

# Morphometric study of the blood supply of pedunculated colon polyps: What is the optimal position on the stalk for snare resection?

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**Bibliography**

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**Background and study aims:** Bleeding after colonoscopic resection of pedunculated polyps cannot be easily predicted. The aims of this study were to evaluate the blood supply in pedunculated polyps and to clarify the optimal position on the polyp stalk for snare placement to prevent post-polypectomy hemorrhage.

**Patients and methods:** In one institution, 11 pedunculated polyps from 11 patients were studied prospectively. All polyps were resected at the base of the stalk using a snare wire with electrocautery. Histologic axial sections from the apex and base of the stalk were examined with hematoxylin eosin and elastica stains. Elastica stains were used to identify blood vessels. The cross-sectional area of the stalk, total vessel area, maximum diameter of artery/arteriole lumen, number of thick ( $\geq 0.1$  mm) vessels, and number of arter-

ies/arterioles were measured in each section with image processing software. Wilcoxon signed-ranks test was used for comparison.

**Results:** The median polyp diameter was 16 mm (range 7 to 24 mm) and median length of the stalk was 11 mm (range 7 to 23 mm). Two invasive cancers (T1) were included. The maximum diameter of the arterial/arteriolar lumen was greater at the base ( $P=0.0044$ ), whereas the ratio of the vessel area to the cross-section area was greater at the apex ( $P=0.016$ ). The number of thick vessels and arteries/arterioles were equivalent between apex and base.

**Conclusions:** Morphometric study of the blood supply of pedunculated polyps confirmed that the optimal site for the excision of pedunculated polyps is in the middle of the stalk.

## Introduction



Endoscopic polypectomy is a standard technique for treatment of colonic polyps, although it is associated with a risk of complications. The most common complication is hemorrhage after polypectomy [1], and delayed hemorrhage is known to occur in 0.3% to 6.1% of patients [2]. Several factors, including the patient's age, polyp size [3], location [4,5], morphology [6,7] and malignant potential [6], and concomitant anticoagulant therapy [8], are associated with bleeding. In addition, bleeding occurs more often after excision of sessile or pedunculated polyps with a broad stalk [3]. Large pedunculated polyps have larger vessels within the stalk [6].

Several techniques are available to prevent bleeding after colonoscopic polypectomy, including submucosal injection of epinephrine solution in the base of polyp [9], clip closure [10], detachable snare placement around the stalk [11] and development of the electrosurgical device [2]. However, no data are available to indicate the optimal

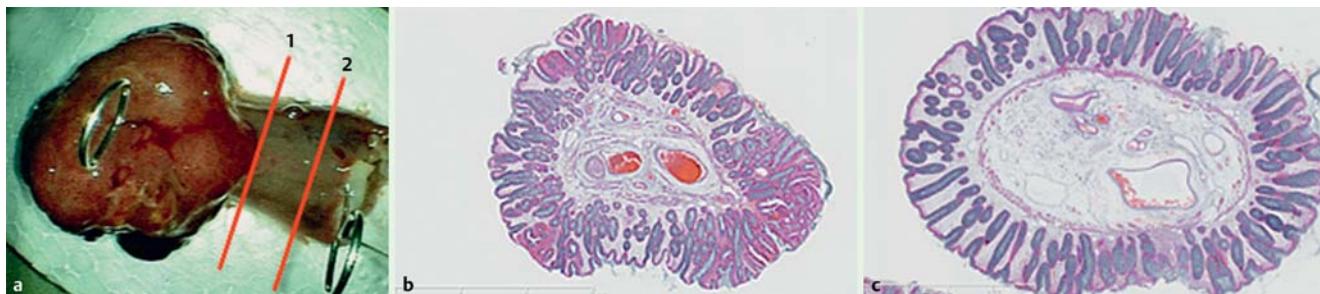
position for snare placement on the stalk to prevent hemorrhage following endoscopic resection of pedunculated polyps.

