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**Risk factors for proximal migration of biliary tube stents**

Kawaguchi Y *et al.* Risk factors for biliary stent migration

Yoshiaki Kawaguchi, Masami Ogawa, Yohei Kawashima, Hajime Mizukami, Atsuko Maruno, Hiroyuki Ito, Tetsuya Mine

**Yoshiaki Kawaguchi, Masami Ogawa, Yohei Kawashima, Hajime Mizukami, Atsuko Maruno, Hiroyuki Ito, Tetsuya Mine,** Department of Gastroenterology, Tokai University School of Medicine, Isehara 259-1193, Japan

**Author contributions:** Kawaguchi Y contributed mainly to this work; Kawaguchi Y designed research; Kawaguchi Y, Ogawa M, Kawashima Y, Mizukami H, Maruno A and Ito H performed research; Kawaguchi Y and Mine T analyzed data; Kawaguchi Y wrote the paper.

**Correspondence to:** **Yoshiaki Kawaguchi, MD, PhD,** Department of Gastroenterology, Tokai University School of Medicine, 143 Shimokasuya, Isehara 259-1193, Japan. y711kawa@is.icc.u-tokai.ac.jp

**Telephone:** +81-463-931121 **Fax:** +81-463-937134

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**Abstract**

**AIM**: To analyze the risk factors for stent migration in patients with benign and malignant strictures.

**METHODS**: Endoscopic stent placement was performed in 396 patients with bile duct stenosis, at our institution, between June 2003 and March 2009. The indications for bile duct stent implantation included common bile duct stone in 190, malignant lesions in 112, chronic pancreatitis in 62, autoimmune pancreatitis in 14, trauma in 8, surgical complications in 6, and primary sclerosing cholangitis (PSC) in 4 patients. We retrospectively examined the frequency of stent migration, and analyzed the patient factors (disease, whether endoscopic sphincterotomy was performed, location of bile duct stenosis, and diameter of the bile duct), and stent characteristics (duration of stent placement, stent type, diameter, and length). Moreover, we investigated retrieval methods for migrated stents and their associated success rates.

**RESULTS**: The frequency of tube stent migration in the total patient population was 3.5%. The cases wherein tube stent migration occurred included cases with common bile duct stones (3/190; 1.6%), malignant lesions (2/112; 1.8%), chronic pancreatitis (4/62; 6.5%), autoimmune pancreatitis (2/14; 14.3%), trauma (1/8; 12.5%), surgical complications (2/6; 33.3%), and PSC (0/4; 0%). The potential risk factors for migration included bile duct stenosis secondary to benign disease such as chronic pancreatitis and autoimmune pancreatitis (*P* = 0.030); stenosis of the lower bile duct (*P* = 0.031); bile duct diameter > 10 mm (*P* = 0.023); duration of stent placement > 1 mo (*P* = 0.007); use of straight-type stents (*P* < 0.001); and 10-Fr sized stents (*P* < 0.001). Retrieval of the migrated stents was successful in all cases. The grasping technique, using a basket or snare, was effective for pig-tailed or thin and straight stents, whereas the guidewire cannulation technique was effective for thick and straight stents.

**CONCLUSION:** Migration of tube stents within the bile duct is a rare but possible complication, and it is important to determine the risk factors involved in stent migration.

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**Key words:** Migration; Endoscopic biliary stent; Risk factor; ERCP; Retrieval

**Core tip:** Endoscopic biliary stenting with a tube stent have become an accepted therapy for biliary obstruction due to malignant or benign disease. However stent migration occurs in about 5%–10% of patients undergoing biliary stenting. Therefore it is important to know the factors affecting biliary tube stent migration that have not yet been clear. We retrospectively examined endoscopic stent placement performed for 396 bile duct stenosis at our institution, and analyzed the frequency of stent migration and the risk factor (patient factors disease, endoscopic sphincterotomy, location of stenosis, diameter of bile duct) and stent factors (duration of placement, type, diameter, length).

