Intraoperative free jejunum flap monitoring with indocyanine green near-infrared angiography

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ABSTRACT

The free jejunum flap technique has been regarded as the optimal approach during circumferential pharyngolaryngectomy reconstruction. Although classical patency tests are available, an intraoperative guarantee of the patency of anastomoses and microcirculations is inevitable. Indocyanine green near-infrared angiography (ICGA) was intraoperatively performed in six patients after reconstruction using the free jejunum flap. An adequate arterial as well as venous phase were observed. In addition to classical patency tests and doppler, we have successfully monitored the flap after total pharyngolalyngectomy intraoperatively using the ICGA. Our preliminary results implicate that this novel technique offers secure intraoperative monitoring of a free jejunum graft. This technique will provide us with advantages over regular patency test in selected cases.

Key Words: free jejunum flap; intraoperative monitoring; indocyanine green; near-infrared angiography; total pharyngolaryngectomy

Introduction

The free jejunum flap technique has been regarded as the optimal approach during circumferential pharyngolaryngectomy reconstruction, as has been reported by several authors [1]. Early flap failure and postoeprataive reexploration have been predominantly prescribed to technical problems at the anastomotic site; therefore, postoperative monitoring of graft viability is necessary to identify vascular compromise. However, only a few devices are available for practical bedside monitoring of the buried free jejunum flap [2].

Although postoperative monitoring is inevitable to achieve successful free tissue transfer, the importance of intraoperative monitoring of the flap has been stressed by several authors [3]. Clinically, a patency test or inspection of the vessels and the flap has been traditionally performed for the purpose. In order to guarantee the secure patency of the vessels, in the present preliminary study, we have successfully monitored a free jejunum flap for reconstruction after total pharyngolalyngectomy intraoperatively using indocyanine green near-infrared angiography (ICGA).

Materials and methods

Six patients with advanced hypopharyngeal cancer underwent this technique intraoperatively after obtaining informed consent. Briefly, patients received circumferential pharyngolaryngectomy and reconstruction using the free jejunum flap technique at Kanazawa University Hospital. Bilateral neck dissections were also performed. After the jejunum graft was placed in the neck, microvascular arterial and venous anastomoses were performed between the donor and recipient vessels. End-to-side anastomoses to the common carotid artery or internal jugular vein were adopted for this purpose. After proximal and distal mucosal anastomoses were performed, the patency of the artery and vein was evaluated by the surgeon using usual clinical patency tests including vessel filling and the flap color. When open microvascular anastomoses were confirmed, ICGA was further conducted. ICGA was performed with a commercially available imaging device (SPY™

Intra-operative Imaging System; Novadaq Technologies Inc., Concord, Canada). Indocyanine green (ICG) dye was injected once as a bolus into a central or peripheral vein (0.2 mg / kg body weight).

Results

After the injection of ICG dye, the imaging device clearly demonstrated the arterial network in the transferred mesentery and jejunum, which indicated patency of the arterial anastomosis (Fig. 1A, 1B, and 1C). Then, perfused dye was detected in the entire transferred free jejunum followed by the appearance of dye at the venous anastomosis (Fig. 1D). Fully perfused dye gradually diminished from the jejunum graft (Fig. 2A and 2B). All six cases demonstrated an adequate arterial as well as venous phase. The intrinsic transit time of the flap, which was defined as the time period from the dye appears at the arterial anastomosis till it reached the suture line of the venous anastomosis, seemed about 10 seconds although it was not necessarily measured in all cases. As a result, the grafted jejunum became fully viable without any problems in the postoperative course in all six cases.

Discussion

Significant advances in surgical instruments and increasing experience with microsurgery have increased the success rate of free tissue transfer to more than 90%. However, even in the most experienced hands, vascular compromise of a transferred flap can still occur. Currently, no validated technique exists for objective intraoperative assessment of the quality of anastomoses.

The ICGA, a recently commercialized technique to semi-quantitatively measure microvascular perfusion of soft tissue flaps, is based on detection of the distribution of a systemically, namely intravenously, administered ICG dye, under exposure to near-infrared rays. Intravenous administration of the dye is an established procedure as the ICG clearance test is widely used for liver function test in the world [4]. The emitted signals are captured through an optic filter. It takes only a couple of minutes to obtain images of angiography. The fate of systemically administered ICG is excretion through the bile, with a plasma half-life of 3-4 minutes.

In 2002, a prospective clinical study on 20 patients was the first to demonstrate that the evaluation of perfusion by ICG imaging was feasible for microsurgical flaps, and that intraoperative findings strongly correlated with the clinical outcome [5]. Since then, the availability of ICGA for intraoperative free flap monitoring has been demonstrated [6,7]. However, the application of this technique for a free jejunum graft has not been reported to date.

