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Evaluation of cryptorchidism in cats and dogs

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ABSTRACT

Objective: Cryptorchidism, the failure of one or both testes to descend into the scrotum, is a common congenital condition in male cats and dogs. This study aimed to assess the incidence and characteristics of cryptorchidism in neutered cats and dogs.

Materials and Methods: A retrospective analysis was conducted on 1622 animals (348 dogs and 1274 cats) brought for neutering between 2015 and 2023. Cryptorchid was diagnosed by clinical examination and its location was determined by ultrasound examination. Animals diagnosed with cryptorchid were castrated. Breed, age, weight, and location of the retained testicle of all patients were recorded.

Results: Dogs exhibited a higher prevalence (8.91%) compared to cats (3.30%). The affected testes were predominantly subcutaneous in both species (61.29% in dogs, 73.81% in cats). Unilateral cryptorchidism was more common, with equal distribution between the right and left sides in dogs and a higher incidence on the left in cats. Purebred animals, particularly small-sized breeds, showed a higher susceptibility to cryptorchidism.

Conclusion: Our study provides valuable insights into the prevalence, localization, and characteristics of cryptorchidism in cats and dogs, emphasizing the importance of detection and intervention to safeguard the health of affected animals. The findings highlight the higher susceptibility of purebred cats and dogs.

Keywords: *Cryptorchidism, Cat, Dog*

INTRODUCTION

The failure of one or both of the testes to descend into the scrotum is known as cryptorchidism (Davidson, 2020; Gradil and McCarthy, 2023). Cryptorchidism is considered the most common congenital disease in male cats and dogs (Villalobos-Gomez et al., 2023). In embryonic life, the testes are located caudal to the kidneys (Romagnoli, 1991; Englar, 2019) in the abdominal cavity. The right testicle is slightly more cranial than the left testicle (Spangenberg, 2021). The testes, which complete their development before the inguinal canal closes, descend from the abdominal cavity into the scrotum through the inguinal canal (Romagnoli, 1991; Englar, 2019; Spangenberg, 2021). The gubernaculum, a peritoneal fold also known as the genito-inguinal ligament, is a long, cylindrical, mesenchymal structure that connects the testes to the scrotum at one end. This structure mediates the descent of the testicle from the inguinal canal to the scrotum (Romagnoli, 1991; Gier and van Sluijs, 2010; Spangenberg, 2021). The testicles descend into the scrotum in 3 stages; (a) abdominal testicular translocation: testes translocate from the lower part of the kidneys to the

entrance of the inguinal canal, (b) trans inguinal testicular migration: within the inguinal canal, (c) inguinoscrotal testicular migration: refers to the process of displacement from the outer ring of the inguinal canal into the scrotum (Amann and Veeramachaneni, 2006; Gier and van Sluijs, 2010). Insulin-like peptide 3 produced by fetal leydig cells mediates the descent of the testis from the caudal aspect of the kidney into the inguinal canal (Gier and van Sluijs, 2010; Davidson, 2020). Inguinoscrotal descent is mediated only by testosterone (Davidson, 2020). While the inguinal canal closes in dogs at around 6 months of age (Yates et al., 2003), it is reported to close in cats at 7-8 months of age (Little, 2011).

Although cryptorchidism in dogs is inherited and transmitted as a sex-limited autosomal recessive trait (Gier and van Sluijs, 2010; Davidson, 2020; Gradil and McCarthy, 2023), it is probably caused by more than one gene (Gier and van Sluijs, 2010). Since the gene(s) responsible for testicular descent is autosomal, cryptorchidism can be carried by both males and females (Gradil and McCarthy, 2023). Cryptorchidism in cats is assumed to be inherited and a polygenic mode of inheritance has been proposed (Davidson, 2020; Gradil and McCarthy, 2023). The prevalence of cryptorchidism in dogs varies between 1.2% and 10% (Gier and van Sluijs, 2010; Gradil and McCarthy, 2023). In cats, it has been reported as 0.37-3.8% (Gier and van Sluijs, 2010; Little, 2011; Gradil and McCarthy, 2023) and this rate is generally lower than the prevalence in dogs (Little, 2011). Unilateral cryptorchidism does not lead to infertility due to the presence of one scrotal testicle. Bilateral cryptorchid cats and dogs are infertile due to lack of normal spermatogenesis resulting from intra-abdominal temperature (~5° > scrotal). In both cases, libido and secondary sex characteristics are normal as interstitial cells continue to produce testosterone (Davidson, 2020; Griffin, 2020). Especially older dogs with abdominal cryptorchids are at high risk for the development of Sertoli cell tumors and spermatic cord torsion (Englar, 2019; Griffin, 2020). Although unilateral cryptorchidism is common in cats and dogs (Little, 2011; Griffin, 2020; Gradil and McCarthy, 2023; Villalobos-Gomez et al., 2023; Runge et al., 2024), bilateral cryptorchidism also appears (Griffin, 2020). Left and right sides are equally affected (Villalobos-Gomez et al., 2023). However, it is stated that it is more common in the right testicle in dogs (Moon, 2014; Griffin, 2020; Gradil and McCarthy, 2023).