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**INTRODUCTION**

Endoscopic biliary stenting using a tube stent is currently a well-accepted therapy for biliary obstruction developing secondary to malignant or benign disease[1]. The complication rate associated with biliary stent use reportedly ranges from 8% to 10%[2-4], and the described complications include cholangitis, cholecystitis, duodenal perforation, bleeding, pancreatitis, stent fracture, proximal stent migration, distal stent dislocation, and stent occlusion resulting in recurrent biliary obstruction[5-16]. Stent migration is a rare complication associated with biliary stenting[11,17,18]. Most tube stents are pig-tailed shaped with flaps at each end, to prevent proximal or distal migration. However, stents may migrate proximally or distally as a late complication of endoscopic stenting in approximately 5%–10% of patients who have undergone biliary stenting[19]. Proximal stent migration can cause biliary obstruction and cholangitis, thus requiring retrieval or re-stenting. Therefore, it is important to determine the factors influencing biliary tube stent migration that have not yet been documented. A few studies in the literature have reported on the risks of stent migration[17]. Johanson *et al*[17] reported that stent migration occurs in cases of cholangiocarcinoma, larger diameter stents, and short stents. In addition, they concluded that the reason for migration was malignant stricture of the bile duct or-in cases of benign disease-advancement of a stricture that was previously present. In addition, the presence of multiple stents, a broken stent, and differences in physical constitution are proposed as factors causing stent migration. The retrieval of migrated stents is technically challenging, but may usually be achieved endoscopically, by using forceps, snare, or balloon technique, and rarely requires surgical intervention[18,20-22]. In the present study, we aimed to determine the frequency of biliary stent migration; analyze the risk factors for proximal stent migration; and describe the methods used for retrieval of migrated stents.

**MATERIALS AND METHODS**

***Patients***

Between June 2003 and March 2009, endoscopic stent placement was performed in 396 patients with bile duct stenosis at our institution. The diseases requiring bile duct stenting included common bile duct stones in 190, malignant lesions in 112, chronic pancreatitis in 62, autoimmune pancreatitis in 14, trauma in 8, surgical complications in 6, and PSC in 4 patients (Table 1).

***Endoscopic therapy***

Endoscopic retrograde cholangiopancreatography (ERCP) was performed using a JF-240, JF-260V, or TJF-260V unit (Olympus Medical Systems Corp., Tokyo, Japan) with the patient under conscious sedation with diazepam and pethidine. We attempted to place a guidewire (JagwireTM High Performance Guidewire, Boston Scientific Corp., Natick MA, United States) across the stenotic lesion. After the guidewire was successfully placed across the stenotic lesion, intraductal ultrasonography, brushing cytology, bile juice cytology, and biopsy were performed to diagnose the disease on a case-by-case basis.

***Dilation of stenosis***

In the case of severe stenosis, the stenotic lesions were dilated with a dilation catheter (6-, 7-, or 9-Fr, Soehendra Biliary Dilation Catheter, Cook Medical., Bloomington, IN, United States) or a dilation balloon catheter (diameter: 6 mm, length: 2 cm; Hurricane TM RX Balloon Dilation Catheter, Boston Scientific Corp., Natick MA, United States).

***Bile duct stenting***

After dilation, a pig-tail shaped (Cook Medical., Bloomington, IN, United States) or a straight stent (Double layer stent, Olympus Medical Systems Corp., Tokyo, Japan) was implanted in the stenotic lesion; the stents included 7- or 10-Fr polyethylene stents with multiple side holes.

A bile duct stent was implanted to drain the bile juice and dilate the stenotic lesions of the bile duct. In cases involving common bile duct stones, a temporary stent was implanted in cases with residual stones, and residual stone removal was postponed until the next procedure.

***Stent migration***

We have defined stent migration in the present study as proximal migration of the stent into the bile duct.

***Retrieval of migrated stents***

We retrieved the migrated stents by using a basket catheter (4 wires, 8 wires), snare catheter, rat-toothed forceps, biopsy forceps, balloon catheter, or stent retriever.

***Study items***

We retrospectively examined the frequency of stent migration, and analyzed the patient factors (disease, whether EST was performed, location of bile duct stenosis, diameter of the bile duct) and stent factors (duration of stent placement, stent type, diameter, and length). We also investigated the retrieval methods for migrated stents and their success rates.

