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Hemoclipping of Chronic Canine Ulcers: A Randomized Prospective Study of Initial Deployment Success, Clip Retention Rates, and Ulcer Healing

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Abstract

Background—Several different hemoclips are marketed for endoscopic hemostasis of non-variceal upper GI bleeding. No prior reports have compared success rates of clip deployment onto bases of chronic gastric ulcers (GU's), clip retention rates, or their influence on ulcer healing.

Objectives—For treatment of chronic GU's, to compare 3 different hemoclips with multipolar coagulation (MPEC) and control.

Design—Randomized controlled study.

Subjects—7 adult dogs with prehepatic portal hypertension had GU's created by rubber band ligation. Animals had oral proton pump inhibitors daily and weekly endoscopies to quantitate clip retention and ulcer healing.

Interventions—1 week after banding, 10 chronic ulcers were randomized in pairs to control (no endoscopic treatment), MPEC, or different hemoclips (Olympus-“QuickClip2”-QC; Wilson Cook-“TriClip”-TC; or Boston Scientific Corp-“Resolution Clip”-RC).

Main Outcome Measurements—Times and success of hemoclip deployment, clip retention rates, and ulcer healing rates on weekly endoscopies.

Results—Success rates of clip deployment were 100% for RC, 93.1% for TC to 83.3% for QC. Clip retention rates were significantly higher with RC clips than QC or TC at 1 to 3 weeks. Retained clips did not delay GU healing compared with MPEC or control.

Conclusions—1) Hemoclipping time was similar with all three, 2) RC clips were retained significantly longer than QC or TC, 3) Hemoclips did not delay ulcer healing compared to control or MPEC, and 4) All 3 hemoclips were safe and no complications such as bleeding or weight loss were noted.

Keywords

Chronic ulcer; Endoscopic hemoclips; hemostasis

Introduction

Several endoscopically deployable hemoclips are currently marketed for clinical endoscopic hemostasis (1). The mechanical closure of a bleeding vessel makes sense surgically and may be less traumatic to the tissues than endoscopic coagulation (1,2). Whether current hemoclips can successfully grasp the vessel underlying stigmata and be retained on chronic ulcer bases is uncertain. Endoscopic hemoclips have undergone significant modifications to improve their endoscopic delivery and application. In addition, there are several clinical, randomized and non-randomized clinical reports using endoscopic hemoclips for hemostasis of a variety of focal, non-variceal bleeding lesions throughout the gastrointestinal (GI) tract, but these are all with Olympus hemoclips. There are no comparative studies yet reported about different types of current endoscopic hemoclips for clinical endoscopic hemostasis of chronic upper GI (UGI) ulcers and their deployment success rates, retention rates, or potential effects on ulcer healing. These factors may all influence initial and definitive hemostasis of ulcers (1,2).

Our purposes in this study were: 1) to compare success rates of deployment and retention rates of three different, currently available endoscopic hemoclip types on chronic canine gastric ulcers, 2) on weekly endoscopies, to contrast gastric ulcer (GU) diameter and healing rates with control or multipolar electrocoagulation (MPEC) treated ulcers, and 3) to describe whether retained hemoclips influence gastric ulcer healing or cause complications.

Methods

Prior to starting this comparative study, the two endoscopists (DMJ and GAM) learned how to successfully deploy each type of hemoclip in separate studies. This was first done in porcine stomachs and then endoscopically with acute ulcers in pilot studies in dogs. After gaining that endoscopic expertise, we performed a randomized study with all three endoscopic hemoclips for hemostasis of acute gastric ulcerations (2). These results are reported elsewhere (2).

For the current study of chronic gastric ulcers, seven adult dogs with pre-hepatic portal hypertension, each weighing approximately 50-60 pounds, were included. All endoscopies were performed under isoflurane anesthesia. A therapeutic videoendoscope (Pentax, Orangeburg, NY) with a large suction channel (3.7 mm diameter) and separate water jet irrigation was used for all endoscopies. At the initial endoscopy, ten endoscopic rubber bands (Boston Scientific Corp., Natick, Mass) were placed to create a model of chronic gastric ulcers, when the bands sloughed. These bands were placed in 5 pairs at least 5 cm apart in a linear array from antrum to proximal stomach. The pairs were mapped as distance from the incisors and pylorus and in spatial orientation, to facilitate identification of resultant ulcers one week later and on the weekly follow-up endoscopies after treatments.

