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# The importance of compression time in stapled hemorrhoidopexy: is patience a virtue?

Byung Eun Yoo, Wook Ho Kang, Yong Teak Ko, Young Chan Lee, Cheong Ho Lim

Department of Surgery, Yang Hospital, Namyangju, Korea

**Purpose:** The aim of this study was to evaluate whether longer compression time before firing the stapler reduced the postoperative complications related to staple line formation in stapled hemorrhoidopexy.

**Methods:** This retrospective case-control study was conducted at a colorectal-anal specialty hospital. Consecutive patients with grades III and IV hemorrhoids who underwent stapled hemorrhoidopexy between January 2016 and November 2019 were included. According to the compression time, patients were assigned to the long compression time group (2 minutes) or the typical compression time group (30 seconds). The primary outcome measure was incidence of staple line complications such as dehiscence, bleeding, and stenosis.

**Results:** A total of 348 patients treated with stapled hemorrhoidopexy were evaluated. Seventy-three and 275 patients were included in the long compression time group and the typical compression time group, respectively. No significant differences were observed in patient characteristics between the groups. However, additional procedures were performed more frequently in the typical compression time group (78.1% vs. 92.0%, P = 0.001). Bleeding occurred more frequently in the typical compression time group (1.4% vs. 8.4%, P = 0.030). The rates of dehiscence and stenosis were not significantly different between the groups. Fecal urgency developed more frequently in the typical compression time group (0% vs. 5.1%, P = 0.040). In logistic regression analysis, typical compression time (30 seconds) was the only risk factor for bleeding (odds ratio, 8.496; P = 0.040).

**Conclusion:** Longer compression time was associated with a decreased incidence of postoperative bleeding after stapled hemorrhoidopexy.

**Keywords:** Hemorrhoids; Hemorrhoidopexy; Postoperative complications

## INTRODUCTION

In 1998, Antonio Longo [1] presented stapled hemorrhoidopexy (SH) as an alternative method to conventional hemorrhoidectomy. This procedure restores the hemorrhoidal tissue back to its anatomic position, preserves the physiologic anal cushion for anal continence, and interrupts the superior hemorrhoidal vessels. A large number of randomized trials have reported that SH has shorter operative time, less postoperative pain, and earlier return to normal activities when compared with conventional hemorrhoidectomy [2–4]. However, failure of optimal stapling may result in staple line complications such as dehiscence, bleeding, and stenosis.

Most modern staplers bend each staple into a B-shaped form, which helps secure the tissue in place. Tissue thickness and compressibility can affect the B-shaped staple formation of the staple

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Correspondence to: Byung Eun Yoo, MD, PhD
Department of Surgery, Yang Hospital, 933 Gyeongchun-ro, Namyangju 12234, Korea
Email: Dr.yoo@hotmail.com

line. The hemorrhoidal tissue is highly compressible while stapling, as hemorrhoids are submucosal cushions of highly vascular tissue. However, in grades III and IV hemorrhoids, the higher bulk of the hemorrhoidal tissue prevents the staple from forming a B-shape. Nakayama et al. [5] showed a relationship between tissue compression time and acceptable B-shaped staple formation in stomach tissue. They assumed that the tissue was compressed gradually and became thinner during the compression time. In the present study, we aimed to evaluate whether compression time before firing the stapler affected postoperative dehiscence, bleeding, and stenosis caused by unacceptable staple formation.

## METHODS

The present study was approved by the Institutional Review Board of Yang Hospital (No. 196452-HR-00010). The requirement for obtaining informed consent was waived.

Between January 2016 and November 2019, consecutive patients who underwent SH at Yang Hospital (Namyangju, Korea) were retrospectively evaluated. Patients who were not followed up for more than a month were excluded from this study. According to compression time, patients were divided into 2 groups (long compression time and typical compression time). Before surgery, clinical history of all patients was carefully obtained. All patients underwent inspection, digital examination, and proctoscopy. The indications for SH were grades III and IV prolapsed hemorrhoids. SH was not performed in patients with a narrow anal canal, active anorectal abscess, or full-thickness rectal prolapse. Antiplatelet drugs and anticoagulants were discontinued for several days before the surgery according to a specialist's opinion.