***Statistical analysis***

Results were expressed as means or as a percentage of the total number of patients. The Mann-Whitney U test and the chi square test were used to compare differences between the 2 groups. Statistically, a P value of less than 0.05 was considered to be significant. All analyses were performed using statistical software (Stat View Ver.5.0, SAS Institute, Cary, NC, United States).

**RESULTS**

***Frequency of stent migration***

The frequency of stent migration was 3.5% (14/396) (Table 1). Stent migration occurred in cases with common bile duct stones (3/190; 1.6%), malignant lesions (2/112; 1.8%), chronic pancreatitis (4/62; 6.5%), autoimmune pancreatitis (2/14; 14.3%), trauma (1/8; 12.5%), surgical complications (2/6; 33.3%), and PSC (0/4; 0%) (Table 1).

***Patient factors***

**Disease (benign or malignant):** In total, 12 of 14 cases (85.7%) of stent migration had benign disease. The overall number of cases with benign disease in this series was 227/396 (57.3%). The frequency of migration was significantly higher in cases with benign disease, such as chronic pancreatitis and autoimmune pancreatitis, when compared with cases of malignant disease (*P* = 0.030) (Table 2, Figure 1).

**Cases undergoing EST:** In total, 11 of 14 cases (78.6%) of stent migration had previously undergone EST. The overall number of cases who had undergone EST in this series was 263/396 (66.4%). The frequency of migration was not significantly higher in cases who had undergone EST when compared with cases who had not undergone EST (*P* = 0.40) (Table 2).

**Location of bile duct stenosis:** Among the cases with bile duct stenosis, except for cases with common bile duct stones, stenosis of the lower common bile duct was noted in 10 of the 11 cases (90.9%) with stent migration. Among the total number of cases with bile duct stenosis in the series, stenosis of the lower common bile duct was noted in 156 of 263 cases (59.3%). The frequency of migration was significantly higher in cases with stenosis of the lower common bile duct when compared with cases with hilar stenosis or stenosis of the middle common bile duct (*P* = 0.031) (Table 2, Figure 1).

**Bile duct diameter:** Among the cases of stenosis of the lower bile duct, except for cases of hilar stenosis or stenosis of the middle bile duct, a bile duct diameter of > 10 mm was noted in 11 of 13 cases (84.6%) of stent migration. The overall number of patients with a bile duct diameter of > 10 mm was 154/289 (53.3%). The frequency of migration was significantly higher in cases with a bile duct diameter of > 10 mm when compared with cases with a bile duct diameter of ≤ 10 mm (*P* = 0.023) (Table 2, Figure 1).

***Stent Factors***

**Duration of stent placement:** A stent placement duration of > 1 mo was noted in 10 of 14 cases (71.4%) of stent migration. The number of patients with stent placement duration of > 1 mo in the series was 133/396 (33.6%). The frequency of migration was significantly higher in cases with a stent placement duration of > 1 mo when compared with cases with a stent placement duration of ≤ 1 month (*P* = 0.007) (Table 2, Figure 1).

**Stent shape:** Straight-type stents were used in 11 of 14 cases (72.7%) of stent migration. The overall number of patients receiving straight-type stents was 133/396 (33.6%). The frequency of migration was significantly higher in cases with straight-type stents when compared with cases with pig-tailed stents (*P* < 0.001) (Table 3, Figure 1).

**Stent diameter:** In total, 11 of 14 cases (78.6%) of stent migration had received a 10-Fr sized stent. The overall number of patients who received a 10-Fr sized stent was 116/396 (29.3%). The frequency of migration was significantly higher in cases with 10-Fr sized stents when compared with those with 7-Fr sized stents (*P* < 0.001) (Table 3, Figure 1).

**Stent length:** A 5-, 7-, and 9-cm stent was used in 5/14 (57.1%), 8/14 (57.1%), and 1/14 (7.1%) cases of stent migration, respectively. The overall number of patients who received a 5-, 7-, and 9-cm stent was 108/396 (27.3%), 270/396 (68.2%), and 18/396 (4.5%), respectively. No significant differences in the frequency of migration were noted among the patients who received 5-, 7-, and 9- cm stents (Table 3).