Although the watch window technique and sentinel segment technique have been reported for monitoring, a buried free jejunum flap is difficult to monitor postoperatively [8,9]. Currently, the method to intraoperatively monitor the flap relies on the classical observation of peristalsis, the serosal color, and capillary refill. Because the high success rate of free jejunum transfer has been reported, the classical procedure may be enough for intraoperative monitoring. However, there seem to be several advantages of the ICGA over the classical procedure with regard to detection of conditions unrecognized by the regular patency test or doppler. Indeed, in coronary bypass surgery, Desai et al. reported that information from intraoperative ICGA led to graft revisions for technical problems in certain cases that would have otherwise gone unrecognized [10]. Similarly, ICGA can provide us with more reliable intraoperative guarantee of the patency of anastomoses and microcirculations. There may be partial insufficiency of circulation in transferred jejunum due to a microthrombosis in the network of mesenteric vessels. However, visualization of entire transferred jejunum will detect such region as a defect of fluorescence in ICGA. Furthermore, this technique can detect venous congestion, which runs the risk of irreversible flap complications, by observation of delayed diminishing of fluorescence.

We recognized that postoperative monitoring also plays a major role in success of head and neck reconstruction with free flap. Intraoperative blood flow dose not necessarily reflect the flap success after the wound closure. However, the intrinsic transit time of free microvasclular flaps has a significant predictive value for the development of flap compromise and early re-exploration surgery [7].

We consider that this technique will not be performed in all cases of free jejunum transfer. Previous retrospective study demonstrated that diabetes, salvage free flap transfer and use of interposition vein grafts were significant factors predicting free flap complications in head and neck reconstruction [11]. Another retrospective study demonstrated that preoperative neck irradiation at doses more than 60 Gy was associated with a significantly increased risk of free flap failure [12]. Therefore, this technique can be performed in selected cases with high risk for free flap transfer including cases described above.

Although a number of patients in this preliminary study are small, our results suggest that the ICGA technique highlights the intraoperative quality assurance of anastomoses and mesenteric circulation in free jejunum transfer. This technique can be applied for postoperative confirmation of blood flow through the watch window of a buried free jejunum flap. Further advances of this technique will be expected in a free jejunum transfer.

In conclusion, although the free jejunum flap technique has been regarded as the optimal approach during circumferential pharyngolaryngectomy reconstruction, the ICGA objectively offers secure intraoperative monitoring of a free jejunum flap. This technique provides an intraoperative guarantee of the patency of anastomoses and microcirculations in a buried free jejunum flap in addition to classical patency tests.

Conflicts of Interest

The authors declare that they have no conflict of interest.

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FIGURE LEGENDS

Figure 1.

Indocyanine green near-infrared angiography in a free jejunum flap. (A) No fluorescence before the injection of indocyanine green dye. (B) Arterial fluorescence immediately after injection of the dye. (C) Intense arterial fluorescence and the beginning of total fluorescence. (D) Intense total fluorescence in the transferred jejunum.

Figure 2

Indocyanine green near-infrared angiography in another free jejunum flap. (A) Early phase of diminishing fluorescence in the entire jejunum. Remaining faint fluorescence in arterial anastomosis (arrowhead) and clear fluorescence in venous anastomosis (arrow). (B) Diminishing fluorescence in the entire jejunum, arterial anastomosis (arrowhead), and venous anastomosis (arrow).