One week later, the chronic appearing ulcers were randomized in pairs (2 to each endoscopic treatment or control per dog). This was done by opening sealed envelopes (with the four endoscopic treatments or control designations) which had been created by random numbers tables for the 7 dogs. The treatment allocations were to control (no endoscopic hemostasis) or four different endoscopic treatments: three different endoscopic clips (standard size-8 mm open-Olympus-“QuickClip2”-QC, Wilson-Cook-“TriClip”-TC, or Boston Scientific Corp-“Resolution Clip”-RC) or to multipolar electrocoagulation (MPEC).

For the hemoclip treatments, the goal was to successfully place at least 2 hemoclips in the center of the ulcer base or at the stigmata of hemorrhage (if one were present which was the case about 30% of the time). For the MPEC treatments, large probe (10 French size), low power (12 watts), long duration pulses (10 sec) and firm tamponade pressure with 3 pulses

to the base were utilized as MPEC treatment, similar to clinical hemostasis of chronic peptic ulcers (3). For initial outcome measurements, the treatment times and success/failure rates of hemoclip placement were compared.

Before initial endoscopic rubber bands were placed, all animals were treated with oral proton pump inhibitors (PPIs) once daily (Esomeprazole 40 mg before meals – AstraZeneca Pharmaceuticals LP, Wilmington, DE). The PPI was continued until all GU's were healed, as documented on follow-up endoscopies. All animals had clinical evaluations (daily for the first week and then twice weekly) to check for potential clinical complications. They also had weekly endoscopies to evaluate for ulcer size, ulcer healing, and clip retention. Long-term treatment endpoints included: 1) clip retention rates on weekly follow-up endoscopies, 2) complete ulcer healing (e.g. re-epithelialization), and 3) clinical evidence of bleeding or complications of endoscopy or treatments (perforation, vomiting, interruption in eating, or weight loss).

For statistical comparisons at the end of the study, the time-to-event outcomes (e.g. time to successfully place 2 hemoclips or 3 MPEC coagulation pulses, duration of hemoclip retention, and time to ulcer healing) were compared by log-rank tests. Proportions (e.g. failures of hemoclip placement and hemoclip retention at 1-8 weeks) were compared by Chi square tests. A p value of less than 0.05 was considered significant for all comparisons.

Results

We gained significant initial experience with hemoclipping during practice with endoscopic porcine model and subsequently during the performance of endoscopic pilot studies and an acute bleeding gastric ulcer study, prior to the initiation of this chronic ulcer study (2). Our familiarity with endoscopic hemoclips was helpful, but there was still a short learning curve to be able to deploy hemoclips onto the base of these large (10-12 mm diameter), fibrotic, chronic ulcers.

One week after rubber band ligation, chronic appearing ulcers resulted and these were 10-12 mm in diameter and 2-3 mm deep, as estimated with endoscopic probes and biopsy forceps of known dimensions. Refer to Figure 1. Approximately 30% of all ulcers had some stigmata of hemorrhage – adherent clots, non-bleeding visible vessels, or flat spots – and these were usually located in the center of the ulcer base.

Some differences were noted among the three different hemoclip devices that made their deployment easier or more difficult onto the base of chronic ulcers. The most important was a grasp-release-regrasp mechanism of the hemoclipping device. This was a distinct advantage of the BSC hemoclip and was helpful for chronic, fibrotic based ulcers which were often difficult to grasp in the base. This also allowed for repositioning of the hemoclip prior to triggering the release mechanism. This reopening and repositioning feature was not possible with either the QC or TC clips. Once the QC or TC were closed, they could not be opened and the clip was lost. Rotation of the clips was another helpful feature. Hemoclip rotation was more accurate with the RC clip than with the QC clip (which tended to flip in 45°- 90° arcs with rotation). No rotation was possible with the TC. The three wire prongs of the TC often stuck to and sliced through the mucosa on the sides of the ulcer rather than grasping the ulcer base. The TriClip also skipped across the base of the chronic, fibrotic ulcers, without being able to firmly grasp this type of tissue well. Slicing through the tissue was not observed with either the RC or the QC clips. The BSC hemoclips were larger (12 mm open) than the QC or the TC (each was about 8 mm open) and therefore appeared to grasp more tissue upon closing.

The percent of hemoclips which could not be deployed successfully (e.g. failed to adhere) onto the chronic ulcer base varied among the 3 types. Refer to Figure 2. The failure rate for initial hemoclippping (failure of deployment/# attempted to deploy) was QC 16.7%, TC 6.9%, and RC 0%. Significantly more Olympus QC hemoclips (N=42) were required than Wilson Cook TC (N=29) or BSC RC (N=30).

