An endoscopic method for semi-quantitatively measuring internal pyloric diameter in healthy cats: a prospective study of 24 cases.

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Abstract

The objectives of this study were to describe an endoscopic technique for semi-quantitative measurement of the internal pyloric diameter and apply this method to determine its typical size in a population of healthy cats.

Twenty-four healthy adult cats, privately owned or originating from catteries, were prospectively recruited. Endoscopies were performed by the same investigator and cats with moderate to marked macroscopic inflammation were excluded. The internal pyloric diameter was measured with bespoke interchangeable biocompatible 'olives' (ranging from 4 to 12 mm in diameter) that could be attached to a guidewire. Attempts were made to pass the olives through the pylorus, in decreasing order of size, and the internal pyloric diameter was assumed to be equivalent to the size of the first olive that could successfully be passed.

The median duration of the endoscopic procedure was less than 5 (interquartile range 2.7-5.4) minutes and all cats recovered quickly from the procedure without any complications. The median internal pyloric diameter in this population was 9 (interquartile range 9-10) mm, with most (23/24) cats having an internal pyloric diameter within ±1 mm of this measurement. There was no apparent effect of age, sex, breed or weight on the pyloric size.

This study is the first to describe a quick and safe method for semi-quantitatively assessing the internal pyloric diameter in healthy adult cats. A prospective study is now warranted in order to determine the impact of gastrointestinal disease on pyloric diameter, for example cats with possible pyloric stenosis.

Keywords: pyloric stenosis, gastric emptying, endoscopy, feline, pylorus, vomiting

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Introduction

The pylorus plays an important role in digestion, acting as a valve to regulate the flow of partially-digested food (Simpson, 2013). Gastric outlet obstruction is a syndrome where there is an inability of gastric contents (food or water) to exit the stomach, usually arising from a mechanical blockage at or near the pylorus (Hall, 2013). Stenosis of the pyloric canal is one of the most commonly reported causes of gastric outlet obstruction in dogs and humans, but is poorly-documented in cats.

Histologically, the layers of the gastric wall are organized as in all parts of the digestive tract with a mucosa, submucosa, muscularis and serosa (Simpson, 2013); however, in the distal part of the stomach, the inner circular layer of the muscularis is ring-shaped at the pylorus and thickens to form the sphincter pylori muscle (Couturier et al., 2012). The evaluation of the internal pyloric

diameter in live animals is difficult, and is mainly subjectively evaluated by whether or not it can be successfully intubated by gastroscope (Tams, 2011). The normal ultrasonographic appearance of the pylorus has also been described, with the annular thickening of the muscularis layer appearing as a hypoechoic triangle in longitudinal section (Couturier et al., 2012). Ultrasonographic evaluation of the pylorus enables evaluation of a thickening of individual layers of the gastric wall, but the evaluation of the internal pyloric diameter is not possible and, to the authors' knowledge, a reference range has never been established for healthy cats.

Currently, the diagnosis of pyloric stenosis (PS) is based on clinical signs of pyloric outflow obstruction, mainly chronic food vomiting delayed after eating (a few hours) which may even be projectile (Hall, 2013); and on imaging signs of delayed gastric emptying and abnormal pyloric conformation, detected by ultrasonography and characterized by severe fluid distension of the stomach and circumferentially thickening of the pylorus, respectively (Syrcle et al., 2013). In a retrospective study, we recently described 34 cats with chronic alimentary vomiting and in which the pylorus was not passed with an 8.6 mm endoscope (Freiche et al., 2016). The pylorus appeared to be abnormally small on direct examination and a presumptive diagnosis of acquired PS was made. Although, a reliable method of diagnosis is needed to establish a definitive diagnosis of PS in cats. The first aim of this study was to describe an endoscopic procedure allowing the measurement of the internal pyloric diameter in cats. Having done this, a second aim was to create a reference range for this measurement in healthy cats.

