Clinic, Seoul, Korea
5Samsung Feel Clinic, Seoul, Korea

Background and Objectives
Ocular complications are rare, but tragic, side effects of treatments with hyaluronic acid filler. While several study groups have proposed preventive guidelines for hyaluronic acid filler injections, their basis remains somewhat controversial due to a lack of science evidence thereon. The present study sought to simplify preventive guidelines for the use of hyaluronic acid filler injections in clinical practice and to provide scientific data in support thereof.

Materials and Methods
We reviewed evidence of ocular complications secondary to filler injections reported in the literature and recent publications on methods to prevent them.

Results
For easier memorization and recall during routine clinical practice, we developed a set of guidelines organized as an acrostic list of ABCs. The guidelines cover the following aspects of filler injections: An anatomy (doppler ultrasound), As aspiration with proper technique, B) big cannulas, C) compression, D) direction of injection, E) epinephrine, F) filler technique for augmentation or wrinkle correction, G) gentle injection of a small amount, and H) history of prior operations or injections.

Conclusion
Clinicians ought to consider the ABCs of hyaluronic acid filler injections for the prevention of ocular complications.

Key words
Hyaluronic acid filler, Blindness, Prevention, Filler complications, Soft tissue filler
INTRODUCTION

Hyaluronic acid (HA) filler injections are commonly utilized in aesthetic procedures for facial rejuvenation. However, the use of HA fillers is associated with serious complications, including skin necrosis and blindness [1]. Although research has elucidated the potential pathophysiologic mechanisms of ocular complications stemming from the use of HA fillers and although several guidelines have been proposed to prevent the occurrence thereof, studies have yet to provide scientific evidence in support of a single treatment modality with HA filler that completely or markedly reduces the likelihood of ocular complications occurring, and since there is no definite treatment for correcting HA filler-induced complications of the ocular area, prevention is of utmost importance [2,3]. Accordingly, various methods and guidelines aimed at preventing unwanted complications from HA filler injections have been proposed, although some are based only on consensus and have no basis in scientific evidence [4,5]. Therefore, we sought to develop clear guidelines based on recent scientific data reported in the literature that are memorable and readily applicable in clinical practice.

MATERIALS AND METHODS

To begin, we reviewed evidence on methods of prevention of ocular complications secondary to filler injections reported in the literature. The search terms ‘hyaluronic acid filler’, ‘dermal filler’, ‘filler complications’, ‘blindness’, ‘ocular complications’, and ‘vision loss’ were input as key words in the search engines PubMed MEDLINE and Google Scholar. A total of 34 articles addressing filler injections were reviewed. Finally, we developed a set of preventive guidelines for HA filler treatment supported by recent scientific data.

RESULTS AND DISCUSSION

The guidelines that we propose are discussed in individual sections below. We have organized them as an acrostic list of ABCs for easier memorization and recall during routine clinical practice, as shown in Table 1.

An) Anatomy

All of the articles that we reviewed emphasized the importance of awareness of anatomical structures during filler injection procedures. As stated above, the pathophysiology of filler-induced ocular complications is well known, and the most important structures affecting ocular complications are the branches of the internal carotid arteries (Fig. 1). In the literature, several articles have analyzed ocular complications associated with filler procedures, and while some reported possible ocular complications as a result of external carotid artery embolism, the rates thereof were much less than those occurring as a result of embolism of the internal carotid artery [6].

Unlike surgery, filler injection procedures are conducted blindly (i.e., not under direct visualization of underlying structures). Accordingly, no matter how well-versed the clinician is in the vasculature of the internal carotid arteries, filler injections are not 100% safe because of arterial variations. Indeed, several variations in the supratrochlear, supraorbital, and dorsal nasal arteries have been described [7,8]. In addition to variations, studies of the human anatomy are primarily conducted in cadavers, the results of which may differ from those in a living human body. Since we perform procedures on the living human body, the actual anatomy thereof is most important. Therefore, anatomical results

Table 1. ABCs in the prevention of filler-induced ocular complications

<table>
<thead>
<tr>
<th>An) Anatomy (Doppler ultrasound)</th>
<th>As) Aspiration with proper technique</th>
<th>B) Big cannulas</th>
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<tbody>
<tr>
<td>C) Compression</td>
<td>D) Direction of injection</td>
<td>E) Epinephrine</td>
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<tr>
<td>F) Filler technique for augmentation or wrinkle correction</td>
<td>G) Gentle injection of a small amount</td>
<td>H) History of prior operations or injections</td>
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</table>

