CURRICULUM VITAE

차 원 재

학력
1997-1999	서울대학교 자연과학대학 의예과
1999-2003	서울대학교 의과대학 의학과
2012	서울대학교 대학원 의학과 석사(이비인후과학 전공)
2015	서울대학교 대학원 의학과 박사(이비인후과학 전공)

경력
2003-2004	서울대학교병원 인턴
2004-2008	서울대학교병원 이비인후과 전공의
2011-2012	서울대학교병원 이비인후과 임상강사
2012.9	UPMC (University of Pittsburgh Medical Center) 연수
2012-2013	서울대학교병원 이비인후과 조교수
2012-2013	서울대학교 암병원 갑상선-구강-두경부암 센터 교수
2012-2013	서울대학교병원 이비인후과 음성클리닉 교수
2013.9-	부산대학교병원 이비인후과 조교수
2014.11-2016.10	Global On-Line Fellowship of IFHNOS (International Federation of Head and Neck Oncologic Societies, 세계두경부종양학회)

연구지원
2016.11-2020.7	미래창조과학부 바이오·의료기술개발사업 임상의과학자 연구역량강화 사업

학회활동
대한이비인후과학회 정회원
대한이비인후과학회 간행위원회 위원(2016-2017)
대한갑상선두경부외과학회 정회원
대한후두음성언어의학회 정회원
대한후두음성언어의학회 총무간사(2015-2017)
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Development of a Device for Real-Time Light-Guided Vocal Fold Injection

Department of Otorhinolaryngology-Head and Neck Surgery, Pusan National University Hospital, Department of Otorhinolaryngology-Head and Neck Surgery, School of Medicine, Pusan National University, Busan, Korea

Wonjae Cha, MD, PhD

Vocal fold injection is a minimally invasive technique for various vocal fold pathologies including vocal fold paralysis, vocal fold atrophy, vocal fold scarring, vocal fold papillomatosis, vocal fold nodules, vocal fold polyps, vocal fold granuloma, laryngeal stenosis, and Reinke's edema. Recent advances in injection materials have broadened the indications for this technique, and the expanding capabilities of endoscopic technology have increased the number of available approaches and precision of injection. There are several approaches to vocal fold injection in the office-based setting, which are the transoral approach, the transthyrohyoid membrane approach, the transthyroid approach, and the trans-cricothyroid (CT) membrane approach according to the route of injection. In practice, each approach has its advantages and disadvantages, and the choice of approach usually depends on the surgeon's preference, the injection material, and the condition of the patient.

The peroral approach is easy to learn and allows good localization of the needle tip. However, it is difficult to handle the long curved needle delicately, which can lead to spillage of the injectate. Additionally, there is a risk of bleeding and laryngeal spasm due to mucosal penetration. Compared to the transoral approach, the CT approach has the advantages of a low complication rate, suitability as an office-based procedure, and good patient compliance.5 However, in current practice, this approach has the important limitation that precise localization of the needle tip is difficult because it utilizes a submucosal pathway. Because of the invisibility of the needle tip, accurate localization requires a high level of experience. It is also necessary to develop expertise in correlating external landmarks with internal laryngeal anatomy for blind approaches such as the CT approach. There is a steep learning curve involved in mastering this technique.

In our clinic, We usually performs vocal fold injection for most conditions using the CT approach, and assumed that the shortcomings of the CT approach are mainly related to the invisibility of the injection needle. We think that if localization of the needle tip is improved, it can overcome these shortcomings. However, in the office-based setting, simply localizing the needle without enabling simultaneous injection is not sufficient because of the small amount of working space inside the vocal fold, the limited time for injection, and the involuntary movement of patients. Localization with simultaneous injection is necessary to ensure the practicality of vocal fold injection under local anesthesia. We have conceptualized a novel technique, a real-time light-guided vocal fold injection method that permits simultaneous injection under precise needle localization by visualization of a lighted needle tip.

In this study, we developed a device for real-time light-guided vocal fold injection and applied it in an excised canine larynx model.