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Suppression of Fertility in Adult Cats

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Contents

Cats are animals with highly efficient reproduction, clearly pointing to a need for suppression of fertility. Although surgical contraception is highly effective, it is not always the method of choice. This is predominantly because it is cost-intensive, time-consuming and irreversible, with the latter being of major importance for cat breeders. This article reviews the use of progestins, sclerotizing agents, immunocontraception, melatonin, GnRH antagonists and finally, GnRH agonists, in adult male and female cats in detail, according to the present state of the art. By now, various scientific and clinical options are available for the suppression of fertility in adult cats and the decision as to which should be chosen – independent of the legal registration of any state – depends on different facts: (i) feral or privately owned animal? (ii) temporary or permanent suppression of fertility wanted/needed? (iii) sex of the animal? New effective and available methods for hormonal contraception include melatonin implants for short-term postponement of oestrus in adult queens and slow-release GnRH-agonist implants containing deslorelin (Suprelorin[®]) for short- and long-term contraception in male and female companion and breeding cats.

Introduction

Female cats are seasonally polyoestrous, and usually, ovulations are induced by mating (Wildt et al. 1980, 1981), making reproduction highly efficient (Kutzler 2007). The duration of the oestrous cycle depends on whether ovulation occurred or not, with a shorter duration in non-ovulating cycles (Wildt et al. 1980, 1981) – a fact which increases the chance of establishment of pregnancy even more. Due to these reasons, two cats at reproductive age, with three litters of four kittens a year, could theoretically result in an enormous population of 20 736 cats within 4 years.

Thus, reproduction control and, consequently, avoidance of pet overpopulation are the predominant reasons for the suppression of fertility in feral and privately owned cats and a key tool for cat welfare. Further reasons for suppression of fertility are unwanted male tom cat behaviour (urine spraying, mounting, mating), unwanted female oestrous behaviour and roaming of male and female cats due to sexual activity. Surgical spaying/neutering is the most commonly performed procedure as a method of contraception to address the pet overpopulation problem (Howe 2006). It is highly effective, but cost-intensive and time-consuming to perform on a large scale (Levy et al. 2003; Kutzler and Wood 2006; Wallace and Levy 2006). Therefore,

there is a need for alternative methods of contraception (reviews: Kutzler and Wood 2006; Goericke-Pesch 2010). A matrix model pointed out the promise of utilizing a contraceptive with 3 years of contraceptive effect in feral cat colonies (Budke and Slater 2009). The results are close to that of surgery and may well be able to be delivered with less cost and administrative burden. Furthermore, such a product is of interest to owners of cats seeking a less invasive means of contraception or wanting to delay surgery, to safely prevent accidental litters and sexual hormone-dependent behaviour. Hormonal contraception is also interesting for cat breeders when later use for breeding precludes surgery, but temporary, reversible suppression of oestrus and androgen-dependent behaviour is needed.

Various options are available for suppression of fertility in adult cats and the decision as to which should be chosen depends on whether temporary or permanent contraception is wanted in a male or female cat (Table 1). In the following, the use of progestins, sclerotizing agents, immunocontraception, melatonin, gonadotropin-releasing hormone (GnRH)-antagonists and finally, GnRH agonists in adult male and female cats will be reviewed.

Progestins

For decades, progestins have been used as an alternative to surgical spaying in female cats (Jackson 1984; Romagnoli and Concannon 2001; Kutzler and Wood 2006; Goericke-Pesch 2010), mostly outside the USA. Although their direct mode of action is not fully understood, they are considered to work by altering motility of the reproductive tract and receptivity to oocyte implantation. They are also considered to lead to a decreased release of GnRH, follicle-stimulating hormone (FSH) and luteinizing hormone (LH) by a negative feedback on the hypothalamus and pituitary gland (Munson 2006). Without sufficient care, they might induce severe side effects (Johnston et al. 2001; Munson 2006; Greenberg et al. 2013) such as cystic endometrial hyperplasia–pyometra complex (Agudelo 2005), mammary tumours and fibroadenomatosis (Wehrend et al. 2001; Loretto et al. 2005) and insulin resistance causing diabetes mellitus (Johnston et al. 2001; Munson 2006). According to the literature, differences regarding the frequency of side effects exist depending on the active ingredient (with a significantly lower frequency observed after megestrol acetate and proligestone treatment compared to medroxyprogesterone acetate) and depending on the duration of treatment

*Both authors contributed equally to this work.