Materials and methods

Study population

All procedures were approved by the Ethics Committee of the National Veterinary School of Alfort (agreement 2015-10-27) and informed owner consent was obtained. Healthy cats were prospectively recruited from November 2015 to July 2016 at the teaching hospital of Ecole Nationale Vétérinaire d'Alfort. Study cats were owned by the staff or the students from the veterinary school or originated from a colony of reproductive laboratory cats and a colony of specific-pathogen-free (SPF) laboratory cats. Cats were eligible for inclusion if they were between 1 and 8 years old and if their body weight was between 2.5 kg and 5.5 kg. Further, there could be no history of chronic vomiting, no signs of vomiting in the last four weeks, and had not received any medication in the previous 3 months, except for deworming and insecticides. The signalment of each cat was also reviewed (for age, breed, diet and deworming history), a physical examination was performed, and a blood biochemistry panel was performed; cats were not included if any abnormalities were identified on these tests or if it was decided that anaesthesia was contraindicated. Finally, cats were also excluded from the final study population if there was macroscopic evidence of possible gastric lesions during endoscopy (see below).

Anaesthesia and endoscopic evaluation

Cats were fasted for 18 hours prior to the procedure, to ensure that the stomach was empty. Water intake was possible until 12 hours before the procedure. General anaesthesia was induced with propofol (4 mg/kg, IV), cats were then intubated and isoflurane gas anaesthesia was used (1.6 L/min). Cats were positioned in left lateral recumbency, as previously recommended (Tams, 2011), and underwent a gastroscopy with an 8.6 mm diameter insertion tube (Video endoscope GIF 160, Olympus, France) performed by the same clinician (VF). The internal macroscopic appearance of the oesophagus and stomach was evaluated according to recommendations from the World Small Animal Veterinary Association (WSAVA) Gastrointestinal Standardization

Group (Washabau et al., 2010). Even without any clinical signs, cats were immediately excluded from the study, and their endoscopic procedure terminated, if macroscopic gastric hyperaemia was scored as 2/3 or 3/3 or if others macroscopic gastric lesions were observed, according to the WSAVA endoscopic examination report form (http://www.wsava.org/guidelines/gastrointestinal-guidelines). No other procedures were undertaken during the procedure including collection of mucosal biopsy samples. One cat underwent surgery for bone fracture repair following the endoscopic procedure. All other cats were anesthetised for the sole purpose of the planned endoscopic procedure.

Measurement of internal pyloric diameter

To measure the internal pyloric diameter, interchangeable biocompatible resin 'olives' of diameter ranging from 4 to 12 mm were designed and manufactured for this study (Figure 1). Olives could be screwed onto a specific endoscopic guidewire that had been passed through the working channel of the video endoscope (Figure 2). To determine the internal pyloric diameter, attempts were made to pass the olives through the pylorus, in decreasing order of size (i.e. largest to smallest). To do this, the gastroscope and olive were carefully passed through the oesophagus and stomach to the pylorus (Figure 3). The olive was then placed in front of the pylorus and a gentle pressure was applied to pass the olive through (Figure 4). If it was not possible to pass the olive through the pylorus, the endoscope and the olive were gently removed, and the procedure repeated sequentially with smaller olives (i.e. 1 mm smaller each time), until one of the olives could be passed. Once this was done, the olive was then carefully withdrawn, and the cat allowed to recover from the procedure. Therefore, the internal pyloric diameter was assumed to be equivalent to the diameter of the first olive that could be passed into the duodenum.

144 **Data collection and statistical analysis**

145 The parameters recorded for the study included the diameter of the first olive that could be
146 passed, the number of manipulations, the duration of the endoscopic procedure and macroscopic
147 gastric inflammation according to WSAVA criteria, as mentioned above. Basic descriptive
148 statistical analyses were performed using Microsoft Excel. Medians and Interquartile ranges
149 (IQR; first and third quartiles) were provided for all quantitative variables. Because of the small
150 number of cats, two distinct groups were considered in order to test the influence of
151 epidemiological data on the internal pyloric diameter. One group "small pylorus" was defined by
152 the smallest pylorus diameter measured (8 or 9 mm), while the other group "large pylorus" was
153 defined by the largest pylorus diameter measured (10 or 11 mm). Age, sex, weight and breed
154 were compared between the small and large pylorus groups by univariate logistic regression
155 analysis, using a software program (XLSTAT 2017 software, Addinsoft, Paris, France). Odds
156 ratio and 95% confidence intervals were calculated for variables. Statistical significance was set
157 as $P<0.05$ using 2-sided analyses.
158