Cryptorchidism is diagnosed by examination and palpation. Those in the inguinal region can sometimes be palpated, but in young animals, it is difficult to reliably determine the position of the testes due to their small size in the first weeks of life. Testicles cannot be palpated in abdominal cryptorchids (Gier and van Sluijs, 2010). Ultrasound examination is the preferred method to determine the localization of cryptorchidism in suspected cats and dogs (Davidson, 2020). Bilateral castration is recommended for all cryptorchid dogs and cats (Griffin, 2020). The aim of this study is to describe the results of an investigation to determine the incidence and nature of cryptorchidism in neutered cats and dogs. This research is the first and most comprehensive study on this subject in our country.

MATERIALS and METHODS

This study was approved by the Van Yuzuncu Yil University Animal Experiments Local Ethics Committee (2023/14-05). Healthy male cats and dogs brought to Van Yuzuncu Yil University Animal Hospital Surgery Clinic and private clinics for neutering between 2015 and 2023 were included in the study. Breed, age and weight data of all patients were recorded.

Figure 1. Examination and diagnosis of subcutaneously retained testicles by palpation.

Scrotal examination was performed in all animals. Patients in whom one or both testes were absent in the scrotal sac during scrotal examination by palpation were considered as cryptorchids (Figure 1). Ultrasonographic examination was performed in all patients diagnosed as cryptorchids to determine the localization of the undescended testicle. Cryptorchid animals were classified according to the affected testes (right, left or bilateral) and their localization (abdominal, inguinal or subcutaneous).

All patients were sedated and intubated following induction. Surgical approach was performed with standard surgical techniques according to the localization of the cryptorchid testicle. In abdominal cryptorchidism, the testicle was removed from the abdomen by caudal paramedian laparotomy in dogs and midline median laparotomy in cats. In inguinal cryptorchidism, it was removed through a skin incision over the inguinal canal. Subcutaneous cryptorchidism was removed by skin incision just above the testicle (Figure 2).

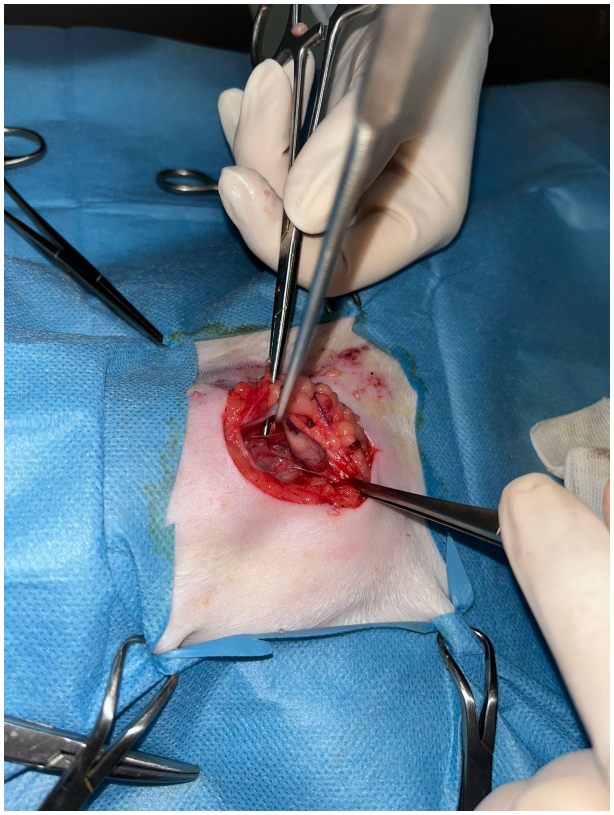

Figure 2. Subcutaneously retained testicle was removed by skin incision just above the testicle.