Fig. 1. Arteries of the face associated with ocular complications. Red, internal carotid artery branches; Black, external carotid artery branches.
reflected in imaging studies of live human subjects, such as ultrasound, are essential to preventing vascular complications. Accordingly, clinicians have recently sought to implement the use of Doppler ultrasound to facilitate visualization of the underlying vasculature in order to improve the safety of HA filler procedures [9,10]: The detection of the supratrochlear artery is particularly important in the correction of glabellar frown lines, and the artery exhibits several variations that run in superficial or deep directions (Fig. 2). The supraorbital artery shows anastomosis to the frontal branch of the superficial temporal artery that is visible under Doppler ultrasound [11]. The dorsal nasal artery is important in augmentation of the nose with filler injections, and it also has many variations detectible with Doppler ultrasound (Fig. 3) [12]. The use of Doppler ultrasound allows the clinician to observe and avoid these pathways to inject HA filler at the desired location without incurring injury thereto.

As) Aspiration with proper technique

Aspiration of the needle prior to injection of HA filler has been suggested to prevent vascular embolism [13], although many have deemed this ineffective [14]. We suspect that the effectiveness of aspiration may depend on the technique applied. HA filler injections can be performed via either a linear retrograde technique or a bolus injection technique. When applying a linear retrograde technique, the clinician will continually move the needle tip, making aspiration ineffective. With a bolus injection technique, however, the needle tip does not move, and thus, aspiration may be useful to prevent vascular embolism [15]. Nonetheless, aspiration tests can produce false negatives, wherein, even though the needle tip is located inside a vessel, blood is not detectable during aspiration. While this is thought to be affected by filler rheology, needle diameter, aspiration time, and negative pressure [16,17], aspiration tests with filler appear to be more dependent of conditions inside the needle. Accordingly, we have performed in vivo tests with rabbits and found that all aspiration tests with HA filler were positive when the needle was first primed with normal saline (Fig. 4).

B) Big cannulas

Previous articles have recommended the use of small-
bore needles for filler injection [4,13,18]. However, while the use of a small-bore needle would minimize the likelihood of perforating an artery, when the needle tip is placed inside the artery, embolism can still occur. Moreover, the use of a small-bore needle poses a greater risk of the needle tip being placed inside the vessel lumen. Compared to needles, cannulas are thought to be less traumatic, although small-bore cannulas (e.g., 27 G) appear to be as equally as dangerous [19]: a recent article also demonstrated that a 27 G cannula required similar forces as a 27 G needle for intraarterial penetration and that small-bore needles or cannulas could penetrate an artery at less force than larger-bore ones [20]. Therefore, we recommend the use of relatively larger bore cannulas.

In regards to preventing arterial embolism, the outer diameter of the cannula or needle is extremely important (See Table 2 for needle diameters). When using a 30 G needle, its outer diameter is 0.31 mm. Since important arteries, such as the supratrochlear, supraorbital, and dorsal nasal arteries, are about 1 mm in diameter [21], a 30 G needle tip can be placed inside these arteries: theoretically, a 21 G needle with an outer diameter of 0.82 mm could also be located inside vessel. A schematic diagram is provided in Fig. 5.

C) Compression
During HA filler injection, compressing the pathway of neighboring arteries is recommended, particularly along the inferior medial orbital rim and the side of the nose [22]. When performing forehead augmentation or glabellar wrinkle correction, digital compression of the supratrochlear/supraorbital arterial pathway is required. For augmentation of the nose, compression of the dorsal nasal artery is needed. When digital compression is performed, however, arterial flow by Doppler ultrasound cannot be detected [23]. Nevertheless, applying digital compression can help prevent ocular complications should arterial embolism occur, as, in a pathophysiologic context, ocular complications are known to develop as a result of retrograde HA filler emboli to the ophthalmic artery [2].

D) Direction of injection
Previous research has demonstrated that even cannulas can perforate the arterial wall, and a perpendicular angle between the artery and the cannula was one factor eliciting vascular injury [19]. While more parallel cannulation is known to be relatively safe, clinicians must also consider the direction in which HA filler is injected after cannulation. Since HA filler embolism occurs as filler enters the arterial lumen via a perforation and completely fills the arterial lumen as the injection continues, injecting filler away from the eye, rather than towards the eye, is paramount to preventing ocular complications (Fig. 6).