Several observations were made about the potential reasons for failure of hemoclip deployment or attachment onto chronic ulcer bases. The lowest rate was in the BSC hemoclip (0% - 30 clips). This appeared to relate to the ability to grasp-release-regrasp feature, reposition capability, and the ability to confirm that the clip was closed upon the area and tissue which the endoscopist had judged was the target of interest. The larger clip (12 mm when open) was an additional advantage and this appeared to grasp a larger volume of tissue. Olympus QuickClip2 had the highest rate of failure (16.7% for 42 clips total attempted). This often related primarily to the inability to grasp and release tissue or reposition hemoclips. The TriClip failure rate was intermediate in initial failure of hemoclip deployment (6.9% for 29 clips attempted).

The mean times to deploy 1, 2, and 3 hemoclips are shown in Table 1. These three times were similar for each of the 3 types of hemoclips, but were consistently greater for TC than QC. The cumulative treatment times were approximately 35 seconds for the first clip; 100 seconds for 2 hemoclips; and 190 seconds for three hemoclips. As shown in Table 1, not all ulcers had 3 hemoclips placed. When 2 hemoclips were successfully placed in the ulcer base, a third hemoclip was not deployed.

Refer to Figure 3 for the percentage of hemoclips (of the total successfully placed initially) that remained on the ulcers during weekly follow-up endoscopies. The proportion was significantly higher for Resolution hemoclip than QuickClip or TriClip for weeks 1-3. For example, the percent of hemoclips remaining on the ulcer base at one (and 2) weeks was 60% (and 37%) for RC, 25% (and 14%) for QC, and 15% (and 7.4%) for TC.

Refer to Figure 4 which shows the percentages of ulcers with one or more hemoclips attached to the ulcer based during weekly follow-up endoscopies. There was a particularly rapid diminution of ulcers with one or more retained hemoclips for TC compared to QC and RC. RC had a significantly higher proportion of ulcers with 1 hemoclips retained at 1-5 weeks. For example, comparing these proportions at 2 (and 4 weeks), RC had 61.5% (and 46.2%), QC had 38.5% (and 15.4%), and TC had 15.4% (and 0%) retained hemoclips respectively.

Figure 5 shows the time to ulcer healing according to the different endoscopic treatments. The median time to healing of RC treated ulcers was arithmetically shorter (about 2.5 weeks), than controls, other hemoclips –which came off before healing (QC or TC), or MPEC (about 2.8 weeks).

No complications occurred in any of the dogs (such as perforations, interference with eating, weight loss, vomiting, or bleeding) related to the chronic ulcer model or endoscopic treatments. The hemoclips did not appear to interfere with ulcer healing and they passed spontaneously in the stool. The longest hemoclip retention time on chronic ulcers was 8 weeks (See Figure 5).

Discussion

Currently, three different companies in the United States (US) market endoscopic hemoclips for clinical use. These are Boston Scientific (Resolution hemoclip), Olympus (QuickClip2), and Wilson-Cook (Tri-Clip). Endoscopic hemoclips were originally developed in Japan by

Kuramata and Hayashi three decades ago and have been marketed by Olympus for endoscopic clinical hemostasis since then (4,5). Olympus endoscopic hemoclips have undergone several modifications and improvements which have made them easier to use (6,7). Recently, Wilson Cook and BSC also introduced different types of endoscopic hemoclips. Endoscopic hemoclips for GI hemostasis are now marketed as preloaded, single-use disposable units (2,8). Some of the features that have made endoscopic hemoclips more user-friendly include the ability to partially rotate the clip for better orientation (Boston Scientific and Olympus), the grasp-release-regrasp feature prior to deployment (Boston Scientific), and larger hemoclips for deeper penetration into the tissue clipped (Boston Scientific; Olympus QuickClip2 Long – not tested in this study) (2).

There is a short but definite learning curve for both the endoscopist and assistants, for consistent and successful deployment of each type of hemoclip. We developed expertise with each device initially using a porcine desktop endoscopic model, subsequently in a pilot endoscopic study, and then a comparative endoscopic study of acute bleeding ulcers (2). We would highly recommend some training sessions for the endoscopist and their GI assistants, prior to attempting hemoclippping of severe GI bleeders, particularly as emergency cases in patients with chronic ulcers.

Although several endoscopic hemoclips are now clinically available and others are in pre-marketing stages of development and testing (9), there are no comparative clinical or laboratory studies to determine the success of deployment, length of retention, efficacy, and possible complications when used for the treatment of chronic UGI ulcers. We believe these are important considerations for the clinician.