All SH procedures were performed by 4 certified colorectal surgeons. Patients were operated in a jack-knife position under spinal anesthesia. Depending on the diameter of the anal canal and the volume of the hemorrhoidal tissue, a suitable circular stapler (CPH 32, CPH 34, or CPH 34HV; Frankenman International Ltd) was selected. The circular anal dilatator and inner lining were introduced after manual reduction of the prolapsed hemorrhoids. After correct placement of the anal dilatator, a purse-string suture was applied at least 2 cm above the apex of the hemorrhoids. The suture was then tied to the stapler shaft. For hemostasis, the stapler was kept closed for a while before firing. One surgeon (BEY) closed the stapler for 2 minutes before firing, while 3 surgeons (YTK, YCL, WHK) closed the stapler for 30 seconds. In all female patients, the vaginal wall was assessed to ensure that it was not entrapped in the stapler ring. To promote hemostasis, the stapler was closed for 20 seconds again after firing. After the stapler was opened and removed, the excision area was inspected for bleeding points. Bleeding points were either cauterized with diathermy or ligated with sutures. Any residual skin tags were excised after the procedure. Patients were discharged 2 days after the surgery. Patients were routinely assessed by the surgeons at 1, 2, 3, 4, and 8 weeks after the surgery.

Patients' medical records were reviewed in detail to determine the incidence of postoperative complications. Bleeding was defined as clinically overt bleeding requiring reoperation or conservative treatment after SH. Early bleeding was defined as bleeding that occurred within 48 hours after SH and late bleeding was defined as bleeding that occurred after 48 hours following SH. Stenosis was defined as narrowing of the staple line, which required reoperation or finger dilatation. Obstructive defecation was defined as difficulty in evacuation or emptying the rectum after 1 month following SH. Fecal urgency was defined as the sudden need to rush to the bathroom to empty one's bowels more than 1 month after SH. Urinary retention was defined as the inability to urinate, which required bladder catheterization after SH. Delayed wound healing was defined as presence of a nonhealing wound for up to 1 month after SH.

Statistical analysis was performed using IBM SPSS Statistics ver. 20.0 (IBM Corp). Quantitative variables were presented as median (range) and were compared using Mann-Whitney U-test or Student t-test. Qualitative variables were expressed as proportions and were analyzed using Fisher exact test or chi-square test. Multivariate logistic regression analysis was used to control for confounding effects on risk factors for staple line complications. Confidence intervals were estimated at 95% and the significance level was set at a P-value of 0.05.

## RESULTS

Among 4,680 consecutive patients who underwent hemorrhoidectomy during the study period, 362 patients underwent SH. After excluding 14 patients who were not followed up for more than 1 month, 348 patients were included in the present study. Seventy-three and 275 patients were divided into the long compression time group (2 minutes) and the typical compression time group (30 seconds), respectively. Age, sex, American Society of Anesthesiologists (ASA) physical status (PS) classification, history of anal surgery, use of antiplatelet drugs and anticoagulants, grade of hemorrhoids, hemostatic suture of staple line during SH, and hospital stay were not significantly different between the groups (Table 1). Additional procedures including excision of the residual skin tags were performed more frequently in the typical compression time group (78.1% vs. 92.0%, P = 0.001). Two patients from the long compression time group and 13 patients from the typical