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**Table 2. Needle diameters**

<table>
<thead>
<tr>
<th>Needle</th>
<th>Outer Diameter (mm)</th>
<th>Inner Diameter (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>18 G</td>
<td>1.27</td>
<td>0.84</td>
</tr>
<tr>
<td>19.5 G</td>
<td>0.99</td>
<td>0.69</td>
</tr>
<tr>
<td>21 G</td>
<td>0.82</td>
<td>0.51</td>
</tr>
<tr>
<td>22 G</td>
<td>0.71</td>
<td>0.41</td>
</tr>
<tr>
<td>23 G</td>
<td>0.64</td>
<td>0.34</td>
</tr>
<tr>
<td>25 G</td>
<td>0.51</td>
<td>0.26</td>
</tr>
<tr>
<td>27 G</td>
<td>0.41</td>
<td>0.21</td>
</tr>
<tr>
<td>29 G</td>
<td>0.34</td>
<td>0.18</td>
</tr>
<tr>
<td>30 G</td>
<td>0.31</td>
<td>0.16</td>
</tr>
</tbody>
</table>
E) Epinephrine

Previous articles have proposed the use of a small amount epinephrine prior to HA filler injection [4,24]. The use of a small amount of epinephrine with lidocaine limits any pain and bruising experienced by the patient. Importantly, only a small amount of epinephrine is recommended, as large amounts can hinder achieving the desired appearance of the face.

F) Filler technique for augmentation or wrinkle correction

In the correction of wrinkles, previous articles have primarily recommended techniques that encompass continual movement of the needle tip when injecting HA filler to prevent arterial embolism, both for an anterograde or retrograde approach [4,18,24,25]. This, however, limits the amount of filler that can be injected to only small amounts. Meanwhile, in Asian patients, filler is also used for augmentation of the nose, typically requiring injections of more than 0.5 mL of hyaluronic acid filler, much greater than the small amounts used for wrinkle correction [26]. For this reason, a single bolus injection of HA filler to the supraperiosteal layer is considered safer for nose augmentation [27], although clinicians ought to consider the properties of the filler when doing so: HA filler has various rheological properties, and for nose augmentation at the supraperiosteal layer, the HA filler should have a relatively high G’ [28]. Also, when injecting a filler with a high G’, a large-bore cannula should be utilized to limit the possibility of alterations to the filler’s properties [29].

G) Gentle injection of a small amount

Gentle injection is important to the behavior of the filler upon injection. The force needed to inject filler is called the injection force (Fig. 7). However, the actual force generated upon ejection of the filler from the needle warrants additional consideration. This force is affected by the viscosity of the HA filler and the inner diameter of the needle [30]. When the filler is ejected gently, the pressure generated by the ejected filler is quite small, but when injected at only a slightly higher force, this pressure increases greatly. In our recent experiments (unpublished data), we noted that only a small increase in ejection force can elicit a much higher pressure (572.67 mmHg) beyond that of the normal systolic pressure of blood vessels. In addition, gentle injection of as little of filler as possible is also critical. A previous report described the mean volume of the supratrochlear artery to be approximately 0.085 mL [31]. Thus, injecting more than this amount during one injection could allow the filler to reach the ophthalmic artery and cause blindness (Fig. 8).

H) History

Previous surgical history can alter arterial pathways, so much so that a few clinicians have recommended never treating a previously traumatized area with filler injections [32]. Alterations in the anatomical locations of vessels following surgical interventions, such as rhinoplasty, pose several concerns [33]: For instance, in augmentation of the nose, clinicians recommend injecting HA filler at the supraperiosteal layer, as it is well known that the dorsal nasal artery is located in the subcutaneous layer at the nose [34]. However, in many Asian patients, augmentation rhinoplasty is performed with silicone implants, and in such cases, HA filler cannot be injected at the supraperiosteal layer and should be injected more superficial than the implant,
meaning it should be injected at the subcutaneous layer where the dorsal nasal artery might located, thereby posing a greater risk of vascular complications.

**CONCLUSION**

In the present study, we sought to provide simplified, preventive guidelines supported by the literature for reducing ocular complications after procedures involving filler injections. Clinicians ought to consider the ABCs of HA filler injections for the prevention of ocular complications: An) anatomy (doppler ultrasound), As) aspiration with proper technique, B) big cannulas, C) compression, D) direction of injection, E) epinephrine, F) filler technique for augmentation or wrinkle correction, G) gentle injection of a small amount, and H) history of prior operations or injections.

**CONFLICT OF INTEREST**

No potential conflict of interest relevant to this article was reported.

**REFERENCES**