The failure of placement onto the base of chronic ulcers in this animal model (QC 16.7% - See Figure 3) is very similar to failure rate of Olympus QuickClip2 (or similar earlier reloadable Olympus hemoclips) in several clinical studies (10-12). For example, the failure rates for Olympus hemoclips reported in clinical randomized studies of bleeding ulcers were 15-16% for Lin et al in two different comparative trials (10,11) and 19% for Villanueva et al (12). Most of their patients who failed hemoclippping had chronic, fibrotic ulcer bases, and the Olympus hemoclips would not grasp the base where the stigmata of hemorrhage was located (10-12). There are no similar clinical studies for hemoclippping chronic ulcers with either TC or RC yet reported. Based upon the current study, we would predict that RC will have a higher success rate, particularly because of the grasp, release, and reposition capability. Larger size of the hemoclips was also an advantage for hemoclippping the base of canine chronic ulcers. Our CURE Hemostasis Research Group's initial hemoclippping results in patients with bleeding chronic ulcers confirm these observations.

Retained hemoclips in the bases of chronic ulcers did not increase time to healing compared to control or MPEC. In fact, there was a trend in shifting the time to healing curve to the left for RC and shortening healing time for ulcers with retained hemoclips (Figure 5). This may relate to partial closure of the ulcer on initial treatment or to apposition of the sides of ulcers in some instances (by larger clips), during initial hemoclippping and hemoclip retention until ulcers healed.

In this study, all ulcers were healed by 4 weeks. This is similar to healing of 10-12 mm diameter chronic ulcers in patients with recent hemorrhage who are treated with daily, oral proton pump inhibitors –PPI's (13-15). From recent studies of patients whose ulcer hemorrhage started as an outpatient before hospitalization, approximately 80% of ulcer rebleeds occurred within 72 hours, but 20% rebled between 4 and 30 days (13-16). For patients with inpatient ulcer hemorrhage (e.g. that develops after a patient is hospitalized for a non-bleeding medical or surgical diagnosis), the pattern of ulcer rebleeding after

hemostasis is quite different (17). At least 50% of ulcer rebleeding episodes in such inpatients occur 1 week or more after initial endoscopic hemostasis (17). Ideally, a hemoclip would be retained on the stigmata of hemorrhage until the ulcer heals. If the hemoclip grasps and stays on the underlying vessel, rebleeding should be markedly reduced compared to ulcers with hemoclips which came off early (1). Hemoclip retention until ulcers healed could promote permanent endoscopic hemostasis of both severe ulcer hemorrhage (that started as an outpatient) and even more severe hemorrhage related to inpatient ulcer bleeding (1,17).

Based upon the current endoscopic comparative study, more ulcers had one or more RC hemoclips retained (Figure 4) and a greater proportion of the total RC hemoclips were retained on the base of these chronic ulcers, than QC or TC treated ulcers (Figure 5). There are no comparative clinical reports about hemoclip retention on chronic ulcers, although similar trends are likely in patients. Based upon our initial clinical studies of chronic ulcers in patients with severe hemorrhage, RC hemoclips have been seen up to 3-4 weeks after initial hemostasis (D. Jensen, personal communications). This may particularly be important in reducing rebleeding for high risk patients with slow ulcer healing or those who require anticoagulants, non-steroidal anti-inflammatory drugs (NSAIDs), or anti-platelet medications, because of severe co-morbidities (1,17).

There are several major advantages of the present study and this model of chronic GU's. These are that this chronic ulcer model provides large endoscopic ulcers (10-12 mm diameter, 2-3 mm deep, and some with stigmata of hemorrhage one week later after band sloughing) that resemble chronic peptic ulcers in patients. Multiple ulcers can be safely created in healthy animals without major complications to moderate sized dogs. They can be treated endoscopically under controlled laboratory conditions and heal within 4 weeks on oral PPI's. Comparative endoscopic studies which are not practical or possible in sick patients can be effectively performed with controlled, safe conditions in this model. The endoscopic conditions resemble those of patients with recent hemorrhage and chronic GU's. Animals resume feeding, PPI's, and usual activity after the endoscopic treatments and recovery from anesthesia. Weekly endoscopies are feasible to document ulcer healing and effects of therapies. Also, endoscopic treatments can be standardized for chronic ulcers with new treatments (such as hemoclip placement of different types) and potential endoscopic guidelines can be developed and tested for hemostasis before clinical application. We have found these features to be extremely valuable, since we utilize this information in workshops for new hemostasis techniques for GI faculty, GI fellows, other gastrointestinal endoscopists, GI nurses and/or GI technicians.