**Table 1.** Patient characteristics (n = 348)

| Characteristic | Long compression time group (n = 73) | Typical compression time group (n = 275) | P-value |
|---|---|---|---|
| Age (yr) | 50 (28–83) | 48 (19–91) | 0.900 |
| Sex | | | 0.750 |
| Male | 32 (43.8) | 115 (41.8) | |
| Female | 41 (56.2) | 160 (58.2) | |
| ASA PS classification | | | 0.290 |
| I | 58 (79.5) | 214 (77.8) | |
| II | 13 (17.8) | 59 (21.5) | |
| III | 2 (2.7) | 2 (0.7) | |
| History of anal surgery | 10 (13.7) | 35 (12.7) | 0.820 |
| Use of antiplatelet drugs and anticoagulants | 4 (5.5) | 21 (7.6) | 0.520 |
| Hemorrhoid grade | | | 0.850 |
| III | 55 (75.3) | 210 (76.4) | |
| IV | 18 (24.7) | 65 (23.6) | |
| Hemostatic suture of staple line during SH | 56 (76.7) | 187 (68.0) | 0.140 |
| Additional procedure | 57 (78.1) | 253 (92.0) | 0.001 |
| Excision of residual skin tags | 56 (76.7) | 247 (89.8) | 0.003 |
| Fistulotomy | 1 (1.4) | 9 (3.3) | 0.690 |
| Fissurectomy | 2 (2.7) | 10 (3.6) | > 0.999 |
| Hospital stay (day) | 3 (2–7) | 3 (2–18) | 0.100 |

Values are presented as median (range) or number (%).
ASA, American Society of Anesthesiologists; PS, physical status; SH, stapled hemorrhoidopexy.

**Table 2.** Postoperative complications (n = 348)

| Complication | Long compression time group (n = 73) | Typical compression time group (n = 275) | P-value |
|---|---|---|---|
| Bleeding | 1 (1.4) | 23 (8.4) | 0.030 |
| Early | 1 (1.4) | 14 (5.1) | 0.210 |
| Late | 0 (0) | 10 (3.6) | 0.120 |
| Treatment of bleeding | | | |
| Conservative | 0 (0) | 13 (4.7) | 0.070 |
| Operative | 1 (1.4) | 10 (3.6) | 0.470 |
| Location of bleeding | | | |
| Staple line | 1 (1.4) | 10 (3.6) | 0.470 |
| Unknown | 0 (0) | 13 (4.7) | 0.070 |
| Dehiscence of the staple line | 0 (0) | 5 (1.8) | 0.580 |
| Stenosis of the staple line | 0 (0) | 12 (4.4) | 0.070 |
| Obstructive defecation | 0 (0) | 12 (4.4) | 0.070 |
| Fecal urgency | 0 (0) | 14 (5.1) | 0.040 |
| Delayed wound healing | 1 (1.4) | 14 (5.1) | 0.210 |
| Local infection | 0 (0) | 1 (0.4) | > 0.999 |
| Urinary retention | 2 (2.7) | 7 (2.5) | > 0.999 |

Values are presented as number (%).

compression time group underwent 2 additional procedures at the same time.

Postoperative complications are described in Table 2. In all postoperative bleeding cases, bleeding developed within 12 days after the surgery. Bleeding occurred in 1 patient (1.4%) in the long compression time group and in 23 patients (8.4%) in the typical compression time group (P = 0.030). One patient in the typical compression time group developed bleeding twice (in the early stage and in the late stage). One patient in the long compression time group was treated with suture ligation of staple line bleeding. In the typical compression time group, 10 patients (3.6%) underwent surgery for postoperative bleeding. In all these patients, the location of bleeding was the staple line. Fecal urgency developed more frequently in the typical compression time group (0% vs. 5.1%, P = 0.040). The rates of dehiscence, stenosis, obstructive defecation, delayed wound healing, local infection, and urinary retention were not significantly different between the groups. None of the patients complained of fecal incontinence.

Among staple line complications such as dehiscence, bleeding, and stenosis, bleeding was significantly more common in the typical compression time group. Therefore, logistic regression analysis was performed to identify the risk factors for bleeding (Table 3). Age, sex, ASA PS classification, history of anal surgery, use of antiplatelet drugs and anticoagulants, grade of hemorrhoids, hemostatic suture of staple line during SH, and additional procedures were not significant risk factors for bleeding. Thirty seconds of compression (typical compression time) was the only risk factor for bleeding in the present study (odds ratio, 8.496; P = 0.04).