Pedunculated polypectomy in the middle of the stalk is recommended by experts [12]. Excision away from the head of the polyp is advised to minimize margin involvement in the case of invasive cancer. Conversely, excision at the base of the stalk is not advised due to the potential for perforation. Although these risks form the theoretical basis for conventional recommendations to excise at the middle of the stalk, supporting evidence for this approach is lacking. Information about the blood supply to pedunculated polyps may guide the approach to endoscopic resection. In this study, we conducted a morphometric analysis of the blood supply to the stalk of pedunculated colon polyps. Our goal was to clarify the optimal position on the stalk for snare resection of pedunculated polyps.

**License terms**



**Fig. 1 a** A pedunculated polyp with large head and long stalk in the sigmoid colon. **b** The polyp was resected at the base of the stalk using a snare with electrocautery.



**Fig. 2** **a** Histologic cross-sections from the apex and base of the stalk were obtained from each resected polyp. **b** Hematoxylin eosin stain of the stalk in cross section near the head (**a**, ①). **c** hematoxylin eosin stain of the stalk in cross section near the base (**a**, ②).

## Patients and methods

### Participants

Before study commencement, the local committee on human experimentation approved this study. We conducted a prospective study in a single center. From April 2011 to November 2012, 11 patients with pedunculated polyps (median age 63 years, range: 37 to 87; all male) were enrolled non-consecutively at our academic endoscopy center. Patients whose pedunculated polyps were suspected to have malignant stalk invasion were excluded. Written informed consent to examine the resected specimens was obtained from all patients after colonoscopic resection.

### Endoscopic polypectomy procedure

All patients received bowel preparation with 2 or 3L of polyethylene glycol electrolytic solution (Niflec: Ajinomoto, Tokyo, Japan). To minimize damage from electrocautery and allow precise evaluation of the histology of the stalk, polypectomy was carried out using thin snare wires (0.3 mm diameter, SD-230U-25, Olympus, Tokyo) without submucosal injection. All polyps were resected using electrocautery with the ICC 200 electrosurgical generator (ERBE, Tübingen, Germany): Endocut, effect 3 (output limit 120W). All polyps were resected at the base of the stalk. An example endoscopic image is shown in **Fig. 1**. All resected specimens were pinned immediately after resection on a board (**Fig. 2**). Before formalin fixation, the maximum diameter of the polyp head, the maximum diameter of the stalk, and the length of the stalk were measured with calipers.

### Histologic examination

All resected polyps were fixed and embedded in paraffin. Axial sections from the head and base of all stalks were obtained and stained with hematoxylin/eosin and elastica (**Fig. 3**). Arteries and arterioles were defined as blood vessels possessing the inter-

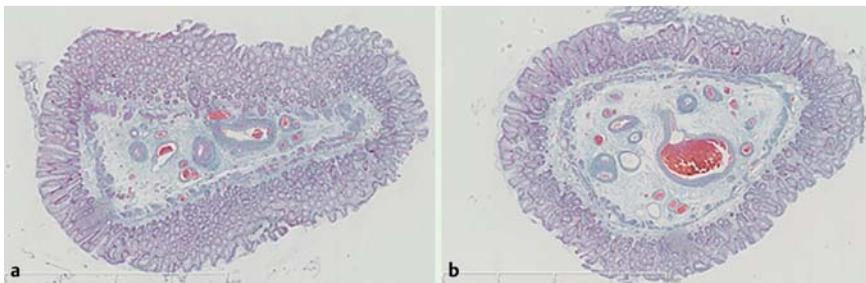


**Fig. 3** The cross-sectional area of the stalk. **a** maximum diameter of arteriole lumen. **b** and number of the vessels measuring 0.1 mm or greater **c** were measured with image processing software (Image J).

nal elastic membrane of the intima, identified with elastica stains. To discriminate lymphatic channels from blood vessels, D2–40 stains were performed on the first three cases. However, very few lymphatic vessels were recognizable in sections. Therefore, in this study, all vessels are defined as blood vessels.