Statistical Analysis

The breed, age, weight, presence of cryptorchidism and localization data of all animals brought for castration were evaluated using descriptive statistical analysis.

RESULTS

In this retrospective study, the presence of cryptorchid was detected in 73 (4.50%) of the 1622 cats and dogs brought to the clinic for castration as a result of clinical examination, palpation and ultrasonographic examination imaging (Table 1).

Table 1. Animal species, numbers and rates of the cryptorchid animals

	Cat	Dog
Castrated animal number	1274	348
Number of cryptorchids	42	31
Total cryptorchid rate (%)	3.3	8.91
Subcutaneous cryptorchids rate (%)	73.81	61.29
Abdominal cryptorchids rate (%)	11.9	25.81
Inguinal cryptorchids rate (%)	14.29	12.9

Of 348 dogs brought for castration, 31 (8.91%) were found to have cryptorchids. The distribution of cryptorchid dogs according to breeds was 27 (9.75%) in purebreds and 4 (5.63%) in crossbreds (Table 2). The distribution of cryptorchid cases according to body weight was 16 (7.21%) in small breeds, 3 (15.79%) in medium breeds and 12 (11.21%) in large breeds. Mean age (months±SD) was 40.59±40.58 and mean weight (kg±SD) was 13.92±11.31. The localizations of the testes in cryptorchid dogs were subcutaneous (61.29%), abdominal (25.81%) and inguinal (12.9%), respectively (Table 1). In animals with unilateral subcutaneous cryptorchids, 42.1% of the cryptorchid testicle was the right testicle and 52.6% was the left testicle. Bilateral subcutaneous cryptorchidism was seen in 5.3%. In dogs with abdominal cryptorchidism, right and left cryptorchid testes were equally affected. In animals with unilateral inguinal cryptorchidism, the rate of right testicle was 75% while the rate of left testicle was 25%. No case of bilateral inguinal cryptorchid was observed. The dog breeds with the highest number of cryptorchids were Poodle, Maltese Terrier, and Chihuahua.

Of the 1274 cats brought for castration, 42 (3.30%) were found to be cryptorchid (Table 1). The distribution of cryptorchid cats according to breeds was 29 (3.90%) in purebreds and 13 (2.45%) in crossbreds. Mean age (months±SD) was 21.29±21.42 and mean weight (kg±SD) was 4.26±0.77 (Table 2). The localizations of cryptorchids were subcutaneous (73.81%), inguinal (14.29%) and abdominal (11.9%), respectively (Table 1). In

animals with unilateral subcutaneous cryptorchid, 32.3% of the cryptorchid testicle was the right testicle and 45.2% was the left testicle. Bilateral subcutaneous cryptorchidism was seen in 22.6%. In animals with unilateral inguinal cryptorchidism, right and left testes were equally affected. In cats with unilateral abdominal cryptorchidism, the rate of right testicle involvement was 40% while the rate of left testicle involvement was 60%. No case of bilateral abdominal cryptorchid was observed. The cat breeds were British Shorthair, Van Cat, Chinchilla, and Domestic Shorthair.

Table 2. Distribution of the cryptorchidism among crossbred and purebred animals**.**

Species	Breed (Crossbred / Purebred)	Total Number	Number of Cryptorchids	Rates (%)
Cat	Crossbred	530	13	2.45
	Purebred	744	29	3.90
Dog	Crossbred	71	4	5.63
	Purebred	277	27	9.75