***Retrieval methods for migrated stents, and their success rates***

The grasping technique was used in 8 of 14 (57.1%) cases of stent migration, wherein 60% of the cases had 7-Fr pig-tail stents. This is a technique of retrieval that is attempted by directly grasping the distal end of the stent with a basket (Figure 2), a snare, rat-toothed forceps or biopsy forceps. This method is effective for pig tailed type stent or thin straight type stent (Figure 3). The cannulation technique was used in 6 of 14 (42.9%) cases of stent migration, wherein 100% of cases had 10-Fr straight stents. This is a technique of retrieval that is attempted by connecting the distal end of the stent with a stent retriever, a balloon catheter, and a cannula (Figure 4) by using the guide wire passed through the lumen of the migrated stent. This method is effective for thick straight type stent (Figure 3). Stent retrieval was successful in all cases.

**DISCUSSION**

Endoscopic biliary stenting using a tube stent is now a well-accepted therapy for biliary obstruction developing secondary to malignant or benign disease[1]. However, certain complications may develop with this technique and should be carefully considered. The complication rate for biliary stents reportedly ranges from 8% to 10%[2-4], and the described complications include cholangitis, cholecystitis, duodenal perforation, bleeding, pancreatitis, stent fracture, proximal stent migration, distal stent dislocation, and stent occlusion resulting in recurrent biliary obstruction[5-16]. Stent migration, a rare complication associated with biliary stenting[7,8,12], is a late complication following endoscopic stenting. It occurs in approximately 5%–10% of patients who undergo biliary stenting, and may involve proximal or distal migration[7,8,15,17,18,20,23-28]. Previous studies have reported that 3.1%–4.9% and 3%–6% of patients undergoing biliary stenting experience proximal and distal stent migration, respectively[5,7,17,18,24,25,29,30]. In the present study, the frequency of stent migration was 3.5%, which is consistent with previous studies.

As stent migration can lead to symptoms of biliary obstruction, it is important to determine the risk factors of stent migration[17,20,31]. However, thus far, the risk factors for biliary stent migration have yet to be clarified. Arhan *et al*[32] reported that proximal stent migration occurs in cases with cholangiocarcinoma, short stents, or stents with large diameters. Moreover, the placement of multiple stents and breaking of stents may cause stent migration. In addition to these risk factors, we also analyzed other possible risk factors including subtypes of both benign and malignant biliary disease; EST use; location of the stenosis; duration of stent placement; and stent shape, diameter, and length.

A previous study has indicated that stent displacement is less frequently noted in malignant biliary stenosis than in benign biliary stenosis, which may be attributed to the tight covering of the stents by malignant tissue[32]. Similarly, in the present study, the frequency of migration was significantly higher in cases of benign disease than in cases of malignant disease (*P* = 0.030). One possible explanation for this phenomenon is that stenosis in cases of benign disease is not as tight as compared to the stenosis in cases of malignant disease, which may be due to differences in the resolution of local inflammation. In cases of malignant stenosis, tumor growth may help to anchor the stent, thus preventing its migration. Arhan et al. reported that stent migration was observed less frequently in postcholecystectomy strictures than in other benign biliary stenoses, except in cases of PSC[32]; the authors had indicated that the tightness of the fibrotic stricture could be a possible explanation for this finding. However, it was difficult to assess these hypotheses due to the low number of available cases in the present study.

Data on whether undergoing an EST before placement of a biliary stent affects the risk of migration are scarce. EST did not significantly affect the frequency of stent migration in previous studies[17,27,29,33]. Similarly, in the present study, the frequency of stent migration was not significantly higher in the cases who had undergone EST compared to those who had not undergone EST (*P* = 0.40). However, one study indicated a higher frequency of stent migration in patients who had undergone stent placement without prior EST compared to patients who had undergone stent placement after undergoing EST. The higher migration rate in these patients was primarily because of distal migration, whereas the incidence of proximal stent migration was not influenced by EST[34]. Thus, undergoing EST prior to stent placement cannot be considered as a proven risk factor for proximal stent migration.

With regard to location of the stricture, we generally believe that distal stent dislocation occurred more frequently in cases with stenosis of the upper bile duct, whereas proximal stent migration occurred more frequently in those with stenosis of the lower bile duct. In the present study, the frequency of migration was significantly higher in cases with stenosis of the lower common bile duct when compared with cases with hilar stenosis or stenosis of the middle common bile duct (*P* = 0.031). However, in cases with stenosis of the lower common bile duct, it is unclear whether the migration is related to stent length.