### Image analyses

All histologic images were processed with a virtual pathology system (Nanoozoomer digital pathology, Hamamatsu photonics, Japan). The cross-sectional area of the stalk, total vessel area, number of vessels measuring  $\geq 0.1$  mm, number of arteries/arterioles (possessing internal elastic membrane), and maximum diameter of arteries/arterioles lumen were measured with image processing software (Image J [13]). The cross-sectional area of the stalk was defined as the area excluding the epithelial layer (**Fig. 4**).



**Fig. 4** **a** Cross-sectional area of the stalk apex. **b** Cross-sectional area of the stalk base. Two different sections from the same polyp are shown. The maximum diameter of the arteries/arterioles lumen in the base is greater than that of the apex. In contrast, the ratio of the vessels to the cross section is greater in the apex than the base. However, the vessel area, number of vessels, and number of arteries/arterioles are equivalent between the apex and base.

**Table 1** Characteristics of 11 polyps

Polyp	Location	Maximum diameter of the head (mm)	Maximum diameter of the stalk (mm)	Length of the stalk (mm)	Histology
1	Sigmoid	15	12	13	Cancer in situ, tub2 <sup>1</sup>
2	Sigmoid	12	9	11	tubular adenoma, high-grade
3	Sigmoid	24	12	8	T1 <sup>2</sup> , tub1 <sup>3</sup>
4	Sigmoid	20	5	12	Tubular adenoma, high-grade
5	Sigmoid	16	12	8	T1 <sup>2</sup> , tub1 <sup>3</sup>
6	Ascending	7	5	7	Tubular adenoma, low-grade
7	Ascending	10	10	12	Tubular adenoma, low-grade
8	Sigmoid	18	7	11	Tubular adenoma, low-grade
9	Sigmoid	14	7	8	Tubulovillous adenoma
10	Sigmoid	22	13	9	Traditional serrated adenoma
11	Ascending	16	7	16	Cancer in situ, tub1 <sup>3</sup>

<sup>1</sup> moderately differentiated type tubular adenocarcinoma

<sup>2</sup> tumor invading submucosal layer

<sup>3</sup> well-differentiated type tubular adenocarcinoma

**Table 2** Comparison between apex and base

	Apex		Base		<b>P-value</b>
	Median	Range	Median	Range	
Cross-section area (mm <sup>2</sup> )	7.89	0.74–23.0	10.31	1.54–26.5	<b>0.0099</b>
Vessel area (mm <sup>2</sup> )	1.58	0.14–4.10	1.07	0.19–3.78	0.72
Ratio of CSA <sup>1</sup> to vessel area	0.18	0.07–0.30	0.13	0.07–0.24	<b>0.016</b>
No. of vessels ( $\geq 0.1$ mm)	43	12–72	43	15–86	0.96
No. of arteries/arterioles	3	1–	3	2–	0.37
Maximum size of arteriole (mm)	0.48	0.08–1.53	0.74	0.15–1.66	<b>0.0044</b>

Significant P-values are expressed in bold.

<sup>1</sup> cross-section area.

## Statistics

The cross-sectional area of the stalk, total vessel area, number of vessels measuring  $\geq 0.1$  mm, number of arteries/arterioles and maximum diameter of arteries/arterioles lumen were compared between the apex and base of the stalk, using the Wilcoxon signed-ranks test. The ratio of total vessel area to cross-sectional area also was analyzed. The criterion for statistical significance was  $P < 0.05$ . All statistical analyses were performed with Stata 11.0 (Stata Corp., TX, USA).

## Results



Characteristics of the polyps in the 11 patients studied are shown in **Table 1**. Eight polyps were located in the sigmoid colon and three in the ascending colon. The median size of the polyp head was 16 mm (range 7–24 mm) and median stalk length was 11 mm (range 7–23 mm). Two of the polyps were

T1-stage cancers (submucosal invasion depth: 950  $\mu$ m and 1000  $\mu$ m), and were included in the analyses.