## DISCUSSION

To promote hemostasis during SH, it is usually recommended to wait for 30 to 60 seconds after completely closing the instrument before firing the stapler. However, studies regarding compression time during SH are scarce. Kawada et al. [6] reported that sufficient compression before firing the stapler reduced early anastomotic leakage in low anterior resection with the double-stapling technique. They secured intervals of more than 30 seconds before each firing of the linear stapler and intervals of more than 2 minutes before the firing of the circular stapler. Therefore, since January 2016, a surgeon (BEY) at our hospital has closed the stapler for 2 minutes before firing to reduce the complications associated with failed stapling.

Hemorrhoids are cushions of specialized and highly vascular tissue found within the anal canal in the submucosal space [7]. The hemorrhoidal tissues are primarily made up of liquid compo-


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**Table 3.** Risk factors for bleeding (n = 348)

| Risk factor | No bleeding (n = 324) | Bleeding (n = 24) | Odds ratio (95% CI) | P-value |
|---|---|---|---|---|
| Age (yr) | | | | |
| < 49 | 165 (92.7) | 13 (7.3) | 1 | - |
| ≥ 49 | 159 (93.5) | 11 (6.5) | 0.643 (0.240–1.724) | 0.380 |
| Sex | | | | |
| Male | 133 (90.5) | 14 (9.5) | 1 | - |
| Female | 191 (95.0) | 10 (5.0) | 0.538 (0.226–1.279) | 0.160 |
| ASA PS classification | | | | |
| I | 255 (93.8) | 17 (6.3) | 1 | - |
| II, III | 69 (90.8) | 7 (9.2) | 1.992 (0.666–5.957) | 0.210 |
| History of anal surgery | | | | |
| No | 283 (93.4) | 20 (6.6) | 1 | - |
| Yes | 41 (91.1) | 4 (8.9) | 1.557 (0.480–5.054) | 0.460 |
| Use of antiplatelet drugs and anticoagulants | | | | |
| No | 300 (92.9) | 23 (7.1) | 1 | - |
| Yes | 24 (96.0) | 1 (4.0) | 0.361 (0.041–3.195) | 0.360 |
| Hemorrhoid grade | | | | |
| III | 245 (92.5) | 20 (7.5) | 1 | - |
| IV | 79 (95.2) | 4 (4.8) | 0.751 (0.232–2.432) | 0.630 |
| Hemostatic suture of staple line during SH | | | | |
| No | 100 (95.2) | 5 (4.8) | 1 | - |
| Yes | 224 (92.2) | 19 (7.8) | 1.812 (0.642–5.116) | 0.260 |
| Additional procedures | | | | |
| No | 34 (89.5) | 4 (10.5) | 1 | - |
| Yes | 290 (93.5) | 20 (6.5) | 0.409 (0.119–1.404) | 0.150 |
| Compression time | | | | |
| Long time | 72 (98.6) | 1 (1.4) | 1 | - |
| Typical time | 252 (91.6) | 23 (8.4) | 8.496 (1.078–66.931) | 0.040 |

Values are presented as number (%).
CI, confidence interval; ASA, American Society of Anesthesiologists; PS, physical status; SH, stapled hemorrhoidopexy.

nents rather than solid components. This fact is important in SH, as the pressure applied to the bulky hemorrhoidal tissue displaces the liquid component, resulting in compression and elongation of the solid component [8]. Ideal compression time will result in optimal tissue thickness, ensuring that the staple line will be intact without the development of unacceptable staple formation. Moreover, stapling the bulky hemorrhoidal tissue after sufficient elongation resulting from ideal compression time can prevent tissue shearing at the staple line, a complication that can lead to injury requiring immediate repair and subtle damage that is not recognized until the staple line complications arise. In the present study, dehiscence of the staple line developed in 5 patients from the typical compression time group, while no patient from the long compression time group developed staple line dehiscence. However, the difference between the groups was not statistically significant. Two out of these 5 patients (40.0%) developed postoperative bleeding despite immediate suture reinforcement of the dehiscence site during SH.