We believe that a greater amount of space in the proximal bile duct is necessary for migration. Therefore, we hypothesized that the stent would be more likely to migrate proximally in cases with a larger bile duct diameter. In the present study, the frequency of migration was significantly higher in cases with a bile duct diameter of > 10 mm when compared with cases with a bile duct diameter of ≤ 10 mm (*P* = 0.023).

Moreover, in the present study, the frequency of migration was also significantly higher in cases with a stent placement duration of > 1 mo when compared with cases with a stent placement duration of ≤ 1 mo (*P* = 0.007). A longer duration of stent placement increases the risk of migration. Therefore, we suggest that the stents should be exchanged or removed after a short placement interval.

Biliary stent design may also affect the risk for migration. With regard to stent shape, we used pig-tailed shaped and straight tube stents only in the present study. Straight tube stents have been modified with side flaps or barbs to decrease the risk of migration[35]. Pig-tailed shaped stents were also used to decrease the risk of migration. In the present study, the frequency of stent migration was significantly higher in cases with straight-type stents when compared with those with pig-tailed stents (*P* < 0.001). We noted that the presence of side flaps or barbs was not sufficient to prevent stent migration. The diameter and length of the stents may also be associated with the risk of migration[17]. With regard to stent diameter, in the present study, the frequency of migration was significantly higher in the cases with 10-Fr sized stents when compared with cases with 7-Fr sized stents (*P* < 0.001). We believe that, since stenotic lesions of the bile duct were already improved in cases wherein thick stents (such as 10-Fr stents) were used, these cases were more likely to experience migration. With regard to stent length, in the present study, no significant differences in the frequency of migration were noted among the patients who had 5-, 7-, and 9-cm stents. Arhan et al. reported that shorter stents tended to migrate proximally, whereas longer stents tended to migrate distally, in cases of benign biliary stenosis[32]. Moreover, longer stents in the bile duct are less likely to migrate because a longer portion is fixed in the common bile duct, thus limiting proximal movement[17]. I think that we should pay attention in case of using shorter and straight type stent in the high-risk patients. I had better use pig-tailed type stent in this case.

Most of the stents that have migrated proximally can be successfully retrieved indirectly, through stone extraction with a balloon catheter, or directly by using various grasping accessories. Since all the stents were successfully retrieved in the present study, none of the patients required surgery for stent retrieval. In patients with benign strictures, this favorable finding could be a result of the dilation of the stricture due to further stenting, thereby facilitating the retrieval of the proximally migrated stent.

In conclusion, the risk of stent migration is higher in benign biliary stenosis than in malignant biliary stenosis. Proximal migration of biliary or pancreatic stents is an infrequent occurrence. Proximal stent migration was found to be closely associated with benign stenosis, stenosis in the lower common bile duct, bile duct diameter of > 10 mm, stent placement duration of > 1 mo, straight-type stents, and 10-Fr sized stents. The migrated stents can be extracted endoscopically, with a high degree of success, using a variety of techniques involving baskets or balloons.

**COMMENTS**

***Background***

Endoscopic biliary stenting using a tube stent is currently a well-accepted therapy for biliary obstruction developing secondary to malignant or benign disease. Endoscopic biliary stents may migrate proximally or distally as a late complication in approximately 5%–10% of patients who have undergone biliary stenting. It is important to determine the factors influencing biliary tube stent migration. However a few studies in the literature have reported on the risks of stent migration.

***Research frontiers***

In this study, the frequency of tube stent migration in the total patient population was 3.5%. And the potential risk factors for migration included bile duct stenosis secondary to benign disease (*P* = 0.030); stenosis of the lower bile duct (*P* = 0.031); bile duct diameter > 10 mm (*P* = 0.023); duration of stent placement > 1 mo (*P* = 0.007); use of straight-type stents (*P* < 0.001); and 10-Fr sized stents (*P* < 0.001).

