Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.JournalofSurgicalResearch.com

Fluorescence imaging–guided robotic thyroidectomy and central lymph node dissection

Wan Wook Kim, MD,[*,1] *Jin Ah Choi, MD,*[1] *Jeeyeon Lee, MD, Jin Hyang Jung, MD, and Ho Yong Park, MD*

Department of Surgery, School of Medicine, Kyungpook National University, Kyungpook National University Hospital, Daegu, South Korea

ARTICLE INFO

Article history:
Received 4 February 2018
Received in revised form
15 May 2018
Accepted 31 May 2018
Available online xxx

Keywords:
Bilateral axillo-breast approach
Fluorescence image
Indocyanine green
Node dissection
Robot

ABSTRACT

Background: The purpose of this study was to evaluate the feasibility of complete central compartment node dissection (CCND) using fluorescence imaging (FI) during robotic thyroidectomy.

Methods: A total of 110 patients underwent robotic thyroidectomy and CCND from August 2015 to June 2016; 55 patients underwent robotic surgery using FI (FI group) and the other 55 patients without it (control group). The FI group was injected with indocyanine green into the thyroid to enhance the identification of lymph nodes (LNs).

Results: Indocyanine green–stained LNs were easily detected using FI. The number of harvested LNs was 7.0 in the FI group and 4.8 in the control group ($P = 0.004$). There was lower rate of transient hypocalcemia in the FI group (18.5%) than control group (26.7%), but there was no significant difference ($P = 0.417$). There were no other significant differences between the two groups.

Conclusions: The use of FI during robotic thyroidectomy facilitated the identification of LNs and guided complete CCND.

Introduction

With the development of new and improved instruments, such as energy-based devices and robotic surgery systems, much progress has been made in thyroid surgery, allowing surgeons to perform surgeries easily and to perform more sophisticated surgeries.[1] Robotic surgery has many advantages, such as high definition, 10 times magnified and three-dimensional imaging, as well as the use of instruments for greater range of motion (i.e., multiarticulation), for delicate operations requiring fine motion and for the reduction of hand tremors. Robotic thyroid surgery is a new alternative procedure for patients who do not want a neck scar.[2] Many robotic surgeries have been performed since robotic thyroid surgery was introduced in 2007; based on the positive results, robotic thyroid surgery has become a crucial method for thyroid surgery.[3-5] The oncologic results of previous robotic thyroid surgery studies show that robotic surgery is comparable to open surgery.[6-8] The most popular surgical methods include the transaxillary approach, the bilateral axillo-breast approach (BABA), and the retroauricular approach; the transoral approach has recently been attempted.[5,9-11] BABA have resulted in superlative cosmetic outcomes and great patient satisfaction because the incision scars (1-1.5 cm) in the breast areola and axilla are very faint. However, it is difficult to identify deep central lymph nodes (LNs) using BABA because

* *Corresponding author*. Department of Surgery, Kyungpook National University, Kyungpook National University Hospital, 807 Hogukno, Buk-gu, Daegu, Korea 702-120. Tel.: +82 53 200 2705; fax: +82 53 200 2027.
E-mail address: kww1324@naver.com (W.W. Kim).

[1] These authors contributed equally to this study as co-first authors.

0022-4804/$ – see front matter
https://doi.org/10.1016/j.jss.2018.05.071

the camera is inserted through the breast incision. Several studies have reported that there are fewer retrieved LNs after BABA compared with open surgery, and certain groups have suggested that BABA is not as complete as open surgery for central compartment node dissection (CCND).[2,12,13]

There is still some debate as to whether prophylactic CCND should be performed for clinically N0 (cN0) differentiated thyroid cancer. Nonetheless, most surgeons agree that adequate and complete CCND is important for reducing recurrence by eradicating metastatic LNs and determining appropriate treatment strategies through accurate staging.[14] If LNs recur after robotic surgery, it is difficult to excise those recurred LNs (reoperation) through robotic surgery, and patients should therefore receive open surgery. In this case, scarring in the neck cannot be avoided, which is unfortunate not only for the patient but also for the surgeon. Therefore, it is essential to perform complete surgery and remove all tumor burden to reduce recurrence after the first operation, especially for robotic surgery. Recently, fluorescence imaging (FI) techniques have been used to visualize LNs well during surgery. These techniques are being introduced for other cancers; however, there was no study using FI technique in robotic thyroid surgery.[15] The purpose of this study was to evaluate the feasibility of FI technique in robotic thyroidectomy and CCND using BABA.