In the present study, postoperative bleeding rate was significantly higher in the typical compression time group. In 13 out of 23 patients (56.5%) from the typical compression time group, the location of bleeding was not identified. Since bleeding from the excision site of the residual skin tags was relatively easy to detect through bedside physical examination, it is assumed that most of the bleeding from unknown origin occurred at the staple line. Sakran et al. [9] reported that creation of gastrojejunal anastomosis using a circular stapler of smaller height significantly reduced the bleeding rate. They assumed that shorter staple height provided more compression of the tissues and hence, should potentially result in better hemostasis. Longer compression time allows the staple to form a tighter B-shape, which has been associated with decreased bleeding at the staple line. In addition, longer compression time reduces bleeding caused by tissue shearing at the staple line.

The etiology of anastomotic stenosis is not completely understood, but it is likely to be multifactorial. An experimental study indicated that stapled anastomosis heals by secondary intention, as the mucosa of the intestine is not in apposition but is separated

by the inverted layers of muscle and serosa [10]. Therefore, stapled anastomosis predictably forms a circular scar, which results in narrowing of the intestinal lumen. Moreover, mucosal defects caused by tissue shearing and dehiscence can lead to narrowing of the staple line [11]. It is widely believed that anastomotic ischemia and pelvic sepsis play an important role in stenosis [12, 13]. However, SH is not associated with local ischemia and none of the patients in the present study developed pelvic sepsis. Although the rate of stenosis was not significantly different between the groups, stenosis was observed in 12 patients (4.4%) from the typical compression time group. This finding may be due to the more frequent occurrence of unacceptable staple formation and tissue shearing in the typical compression time group.

Salvioli et al. [14] observed a direct association between rectal compliance and the sensation of urgency, suggesting that patients with a stiff or less compliant rectum had reduced rectal sensitivity. In the present study, incidence of fecal urgency was significantly more in the typical compression time group. Inflammatory changes and scarring at the site of the anastomosis due to unacceptable staple formation and tissue shearing can result in decreased rectal compliance, which leads to fecal urgency.

The present study has some limitations. The study was retrospective in nature. To minimize bias resulting from retrospective chart review, we defined study variables that needed to be abstracted from the medical records before performing the study and used template abstraction forms. Moreover, medical records are accurate in clinically important events such as bleeding, stenosis, and dehiscence. Patients were divided into 2 groups according to the different compression times by a single surgeon (BEY). Although all 4 surgeons were well experienced in anorectal surgery and surgical indications for SH were consistent in our hospital, selection bias and confounding factors were inevitable. Excision of the residual skin tags was performed more frequently in the typical compression time group according to surgeons' preference. To control for confounding factors associated with bleeding, logistic regression analysis was performed. The only risk factor for bleeding was typical compression time (30 seconds).

In conclusion, longer compression time before firing requires more patience during SH. Therefore, it is necessary to evaluate whether longer compression time can reduce postoperative complications. The present study showed that postoperative bleeding and fecal urgency after SH were significantly decreased in the long compression time group. In addition, compression for 2 minutes reduced the risk of postoperative bleeding in the multivariate analysis. Further studies including prospective randomized controlled studies are required to overcome the limitations of the present study and to determine the optimal compression time.

## ARTICLE INFORMATION

### Conflict of interest

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

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None.

### Author contributions

Conceptualization: BEY; Data curation: BEY, WHK, YTK, YCL; Formal analysis: BEY, WHK, CHL; Investigation: BEY, YTK; Methodology: BEY, WHK, CHL; Project administration: BEY, CHL; Supervision: BEY; Validation: BEY, CHL; Writing–original draft: BEY; Writing–review & editing: all authors. All authors read and approved the final manuscript.

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