159 **Results**

160 **Study population**

161 Twenty-seven clinically healthy cats were initially included in the study, but three cats were
162 excluded after the endoscopic procedure due to macroscopic gastric hyperaemia graded at 2/3
163 according to the WSAVA criteria (Washabau et al., 2010), leaving 24 cats whose internal pyloric
164 diameter was measured and used in data analysis. The age of three cats was not known, although
165 they were determined to be young adult cats based on clinical examination. For the remaining
166 cats, median (IQR) age was 25 (16-66) months. Median (IQR) weight in the 24 cats included
167 was 3.8 (3.2-4.5) kg (8.4 [7.1-9.9] lb). There were 11 males (1 neutered) and 13 females (3

neutered), with breeds represented including Domestic Shorthair (15/24), Siamese cross (8/24) and Bengal (1/24). All eight mixed Siamese cats were part of a reproductive laboratory cattery and all were entire males, whilst all entire females were SPF cats experimentally infected with toxoplasmosis a few months previously (as part of a separate trial), but free from any clinical signs at the time the current study was conducted. Three cats had a history of bone fracture, 1 cat had a history of previous calicivirus infection; 3 cats presented some moderate lesions of gingivitis and stomatitis (all from the catteries). Only three cats had recently been dewormed; the others lived strictly indoors. All were eating a veterinary dry diet.

Endoscopic findings

The oesophagus and the stomach were evaluated in each cat for macroscopic lesions. Five cats had mild (1/3) gastric hyperaemia without any other significant lesion. No mucosal abnormality was observed in the other 19 cats. The median (IQR) duration of the endoscopic procedure was 4.9 (2.7-5.4) minutes and the median (IQR) number of manipulations was 4 (3-4). No adverse event occurred during the procedure for any cat. All cats recovered from anaesthesia within minutes following the end of the procedure without any complication.

Internal pyloric diameter measurement

The internal pyloric diameter was 8 mm in three cats, 9 mm in twelve cats, 10 mm in eight cats and 11 mm in one cat. The median (IQR) internal pyloric diameter was 9 (9-10) mm, with 23 of 24 cats (96%) having an internal pyloric diameter of 9 ± 1 mm. Fifteen cats were included in the group of “small pylorus”, as described above, with an internal pyloric diameter of 8 or 9 mm; and nine cats were included in the group of “large pylorus” with an internal pyloric diameter of 10 or

11 mm. Univariate logistic regression did not show significantly increased odds of having a smaller pylorus with all variables tested (Table).

Discussion

In this population of 24 healthy cats, the internal pyloric diameter was easily measured by endoscopy by an experienced endoscopic manipulator. The technique developed for the study was safe and quick, with results suggesting a median internal pyloric diameter of 9 mm, with most cats being within ± 1 mm of this measurement. With further validation, this approach could be used in the future as a means of identifying and classifying PS.

Congenital PS is a rare condition in cats with only a few case reports and case series published (Pearson et al., 1974; Syrcle et al., 2013; Twaddle, 1970, 1971). Of the 19 cases described in the veterinary literature, sixteen were young Siamese cats and a predisposition of this breed has been assumed. Furthermore, Twaddle described two cases of feline congenital PS in litter sisters born to a dam who had herself a PS diagnosed and an inherited pattern was suspected (Twaddle, 1971). In one case report, histological and immunohistochemical findings were consistent with a diagnosis of hypertrophy of the tunica muscularis (Syrcle et al., 2013).

In a retrospective study performed by our team, 34 cats underwent upper gastrointestinal endoscopy as part of chronic alimentary vomiting investigation (Freiche et al., 2016). In these cases, a presumptive diagnosis of benign acquired PS was made on the basis that the pylorus was abnormally small on direct examination and could not be intubated with an 8.6 mm gastroscope, which should be possible in healthy cats when performed by an experienced clinician (Tams,