Patients and methods

This study was performed under the approval of the Institutional Review Board of Kyungpook National University Medical Center (No. 2017-03-027). All surgeries were performed using da Vinci Xi robotic systems (Intuitive Surgical, Sunnyvale, CA) with or without Firefly FI technology (NIR illuminator: 805 nm; filter: 825 nm), and by one surgeon (Prof W.W.K.) to maintain equity in the study. The following are the criteria for robotic surgery: a less than 2 cm in size, well-differentiated thyroid cancer; no suspicion of invasion to surrounding structures (i.e., trachea, recurrent laryngeal nerve, esophagus); and a patient who want to undergo a robotic operation. A total of 110 patients were enrolled prospectively from August 2015 to June 2016 at Kyungpook National University Hospital. All patients were diagnosed with papillary thyroid cancer (PTC) using fine needle aspiration (FNA) before the operation and underwent robotic thyroidectomy and prophylactic CCND. All cases were well-differentiated PTC without any other higher-risk pathological characteristics (i.e., tall cell, hobnail, etc). The patients were alternately assigned to either treatment of control groups in a consecutive fashion without any specific selection criteria or selection by the surgeon: a total of 55 patients received CCND using FI (FI group), and the remaining 55 patients received CCND without FI according to the conventional method (control group). Before the injection of indocyanine green (ICG), the sternohyoid muscle was divided to expose the thyroid parenchyma. A total of 25 mg of ICG (Diagnogreen, Daiichi Pharmaceutical, Tokyo, Japan) was mixed with 20 mL of NaCl, and 0.05 mL (1.25 mg/mL) of the ICG mixture was intraoperatively injected into the thyroid parenchyma near the primary cancer rather than peritumoral injection (Fig. 1).

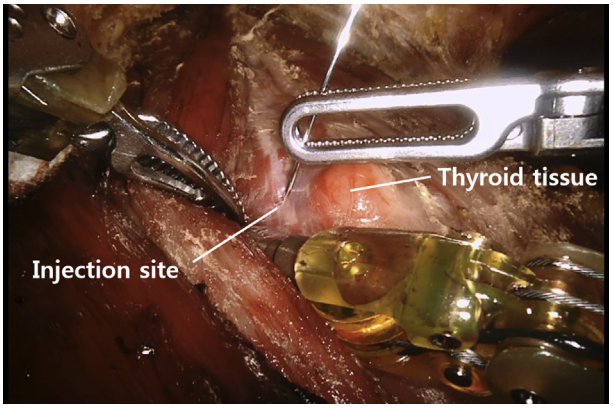

Fig. 1 – Surgeon slowly inject 0.05 mL ICG to thyroid parenchyma through 25G spinal needle intraoperatively before central LN dissection.

For bilateral cancer, injections were performed on both sides. At the beginning of the study, 0.1 mL of ICG was injected; however, ICG spilled into surrounding tissues, and ICG contamination interfered with LN identification. The 0.05 mL of ICG was injected slowly and with low pressure using a thin 25G spinal needle to reduce dye leakage. After the injection, the parenchyma was gently massaged for 3-4 min using gauze to allow the ICG to flow through the lymphatic system. After injecting ICG into the thyroid gland, dye begins to flow along the lymphatics after about 10-20 s and begins to show uptakes in the LNs around the injection site 1-2 min later, which are best seen 3-4 min after injection.

ICG can be seen under near-infrared FI, which allows the surgeon to identify the ICG-uptake LNs in green fluorescent light in real time (Fig. 2). The pretracheal and paratracheal LN dissection were performed before the thyroidectomy for better visualization of the uptake LNs. The thyroidectomy was subsequently performed while preserving the parathyroid, and an additional dissection was performed if the remaining paratracheal LN was present. The surgeon then confirmed that there was no uptake LN on the operative field, and the operation was completed. The surgeon checked that the parathyroid was not included in the removed specimen (i.e.,

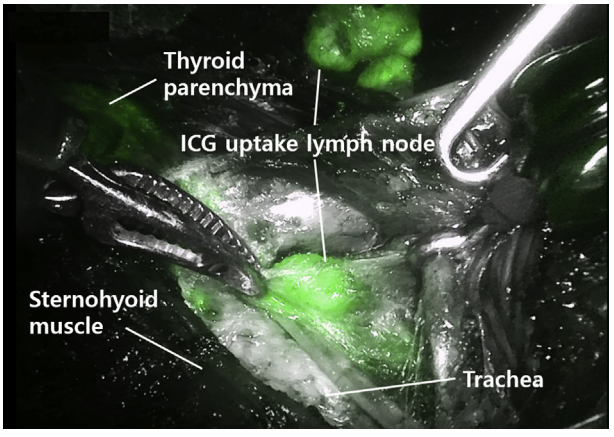

Fig. 2 – LN green-stained by ICG could be detected easily under near-infrared FI scope.