DISCUSSION

In veterinary medicine, cryptorchidism is a hereditary condition and one of the most common congenital defects seen in small animals. (Runge et al., 2024) The testes are the male reproductive organs responsible for sperm production and secretion of sex hormones. Normally, the testes descend from the abdominal cavity into the scrotum shortly after birth in cats and from day 10 (Gier and van Sluijs, 2010; Little, 2011; Griffin, 2020; Gradil and McCarthy, 2023) to day 35 **(**Pretzer, 2008**)** in dogs. If one or both testes are not present in the scrotum by 2 months of age, the animal is considered cryptorchid. It has been reported that testes are unlikely to descend into the scrotum after this age (Birchard and Nappier, 2008; Millard, 2018). However, in some literature, it is reported that the inguinal canal closes at approximately 6 months of age in dogs (Yates et al., 2003), while it closes at 7-8 months of age in cats (Little, 2011). It is stated that it is necessary to wait until the end of the inguinal canal closure period for the testes to descend into the scrotum (Little, 2011; Yates et al., 2003). Affected young animals usually do not show signs of disease unless an associated pathology such as torsion or neoplasia develops in the involved testicle. Because they do not show any clinical signs, the disease often goes unrecognized by the owners (Birchard and Nappier, 2008). On inspection and especially palpation of the scrotum, the animal is easily diagnosed as cryptorchid if one or both testes are absent from the scrotum (Birchard and Nappier, 2008; Villalobos-Gomez et al., 2023). During palpation, a sebaceous gland and lymph node in the scrotum may be perceived as a testicle. It is easily differentiated from the sebaceous gland and lymph node by the free movement of the testicle in the scrotum and the detection of an epididymis attached to the testicle (Miller et al., 2004; Spangenberg, 2021). In this study, cryptorchids were diagnosed in animals in which one or both testes were not in the scrotum by palpation examination of the scrotum of animals brought for castration.

Testicular descent from the abdominal cavity to the scrotum is regulated by both androgenic and non-androgenic factors and mediated by the gubernaculum, a gelatinous tissue of mesenchymal origin. The pathogenesis of defects in testicular descent is poorly understood. However, the physical size and/or growth rate of the epididymites and gubernacular may be involved in abnormal testicular descent. It is hypothesized that lack of regression of the cranial suspensory ligament may prevent overgrowth of the gubernacular and subsequent descent of the testes (Gradil and McCarthy, 2023). As a result of disruption in the descent of the testes to the scrotum, the testes are retained in the abdominal cavity, inguinal canal and subcutaneously after passing the inguinal canal without reaching the scrotum (Amann and Veeramachaneni, 2006; Birchard and Nappier, 2008; Millard, 2018; Griffin, 2020; Spangenberg, 2021). In determining the location of the involved testicle, palpation and ultrasonographic examination are important. Subcutaneously involved testicles can be easily detected by palpation and/or ultrasonographic examination (Miller et al., 2004). Abdominal retained testes may be difficult to detect by ultrasound because they may be smaller in size and in a wider range in location. However, ultrasound is usually more successful in locating testes retained in the inguinal canal (Spangenberg, 2021). In one study, it was reported that ultrasound was used with 96.6% success in the detection of abdominal cryptorchids and 100% success in the detection of inguinal cryptorchids and that it is a sensitive diagnostic technique for locating retained testicles in domestic animals (Felumlee et al., 2012). In our study, palpation and ultrasound examination were used together to locate the retained testes. In

particular, the location of the abdominal and inguinal retained testicle was determined by ultrasound examination and this was later confirmed during surgery. Thus, we suggest that ultrasound examination can be successfully used to localize retained testicles preoperatively.

Currently, it is accepted that cryptorchidism has many causes including genetic, epigenetic and environmental components. However, the role of environmental factors has not yet been established (Amann and Veeramachaneni, 2006). In addition, the presence of umbilical infections and failure to increase abdominal pressure as a result of late closure of the umbilical canal or inability of the testes to reach the scrotum due to adhesion caused by inflammation have been shown as predisposing factors (Romagnoli, 1991). We think that the cases of cryptorchidism in our study had a genetic origin. In addition, we did not find any predisposing factor such as umbilical hernia or infection in the dogs and cats diagnosed with cryptorchidism.