214 2011). However, only a presumptive diagnosis was established because, for now, no
215 complementary exam allowing a definitive diagnosis of PS has been validated.
216
217 In fact, the main thing that this study highlighted is the fact that the exact size of the feline
218 internal pyloric diameter was not known. As a result, we thought that the first step to document
219 benign acquired PS would be to evaluate the internal pyloric diameter in healthy cats. To achieve
220 this, we developed a new endoscopic technique using bespoke measurement devices with an
221 olive shape. The shape of the devices was deliberately chosen to have rounded edges so as to
222 minimize the risk of trauma during insertion, whilst the rest of the device was of constant
223 diameter in order to avoid any risk of bougienage during the passage of the olive through the
224 pylorus. The procedure was easily performed by an experienced clinician in endoscopy and was
225 of short duration with a median duration time less than 5 minutes. Soft pressure was applied and
226 the operator waited for 15 seconds to minimize the possibility that pyloric tone (rather than the
227 internal pyloric diameter) was causing any resistance to passage of the olive. Therefore, while
228 pyloric tone might occasionally have been responsible, we believe that its effect was minimized.
229 No adverse event occurred during any procedure and all cats recovered well in the minutes
230 following the end of the manipulations. The anaesthetic protocol used in this study was chosen in
231 order to avoid the use of any drug known to affect pyloric tone or function (Smith et al., 2004).
232
233 Cats included in the study were determined to be healthy based on history, clinical examination
234 and biochemistry. Most of them had an internal pyloric diameter of 9 ± 1 mm, consistent with the
235 suggestion that the pylorus is supposed to be easily passable in cats with a flexible gastroscope of
236 8.6 mm (Tams, 2011). However, 3/24 cats in our study had an internal pyloric diameter of 8 mm
237 despite no clinical signs of pyloric outflow obstruction. Rather than suggesting subclinical PS, it

238 is possible that, for some cats, a narrower pyloric diameter is a normal finding. Further work
239 involving more cats would be required to confirm normal pyloric diameter. A second
240 observation of note was that moderate to severe macroscopic gastric hyperaemia was evident in 3
241 cats (which were excluded), even though they were apparently healthy with no evidence of
242 clinical signs including vomiting. Given that the internal pyloric diameter was not measured, it is
243 unclear as to whether or not the pyloric size was different. Further, whilst these cats might have
244 had a subclinical gastropathy, no biopsies were taken to confirm this hypothesis.
245
246 Siamese cats are reportedly predisposed both to congenital and acquired PS and, as a result, we
247 expected that the Siamese-cross cats in our study would have a smaller internal pyloric diameter
248 (Freiche et al., 2016; Pearson et al., 1974; Twaddle, 1970, 1971). However, there was no
249 significant difference in breed between cats with different pyloric sizes and, in fact, most
250 Siamese-cross cats had an internal pyloric diameter of 10 mm. This might suggest that the
251 predisposition of this breed to PS is not due to the fact that the pyloric diameter is inherently
252 smaller in this breed. That said, the cats included here were mixed Siamese and so the findings
253 might have been different if a purebred population of Siamese cats had been studied. Therefore,
254 a further study is required to determine the normal internal pyloric diameter of cats of different
255 breeds.
256
257 In humans, infantile hypertrophic PS is a well-known condition of newborns and infants and is
258 the most common condition requiring surgery in infants (Zhu et al., 2017). It is characterized by
259 acquired narrowing of the pylorus secondary to hypertrophy of the pyloric musculature (Peters et
260 al., 2014). Its aetiology is largely unknown but a genetic background is suspected and
261 environmental factors as well as perinatal factors are also likely to play an important role (Peters

et al., 2014; Zhu et al., 2017). In contrast, the adult form of idiopathic hypertrophic PS is a rare disorder in humans and only over 200 cases have been described in the medical literature (Gurvits et al., 2013). In contrast, two forms of benign PS have been described in dogs (Hall, 2013). The congenital form is the least common, most notably in brachycephalic breeds and there are similarities with infantile hypertrophic PS, with selective hypertrophy of the muscularis of the pylorus (Hall, 2013). The acquired form of the disease is more common with the stenosis being due to mucosal hypertrophy in addition to a thickened muscular layer (Hall, 2013). Male dogs and those of smaller breeds (Lhasa Apso, Shih Tzu, Pekingese, Maltese) are overrepresented (Bellenger et al., 1990). In cats, ultrasonographic and endoscopic findings suggest that the acquired form of PS predominantly affects the mucosa (unpublished data). However, full-thickness biopsies have never been performed in cases of acquired PS in cats to confirm these findings.