There are some disadvantages to this canine model and study. First, not all ulcers have stigmata of recent hemorrhage and none have active bleeding. Therefore, some readers may question the relevance to chronic GU's in patients with hemorrhage. We would assure the reader that the stigmata of recent hemorrhage are usually located in the base and some chronic ulcers had stigmata (1,3,18,19). Also, these ulcers resemble clinical GU's and the technical and therapeutic goal is to hemoclip the base where the stigma is located, even though that may be quite difficult (10-12). Second, these ulcers are not bleeding and do not resemble peptic ulcers in patients with severe ulcer hemorrhage. They do resemble chronic GU's in patients with UGI hemorrhage, except in number, location, and orientation. We have purposefully placed the ulcers in pairs where endoscopic treatments would not be exceptionally difficult, tangential, or in retroflexion. These features all make hemoclippping more difficult, especially with Olympus hemoclips which have been studied clinically the most (1,10-12). The goal of this was to be able to compare endoscopic and clinical results under similar conditions. The third limitation is that this is not an endoscopic, necropsy, and

histopathologic correlation study of tissue injury and healing. We agree and think that such a study is warranted in the future.

From the present study, we conclude that:

1. For Olympus QuickClip2, Wilson Cook TriClip, and Boston Scientific Resolution hemoclips, similar endoscopic practice, expertise, and time for deployment were required by the endoscopist and GI assistant for successful hemocclipping of chronic GU's,
2. Initial hemoclip deployment success often depended upon the grasp-release-regrasp and reposition qualities of the hemoclip device.
3. Deployment success rates for the first hemoclip were 83.3% QC, 93.1% TC, and 100% RC.
4. Hemoclip retention rates were significantly higher with RC than QC or TC at 1-3 weeks.
5. Retained hemoclips did not retard ulcer healing. In fact, ulcers with retained hemoclips healed arithmetically faster than controls, ulcers without retained hemoclips, or MPEC treated ulcers.
6. There were no major GI complications, interference with eating, or weight loss with the ulcer model or retained or excreted hemoclips.

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References

1. Jensen DM. Where next with endoscopic ulcer hemostasis? *Am J Gastroenterol.* 2002; 97:2161–2165. [PubMed: 12358226]
2. Jensen DM, Machicado GA, Hirabayashi K. Randomized Controlled Study of Three Different Types of Hemoclips for Hemostasis of Bleeding Canine Acute Gastric Ulcers. *Gastrointest Endosc.* 2006 In Press.
3. Jensen DM, Machicado GA. Endoscopic Hemostasis of Ulcer Hemorrhage with Injection, Thermal, or Combination Methods. *Techniques in Gastrointestinal Endoscopy.* 2005; 7:124–31.
4. Kuramata H, Eto S, Horiguchi K, Unayama F, Kazato K, Tsuboi A. Evaluation of gastrofiberscope for treatment (TGF proto-type by Olympus Co.). *Stomach Intestine.* 1974; 9:355–364.
5. Hayashi T, Yonezawa M, Kawabara T. The study on staunch clip for the treatment by endoscopy. *Gastrointest Endosc.* 1975; 17:92–101.
6. Hachisu T. Evaluation of endoscopic hemostasis using an improved clipping apparatus. *Surg Endosc.* 1988; 2:13–17. [PubMed: 3051463]
7. Hachisu T, Yamada H, Satoh SI, Kouzu T. Endoscopic clipping with a new rotatable clip-device and a long clip. *Dig Endosc.* 1996; 8:127–133.
8. Raju GS, Gajula L. Endoclips for GI endoscopy: Technical Review. *Gastrointest Endosc.* 2004; 59:267–279. [PubMed: 14745407]
9. Machicado GA, Jensen DM, Hirabayashi K. Randomized Controlled Study of a New InScope Multi-Clip Applier, Olympus QuickClip2, MPEC, Injection and Combination Therapy Comparing Hemostasis and Healing of Bleeding Canine Acute Gastric Ulcers. *Am J Gastroenterol.* 2005; 100(973):S335–6.