**Table 2** shows findings for the cross-sectional area of the stalk, total vessel area, number of vessels measuring  $\geq 0.1$  mm, number of arteries/arterioles, and maximum diameter of arteries/arterioles lumen. The cross-sectional area was greater at the base than the apex of the stalk (10.31 mm<sup>2</sup> vs. 7.89 mm<sup>2</sup>;  $P=0.01$ ), as was the maximum luminal diameter of stalk arteries/arterioles (0.74 mm vs 0.48 mm;  $P=0.004$ ). In contrast, the ratio of vessel area to the cross-sectional area was greater in the apex than in the base (0.18 vs. 0.13;  $P=0.016$ ). There was no statistical difference between the apex and the base in total vessel area, number of the vessels measuring  $\geq 0.1$  mm, and number of arteries/arterioles. In subgroup analysis by location, significant differences in cross-sectional area of the stalk and the maximum luminal diameter of stalk arteries/arterioles persisted only in polyps from the sigmoid colon and not those in the ascending colon, although the sample size was limited.

## Discussion

To our knowledge, the microscopic blood supply of the stalk of pedunculated colon polyps has been the focus of limited study. Because it is challenging to evaluate the quantity of blood supply in real time, we chose instead to investigate the histology of the vessels in the stalk. The density, diameter, and morphology of the vessels were used as surrogate markers for blood supply. We searched PubMed using the terms “pedunculated polyp” and “blood supply” and found only one report on this issue. Dobrowolski et al. studied perpendicular sections of the mucosal surface to assess microscopic blood supply [6]. That approach might not be sufficient for morphometric study of vessel number and diameter because the vessels run longitudinally in the stalk. In contrast, we used axial sections of the stalks, easily identifying the exact number of vessels, as well as the maximum diameter of the vessels on a pathology slide. Indeed, the number of vessels measuring  $\geq 100 \mu\text{m}$  was much higher in our study using axial section, compared with Dobrowolski and colleagues’ study, which used longitudinal section (15–86 vs. 1–4 at the base of the stalk).

Our study has shown that the total vessel area, number of vessels measuring  $\geq 100 \mu\text{m}$ , and number of arteries/arterioles did not differ between the apex and the base of the stalk. Our results suggest that the stalk position for snare resection of pedunculated colon polyps is not relevant for prevention of hemorrhage after resection. Nevertheless, oncologic aspects are important, because our 11 polyps included two invasive cancers. Although resection close to the polyp head is safer for avoiding perforation, a sufficient margin is required to achieve complete resection of invasive cancer. Therefore, resection close to the head is not optimal from an oncologic perspective.

It is our practice to primarily apply prophylactic clipping after resection of pedunculated polyps to fully close the resection site on the stump of the residual stalk. In our experience, with delayed bleeding after pedunculated polyp resection, bleeding occurs at the edge of the stump. Our series has shown that the stalk contains a far higher number of vessels than previously expected. Accordingly, complete closure by clipping may be ideal for eradication of delayed bleeding, even though it can be more difficult to achieve technically. Stalk vessel number may explain the lower reported efficacy of prophylactic clipping after polypectomy.[10, 14, 15]

There are acknowledged limitations to our study. Its small size limits the generalizability of the results. Despite that, we believe that the information presented here regarding the blood supply of pedunculated polyps is useful to colonoscopists.

In conclusion, morphometric study of the blood supply of pedunculated polyps confirmed that the optimal site for excision of pedunculated polyps is in the middle of the stalk, as recommended by experts. [12] In addition, our findings that the stalk contains a greater number of vessels than previously expected may explain why delayed bleeding can occur even after prophylactic clipping.

**Competing interests:** None

## Institutions

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