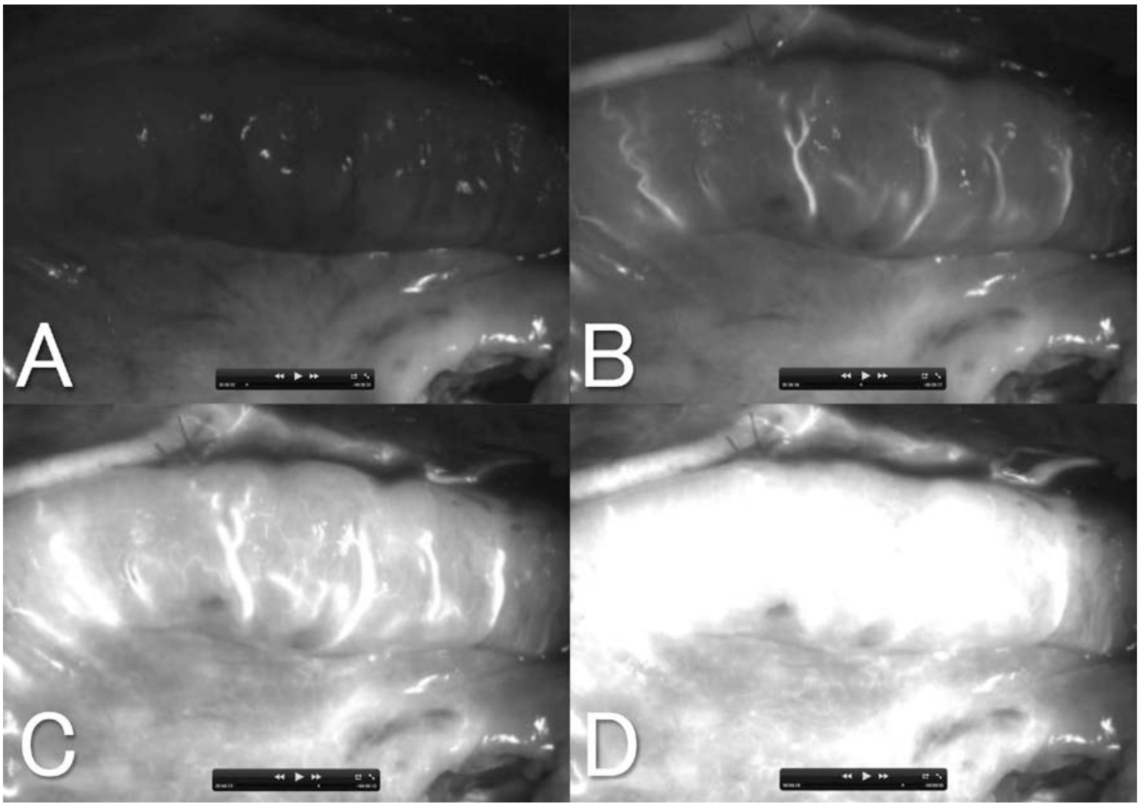

Figure 1

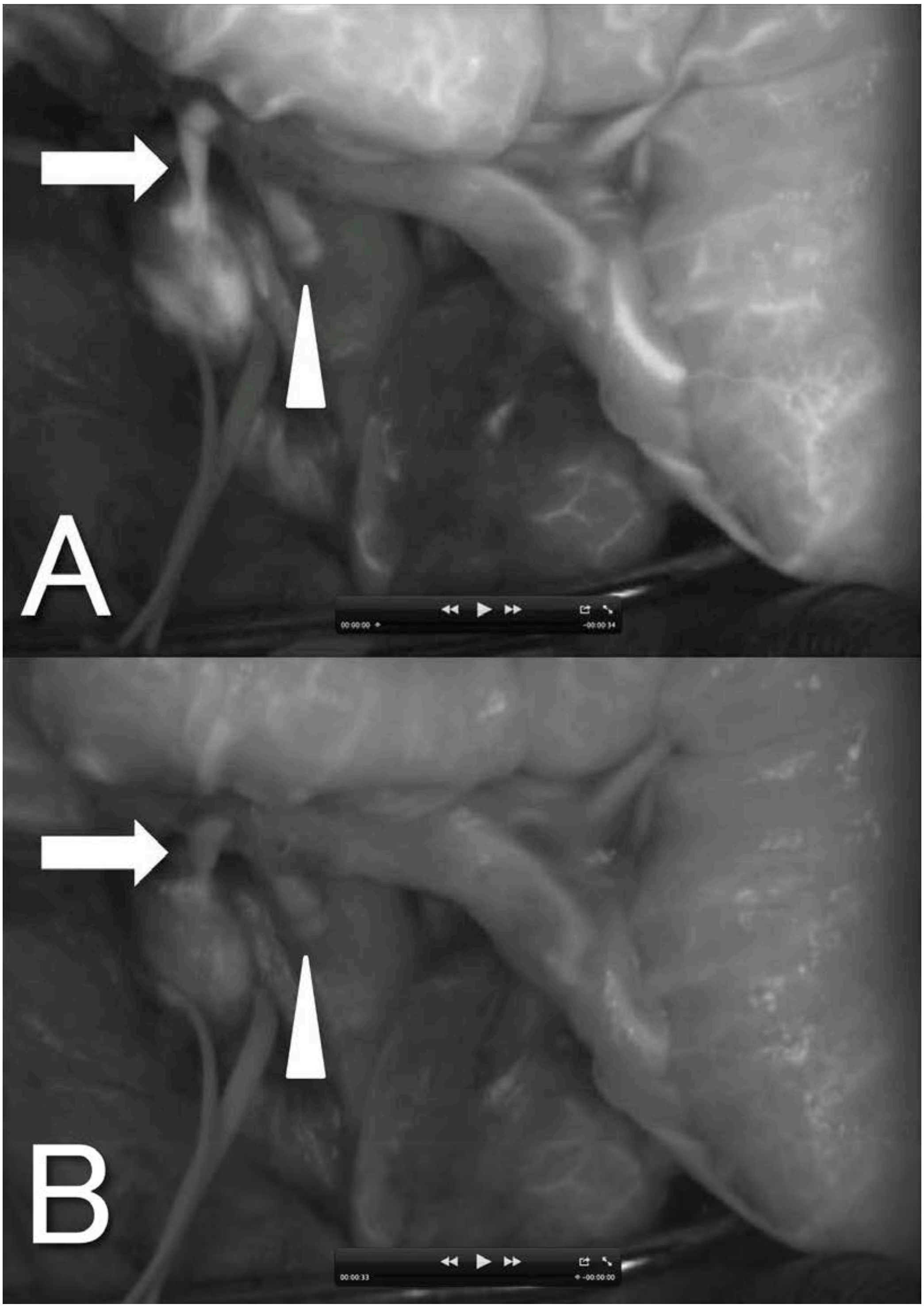

Figure 2