10. Lin HJ, Hsieh YH, Tseng GY, Perng CL, Chang FY, Lee SD. A prospective, randomized trial of endoscopic hemoclip versus heater probe thermocoagulation for peptic ulcer bleeding. *Am J Gastroenterol.* 2002; 97:2250–4. [PubMed: 12358241]
11. Lin HJ, Perng CL, Sun IC, Tseng GY. Endoscopic hemoclip versus heater probe thermocoagulation plus hypertonic saline-epinephrine injection for peptic ulcer bleeding. *Digestive and Liver Disease.* 2003; 35:898–902. [PubMed: 14703887]
12. Villanueva C, Balanzo J, Sabat M, et al. Injection therapy alone or with endoscopic hemoclip for bleeding peptic ulcer. Preliminary results of a randomized trial. *Gastrointest Endosc.* 1996; 43:281.
13. Lau JY, Sung JJ, Lee KK, et al. Effect of intravenous omeprazole on recurrent bleeding after endoscopic treatment of bleeding peptic ulcers. *N Engl J Med.* 2000; 343:310–316. [PubMed: 10922420]
14. Laine L, Peterson WL. Bleeding peptic ulcer. *N Engl J Med.* 1994; 331:717–727. [PubMed: 8058080]
15. Jensen DM, Pace SC, Soffer E, Comer G. Continuous Infusion of Pantoprazole vs. Ranitidine for Prevention of Ulcer Rebleeding: A US Multicenter Randomized, Double-Blind Study *Am J Gastroenterol.* 2006; 101:1–9.
16. Jensen DM. Treatment of patients at high risk for recurrent bleeding from a peptic ulcer. *Ann Intern Med.* 2003; 139:294–295. [PubMed: 12965985]
17. Jensen DM, Kovacs TOG, Yuan JL, Jensen ME. Inpatient Ulcer Hemorrhage Compared to Outpatient Hemorrhage: An Analysis of Prospective CURE Trials for Risk Factors, Rebleeding, & Outcomes. *Gastroenterol.* 2005; 128:A639–W1570.
18. Swain CP, Storey DW, Bown SG, et al. Nature of the bleeding vessel in recurrently bleeding gastric ulcers. *Gastroenterol.* 1986; 90:595–608.
19. Lau JYW, Chung SCS, Leung JW, Lo KK, Yung MY, Li AK. Evolutions of stigmata of hemorrhage in bleeding peptic ulcers: a sequential endoscopic study. *Endoscopy.* 1998; 30:513–8. [PubMed: 9746158]

Figure 1.

Shown are

- a. Rubber band ligation in the stomach, mid-body
- b. Gastric ulcer appearance, 1 week later
- c. Olympus QuickClip2 in open position, before attempted placement onto ulcer base
- d. 2 Olympus QuickClip2 hemoclips on the base and side of a chronic GU

Figure 2. Percent failures (initial inability to place hemoclips on the base of chronic ulcers) for total clips attempted to be deployed (shown as N in the figure). 13 ulcers were treated with each type of hemoclip and a minimum of 2-3 hemoclips was placed on the base of each chronic ulcer.

Figure 3.

Percentage of hemoclips (of total successfully placed at baseline) that remained on the ulcer base during weekly follow-up endoscopies. The treatments are labeled. The number of hemoclips initially placed was RC=30, QC=36, and TC=27 onto 13 ulcers for each in 7 different dogs. Significantly more RC than QC or TC hemoclips remained on ulcers for weeks 1-5.

Figure 4.

Percentage of ulcers with one (or more) hemoclips remaining (attached on the ulcer) during follow-up endoscopies. See Figure 3 legend for details on numbers of hemoclips, ulcers, and dogs. There was a significantly higher proportion of ulcers with one (or more) hemoclips for RC than QC or TC from 1-5 weeks.

Figure 5.

Time (in weeks) to ulcer healing on follow-up endoscopies. The dotted line at the 50% level is the estimated median time to healing (approximately 50% of ulcers). Treatments are labeled. 13 ulcers were randomized to each treatment and there were 12 control ulcers.

Table 1
Time to Successfully Deploy Hemoclips onto Chronic Ulcers

	1 Hemoclip	2 Hemoclips	3 Hemoclips
BSC Resolution	(N=13) 34.8 ± 5.7	(N=13) 93.4 ± 9.1	(N=4-9) 193.0 ± 39.6
Olympus QuickClip2	33.9 ± 4.5	104.5 ± 14.3	167.7 ± 12.3
Wilson Cook TriClip	37.6 ± 4.0	108 ± 10.3	209.8 ± 22.7

Legend. Cumulative time (in seconds ± standard error) to successfully deploy 1 or more hemoclips endoscopically onto the base of chronic gastric ulcers.