***Innovations and breakthroughs***

Retrieval of the migrated stents was successful in all cases. And this paper could describe the methods used for retrieval of migrated stents using some figures. The grasping technique, using a basket or snare, was effective for pig-tailed or thin and straight stents, whereas the guidewire cannulation technique was effective for thick and straight stents.

***Applications***

It is importanat to pay attention for the factors influencing biliary tube stent migration, and know the method for retrieval of migrated stents.

***Terminology***

Proximal stent migration is a rare complication associated with biliary stenting. Proximal migration means movement of stent distal end into common bile duct. Proximal stent migration can cause biliary obstruction and cholangitis, thus requiring retrieval or re-stenting.

***Peer review***

The potential risk factors for migration included bile duct stenosis secondary to benign disease; stenosis of the lower bile duct; bile duct diameter > 10 mm; duration of stent placement > 1 mo; use of straight-type stents; and 10-Fr sized stents. It is importanat to pay attention for these risk factors, and know the method for retrieval of migrated stents. This result is very impressive.

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**Figure 1 Potential risk factors.** The potential risk factors for migration included bile duct stenosis secondary to benign disease (*P* = 0.030); stenosis of the lower bile duct (*P* = 0.031); bile duct diameter > 10 mm (*P* = 0.023); duration of stent placement > 1 mo (*P* = 0.007); use of straight-type stents (*P* < 0.001); and 10-Fr sized stents (*P* < 0.001).

**Figure 2 Grasping technique (Case 1).** Examination was performed for hilus bile duct tumor. Pig-tailed-type 7-Fr sized stent was migrated upon stent insertion. An opened 8-wired basket grasped the distal part of the stent. Stent retrieval was successful in case 1.

**Figure 3 Retrieval methods for migrated stents.**

**Figure 4 Cannulation technique (Case 2).** A: Biliary Drainage was performed for bile duct stenosis due to alcoholic chronic pancreatitis. Straight-type, 10-Fr sized stent was migrated six months after insertion; B: The guide wire was passed through the lumen of the migrated stent; The distal end of the migrated stent was connected with a cannula; C: Migrated stent was pulled orienting axis carefully; D: Stent retrieval was successful in case 2.

**Table 1 Diseases requiring bile duct stenting**

|  |  |  |  |
| --- | --- | --- | --- |
|  |  | **Migrated** | **Non migrated** |
| Benign | 227 | 12 | 215 |
| Common bile duct stone | 133 | 3 | 130 |
| Chronic pancreatitis  | 62 | 4 | 58 |
| Autoimmune Pancreatitis  | 14 | 2 | 12 |
| Trauma | 8 | 1 | 7 |
| Post operation  | 6 | 2 | 4 |
| Primary sclerosing Cholangitis | 4 | 0 | 4 |
| Malignant | 169 | 2 | 167 |

**Table 2 Disease**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  | Migrated | Non migrated | *P* |
| Benign | 227 | 12 | 215 | 0.03 |
| Malignant | 169 | 2 | 167 |  |
| EST | 263 | 11 | 252 | 0.4 |
| Non EST | 133 | 3 | 130 |  |
| Low | 156 | 10 | 146 | 0.031 |
| Hilar or middle | 107 | 1 | 106 |  |
| Bile duct > 10 mm | 154 | 11 | 143 | 0.023 |
| Bile duct ≤ 10 mm | 135 | 2 | 133 |  |
| ≤ 1 m | 263 | 4 | 259 | 0.007 |
| > 1 m | 133 | 10 | 123 |  |

**Table 3 Stent shape,** **diameter and length**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  |  | **Migrated** | **Non migrated** | ***P*** |
| Stent shape |  Pig-tail | 263 | 3 | 260 | < 0.001 |
|  Straight | 133 | 11 | 122 | 　 |
| Stent diameter |  7 Fr | 280 | 3 | 277 | < 0.001 |
|  10 Fr | 116 | 11 | 105 | 　 |
| Stent length |  5 cm | 108 | 5 | 103 | 1 |
| 0.53 |
|  7 cm | 270 | 8 | 262 | 2 |
| > 0.99 |
|  9 cm | 18 | 1 | 17 | 3 |
| 0.45 |

5 cm *vs* 7 cm; 2.5 cm *vs* 9 cm; 3.7 cm *vs* 9 cm.