In children, ultrasonography is the modality of choice for the diagnosis of hypertrophic PS and the main diagnostic criterion is measurement of the thickness of the muscular layer with the use of an abnormal cut off value of 3 mm in thickness (Costa Dias et al., 2012; Peters et al., 2014). Other criteria include abnormal elongation of the canal (greater than 12 or 15 mm in length) and a markedly distended stomach with active peristalsis. However, these criteria are difficult to use in cats because pyloric wall thickness and thickness of the pyloric muscularis vary widely between studies and because several other diseases can affect the pyloric antrum in adult cats, such as neoplasia, benign polyps, ulcers and eosinophilic sclerosing fibroplasia (Couturier et al., 2012; Goggin et al., 2000). In fact, ultrasonography is useful to identify a thickening of one layer or a thickened gastric wall but the internal pyloric diameter cannot be evaluated.

Until now, the presumptive diagnosis of PS in cats was based on the association of clinical findings, radiographic and/or ultrasonographic findings and endoscopic appearance with exclusion of other causes by histologic analysis of multiple biopsies (Syrcle et al., 2013). Knowing the size of the internal pyloric diameter in healthy cat will now allow a more accurate endoscopic evaluation of cats with a suspicion of PS. For comparison, in humans, the size of the internal pyloric diameter has been estimated between 1.2 and 1.5 cm in adult patients, as measured using the index finger during gastric surgery (Maylard, 1904). The size of the internal pyloric diameter has not yet been determined precisely in dogs.

The current study has several limitations that should be considered. First, the repeatability and reproducibility of this technique was not assessed for ethical reasons, for example to avoid prolonged and repeated anaesthesia. However, the procedure was easy to perform and most clinicians experienced in endoscopy should be able to perform the same procedure. Second, only a small number of measurement devices were available, meaning that there was a limitation in the sizes that could be assessed, and measurements could only be made to the millimetre. However, whilst more devices could have been created (for example differing in size by 0.2-0.5 mm), this would have increased the number of manipulations and the duration of the procedure overall. A third study limitation was the fact that mucosal biopsies were not collected during the procedure, meaning that the presence of gastric disease (even subclinical) could not be determined. In fact, gross findings frequently do not correlate with histopathological results in the digestive tract (Hall and Day, 2017). That being said, all cats were healthy without any signs of gastrointestinal disease. However, we thought that adding biopsies at the design of this study would have make the study more invasive, even if the risk of complication would have still been low. A fourth study limitation was that ten cats were SPF cats experimentally infected with

toxoplasmosis in a previous study and the effect that this might have had on the measurements taken is not known. However, all of these cats were clinically healthy and did not excrete oocysts at the time of the study. A fifth limitation was that the number of cats included was small and the absence of statistical significant differences between groups could be due to the fact that the study was underpowered. Finally, since there were many Siamese cats and intact males and females, the cats studied might not be totally representative of cats in the general pet population. Further studies should be considered involving more cats, with a wider range of ages and breeds. Cats with gastrointestinal signs, including those with signs of delayed gastric emptying, should also prospectively be evaluated to determine how the internal pyloric diameter changes with disease. Finally, it would be useful to assess the performance of this technique in young kittens to determine if it might be useful for the diagnosis of congenital PS, and also adapted to dogs.

Conclusion

Pyloric diameter can be easily measured in cats by endoscopy using specially-designed olive-shaped measurement devices. This endoscopic technique was safe and of short duration. In this study, based on 24 healthy cats, the median diameter of the pylorus was measured at 9 mm with 96 % of cats having an internal pyloric diameter within 1 mm of this, using propofol and isoflurane for anaesthesia. A prospective study in now warranted in cats with chronic delayed food vomiting and with a high suspicion of benign PS to compare their internal pyloric diameter to the group of cats described in the present study.

Reference list

Bellenger, C.R., Maddison, J.E., MacPherson, G.C., Ilkiw, J.E., 1990. Chronic hypertrophic pyloric gastropathy in 14 dogs. Aust. Vet. J. 67, 317-320.

Costa Dias, S., Swinson, S., Torrao, H., Gonçalves, L., Kurochka, S., Vaz, C.P., Mendes, V., 2012. Hypertrophic pyloric stenosis: tips and tricks for ultrasound diagnosis. Insights Imaging 3, 247-250

Couturier, L., Rault, D., Gatel, L., Belli, P., 2012. Ultrasonographic characterization of the feline cardia and pylorus in 34 healthy cats and three abnormal cats. Vet. Radiol. Ultrasound 53, 342-347.