Because cryptorchid testicles usually have significantly higher temperatures than normal descending testicles, unilateral cryptorchids reduce semen quality or fail to produce normal sperm. A male with bilateral cryptorchids does not produce normal sperm and is infertile. Both unilateral and bilateral cryptorchid dogs produce testosterone, so most show sexual desire. In cryptorchid cats, the testes produce testosterone and the cats show typical secondary sex characteristics such as urine marking, aggressive behavior and urine odor (Spangenberg, 2021; Gradil and McCarthy, 2023). Abdominally retained testes move more freely than testes within the scrotum and are therefore more susceptible to testicular torsion. Furthermore, the incidence of testicular neoplasia has been found to be 13 times higher in abdominally retained testes than in descending testes (Birchard and Nappier, 2008). There is no proven treatment that causes the retained testicle to descend into the scrotum. It is considered unethical to attempt to treat an animal for reproductive purposes (Miller et al., 2004; Little, 2011). Since cryptorchidism is inherited in all the animals we diagnosed as cryptorchids in our study, we preferred treatment with castration to prevent the transmission of this defect to offspring and because retained testicles are prone to develop neoplasia or torsion (Little, 2011; Davidson, 2020; Griffin, 2020; Spangenberg, 2021; Villalobos-Gomez et al., 2023).

Previous studies have reported the incidence of cryptorchidism to be between 0.8% and 12.9% in dogs (Spangenberg, 2021; Runge et al., 2024) and between 1.3% and 6.2% in cats (Little, 2011; Villalobos-Gomez et al., 2023; Runge et al., 2024). Yates et al. (2003) found a 4% prevalence of cryptorchid in cats and dogs brought for neutering over a 54-month period. While the number of dogs with cryptorchids was 240 (6.8%), this number was 50 (1.3%) in cats (Yates et al., 2003). In a study in which 4924 dogs underwent ultrasound scanning, cryptorchid was found in 8.2% of dogs (Tannouz et al., 2019). In a study evaluating congenital anomalies in puppies, the incidence was found to be 2.6% (Ruble and Hird, 1993). In a previous study, cryptorchids were found in 72 (1.7%) of 4140 neutered cats (Little, 2011). In a 10-year period, 23 (1.7%) of 1345 cats admitted for orchiectomy were found to have cryptorchid (Millis et al., 1992). In a large-scale study in stray cats, the prevalence of cryptorchidism in cats was found to be 1.3% (Wallace and Levy, 2006) and 1.9% in a similar study (Scott et al., 2002). In our study conducted on 1274 cats and 384 dogs brought to our clinics for neutering, the prevalence of cryptorchidism was found to be 8.91% in dogs and 3.30% in cats. The prevalence of cryptorchidism in dogs was higher than in cats and this finding is similar to other studies. We think that the prevalence of cryptorchidism in cats and dogs varies greatly according to the number of animals and animal breeds in the studies.

Testes retained in cryptorchid animals are reported to be localized as 33% abdominal, 49% inguinal and 14% subcutaneous in cats (Richardson and Mullen, 1993) and 59.8% abdominal, 40.2% inguinal and subcutaneous in dogs (Yates et al., 2003). In a study in which testicles retained in the inguinal canal and abdomen were removed by inguinal canal surgery, it was found that 68.18% were retained in the abdominal and 31.82% in the inguinal canal in dogs and 75% in the abdominal and 25% in the inguinal canal in cats (Steckel, 2011). In studies conducted in cats, 48% (Scott et al., 2002), 70% (Yates et al., 2003) abdominal, 52% (Scott et al., 2002), 30% (Yates et al., 2003) inguinal and subcutaneous involvement was reported. In a study conducted to determine the prevalence of cryptorchidism in dogs, it was reported that 38.4% of the involved testes were located in the abdominal region and 61.6% in the inguinal region (Tannouz et al., 2019). In this study, it was determined that cryptorchid testes were located in 25.81% abdominal, 12.9% inguinal and 61.29% subcutaneous regions in dogs and 11.19% abdominal, 14.29% inguinal and 73.81%

subcutaneous regions in cats. It was determined that the testes retained in cats and dogs were mostly localized in the subcutaneous region.