Freiche, V., Da Riz, F., Faucher, M., Lamoureux, A., Benchekroun, G., German, A.J., 2016. Presumed acquired pyloric stenosis in cats: epidemiologic, clinical, histopathological and endoscopic data. A retrospective study of 34 cases. In Proceedings, 26th ECVIM-CA Congress, 228.

Goggin, J.M., Biller, D.S., Debey, B.M., Pickar, J.G., Mason, D., 2000. Ultrasonographic measurement of gastrointestinal wall thickness and the ultrasonographic appearance of the ileocolic region in healthy cats. J. Am. Anim. Hosp. Assoc. 36, 224-228.

Gurvits, G.E., Tan, A., Volkov, D., 2013. Video capsule endoscopy and CT enterography in diagnosing adult hypertrophic pyloric stenosis. World J. Gastroenterol. 19, 6292-6295.

358 Hall, J.A., 2013. Stomach: obstruction. In: Washabau, R.J., Day, M.J. (Eds), Canine & Feline
359 Gastroenterology. Saunders Elsevier, Saint Louis, pp. 624-630.
360
361 Hall, E.J., Day, M.J., 2017. Diseases of the small intestine. In: Ettinger, S.J., Feldman, E.C.,
362 Côté, E. (Eds), Textbook of Veterinary Internal Medicine. Eighth ed. WB Saunders, Philadelphia,
363 pp. 1516-1564.
364
365 Maylard, A.E., 1904. Congenital narrowness of the pyloric orifice a cause of chronic gastric
366 disease in the adult, illustrated by seven cases successfully treated by operation. Br. Med. J. 20,
367 416-419.
368
369 Pearson, H., Gaskell, C.J., Gibbs, C., Waterman, A., 1974. Pyloric and oesophageal dysfunction
370 in the cat. J. Small Anim. Pract. 15, 487-501.
371
372 Peters, B., Oomen, M.W., Bakx, R., Benninga, M.A., 2014. Advances in infantile hypertrophic
373 pyloric stenosis. Expert Rev. Gastroenterol. Hepatol. 8, 533-541.
374
375 Simpson, K.W., 2013. Stomach: structure and function. In: Washabau, R.J., Day, M.J. (Eds),
376 Canine & Feline Gastroenterology. Saunders Elsevier, Saint Louis, pp. 606-609.
377
378 Smith, A.A., Posner, L.P., Goldstein, R.E., Ludders, J.W., Erb, H.N., Simprson, K.W., Gleed,
379 R.D., 2004. Evaluation of the effects of premedication on gastroduodenoscopy in cats. J. Am.
380 Vet. Med. Assoc. 225, 540-544.
381

382 Syrcle, J.A., Gambino, J.M., Kimberlin, W.W., 2013. Treatment of pyloric stenosis in a cat via
383 pylorectomy and gastroduodenostomy (Billroth I procedure). J. Am. Vet. Med. Assoc. 242, 792-
384 797.
385
386 Tams, T.R. Gastroscopy. In: Tams, T.R., Rawlings, C.A. (Eds), Small animal endoscopy. Third
387 ed. Elsevier Mosby, Saint Louis, pp. 97-172.
388
389 Twaddle, A.A., 1970. Pyloric stenosis in three cats and its correction by pyloroplasty. N. Z. Vet.
390 J. 18, 15-17.
391
392 Twaddle, A.A., 1971. Congenital pyloric stenosis in two kittens corrected by pyloroplasty. *N. Z.*
393 *Vet. J.* 19, 26-27.
394
395 Washabau, R.J., Day, M.J., Willard, M.D., Hall, E.J., Jergens, A.E., Mansell, J., Minami, T.,
396 Bilzer, T.W., 2010. Endoscopic, biopsy, and histopathologic guidelines for the evaluation of
397 gastrointestinal inflammation in companion animals. J. Vet. Intern. Med. 24, 10-26.
398
399 Zhu, J., Zhu, T., Lin, Z., Qu, Y., Mu., D., 2017. Perinatal risk factors for infantile hypertrophic
400 pyloric stenosis: A meta-analysis. J. Pediatr. Surg. 52, 1389-1397.
401
402