It is reported in the literature that the testes are usually unilaterally involved in cryptorchid cats and dogs. In studies, the rate of unilateral cryptorchid in cats was reported to be 51.6% to 86% (Scott et al., 2002; Yates et al., 2003; Little, 2011; Steckel, 2011; Villalobos-Gomez et al., 2023) and in dogs it was reported to be 70% to 81.8% (Yates et al., 2003; Steckel, 2011; Tannouz et al., 2019). In the literature, it is stated that unilateral cryptorchid cases occur equally in the right and left testicle (Romagnoli, 1991; Scott et al., 2002; Little, 2011; Moon, 2014). It is suggested that right cryptorchidism is more common because of the longer distance that the right testicle has to travel to reach the scrotum due to the fact that the right testicle is located in the abdomen in the embryonic period in the right testicle is located in a more cranial position than the left testicle (Moon, 2014; Villalobos-Gomez et al., 2023). In previous studies, the rate of involvement of the unilateral right testicle was 57.9% (Villalobos-Gomez et al., 2023) and 52% (Yates et al., 2003) in cats. In dogs, the rate of involvement of the unilateral right testicle was 77.7% (David et al., 2023), 68.1% (Yates et al., 2003), 60.4% (Felumlee et al., 2012), 59.5% (Tannouz et al., 2019) and the rate of involvement of the left testicle was 66.6% (Runge et al., 2024). In the present study, the rate of involvement of the unilateral left testicle in cats was 57.14%, the rate of involvement of the right testicle was 42.86%, while the rates of involvement of the right and left testicles in dogs were found to be equal. While the equal rates of right and left testicular involvement in dogs are similar to many literatures (Romagnoli, 1991; Little, 2011; Moon, 2014), the higher rate of left testicular involvement in cats is consistent with the study by Yates et al. (2003).

The pathogenesis of cryptorchidism is not fully understood. It is emphasized that mostly small breeds and smaller animals within a breed are generally at high risk for cryptorchidism (Gradil and McCarthy, 2023). In a study by Tannouz et al. (2019) investigating the size and breed relationships of cryptorchidism in dogs, it was reported that 280 of 403 cryptorchid dogs were small-size, 62 were medium-size and 57 were large-size. In the same study, 377 of 403 dogs with cryptorchidism were purebred and 26 of them were crossbreds. In this study, cryptorchids were found in 7.21% of small-size, 15.79% of medium-size and 11.21% of large-size dogs brought for neutering. In addition, 16 of the 31 dogs with cryptorchid were small-sized, 3 were medium-sized and 12 were large-sized. Among the 31 dogs diagnosed with cryptorchid, the number of small-sized animals was high. This finding we obtained is in parallel with the studies (Tannouz et al., 2019; Gradil and McCarthy, 2023) emphasizing that cryptorchidism is more common in small-sized breeds.

In addition, it is emphasized that the incidence of cryptorchidism is more common in purebred animals than in crossbred animals (Gier and van Sluijs, 2010; Griffin, 2020). However, there are some breeds such as English Bulldog, Boxer, Chihuahua, Shetland Sheepdog, Chihuahua, Shetland Sheepdog, and Yorkshire Terrier which show a higher incidence and thus are at greater risk for the development of cryptorchidism. (Spangenberg, 2021) In studies, it has been reported to be common in dog breeds such as German shepherd dog, Yorkshire terrier, Boxer, Poodle, (Yates et al., 2003; Tannouz et al., 2019), and cat breeds such as Persian, Ragdoll, Siamese, domestic shorthair, (Villalobos-Gomez et al., 2023; Runge et al., 2024). In the present study, the proportion of purebred breed cryptorchid dogs among 348 dogs brought for castration was 9.75% and the proportion of crossbred cryptorchid dogs was 5.63%. Among 1274 cats brought for castration, the proportion of purebred breed cryptorchid cats was 3.90% and the proportion of crossbred cryptorchid cats was 2.45%. The higher incidence of cryptorchid cases in purebred breeds compared to crossbreds in our study can be explained by the high level of cryptorchidism as a result of the mating of animals with inbreeding, which is a more intensive form of pure breeding (Gradil and McCarthy, 2023). In our study, more cryptorchids were observed in Poodle, Maltese Terrier, Chihuahua dog breeds and cat breeds such as British Shorthair, Van Cat, Chinchilla, Domestic Shorthair.

CONCLUSION

In conclusion, cryptorchidism presents a significant health concern for both cats and dogs. This condition, characterized by the failure of one or both testicles to descend into the scrotum, can lead to various complications, including an increased risk of testicular cancer and potential fertility issues. Neutering is often recommended as the primary course of action for cryptorchid pets, involving the surgical removal of the retained testicle(s). This not only helps prevent future health issues but also

reduces the risk of passing on genetic predispositions.

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