Table 1. Summary of the available treatment options for suppression of fertility in adult cats (Table makes no claim to be complete and includes several products not licensed/registered for the use in cats)

Drug	Formula-tion	Dosage	Use in queens	Use in toms	Mean duration of efficacy (days) ^a	References (referring to dosage and/or duration of efficacy)	Things to be considered in case of use
Progestins	Oral	5 mg/cat/d for 5d	X	-		(Burke 1982)	Side effects: CEH-pyometra complex, mammary tumours, fibroadenomatosis, insulin re-sistance (= > diabetes mellitus) (risks in general lower with MA and PRG than with MPA)
		5 mg/cat/week	X	-		(Burke 1982)	
		2.5 mg/cat/week	X	-		(Romagnoli and Concannon 2001)	
Proligestone (PRG)	Injection	30 mg/cat	X	X	8.0 ± 2.2 mon (IOE)	(Findik et al. 1999)	Other general side effects: lethargy, depression, increased appetite resulting in weight gain, polyuria/polydipsia, coat changes at the injection site. (Henik et al. 1987)
		10–30 mg/kg	X	X	7.57 ± 2.35 mon (OE)		
Medroxyprogesterone acetate (MPA)	Injection	23–30 mg/kg	X	X	Depending on season	Leaflet Delvosteron® (Intervet)	Rare side effects: epidermal atrophy, cutaneous xantho-matosis (Henik et al. 1987)
		25 mg/cat	X	X	3.3 ± 1.0 mon (IOE)	(Dreier 1996, Findik et al. 1999)	
Delmadinone acetate (DMA)	Oral	2.0 mg/kg	X	X	≥ 5 months	(Romagnoli and Concannon 2001)	MPA, CMA: 2.5 mg/tom not effective (Jochle and Jochle 1975)
		2.5–5 mg/cat/week	X	X	♀ not mentioned	(Jochle and Jochle 1975, Dreier 1996)	
		2.5–5 mg/cat/d OE	X	X	♂: expired 8–10 d after last suppl	Leaflet Perlutex 5 mg (Selectavet GmbH)/Sedometril 5 mg (Albrecht)	
		5 mg/cat/week IOE	X	X	Weeks–months (not specified)	(Jochle and Jochle 1975)	
Chlormadinone acetate (CMA)	Oral	2.5–5 mg/cat/week	X	X		(Dreier 1996)	Impractical
		2.5–5 mg/cat/week	X	X	63.0 ± 5.3 (IOE)	(Jochle and Jochle 1975)	
		4–30 mg/cat/d	X	-		(Graham et al. 2004, Faya et al. 2011)	
Melatonin	Implant	1x/week	X	-		(Gimenez et al. 2009)	Oestrus induction possible
		2.5–5 mg/cat	X	-		(Faya et al. 2011)	
GnRH-antagonist	Injection	6 mg/cat, 2x	X	-	61.1 ± 6.8 (OE)	(Pelican et al. 2005)	Prevention of ovulation (88%/pregnancy (94%)) Significant reversible impairment of spermatogenesis for 14 d
		330 µg/kg, once	X	X	113.3 ± 6.1 (IOE) ^b	(Risso et al. 2010)	
			X	X	63.8 ± 5.4 (IOE) ^b	(Garcia Romero et al. 2012)	
GnRH-agonist	Implant	4.7 mg	X	X	17–56	(Goericke-Pesch et al. 2013a,b)	Oestrus induction possible high individual variability High individual variability in onset and duration of efficacy
			X	X	♀ 18.4 ± 1.7 ♂ no effect on T reported	(Goericke-Pesch et al. 2011, 2014)	
Deslorelin		9.4 mg	X	-	♂ 551.9 ± 90.1 (432–>1095)	(Toydemir et al. 2012)	Spayed before end of efficacy

X: data exist about the use in female/male cats; -: no data exist about the use in female/male cats; OE: oestrus; IOE: interoestrus.

^aIf not stated otherwise duration of efficacy in days (mon = months).

^bDifferences between two studies published (Gimenez et al. 2009, Faya et al. 2011)

Leaflet recommendation refers to national registrations in Germany: Intervet Deutschland GmbH, 85716 Unterschleissheim, Germany; Albrecht GmbH, 88326 Aulendorf, Germany; Selectavet Dr. Otto Fischer GmbH, 83629 Weyarn-Holzolling, Germany.

(the longer, the higher the risk) (Romagnoli and Concannon 2001; Greenberg et al. 2013). Jackson (1984) recommended not to use medroxyprogesterone acetate in cats; however, in Europe, it is still widely used by cat breeders and owners. Treatment is particularly challenging with feral or free-roaming cats as regular oral treatment, or implants/injections are needed, and non-target species uptake is to be avoided (Greenberg et al. 2013).

In male cats, progestins are predominantly used for suppression of male sexual behaviour, including urine spraying and improval of intercat behaviour. Fibroadenomatosis (Bethlehem and van der Luer 1993; Wehrend et al. 2001; Meisl et al. 2003; Leidinger et al. 2011) and development of mammary adenocarcinomas (Skorupski et al. 2005; Jacobs et al. 2010) have been described after repeated injections of medroxyprogesterone acetate (MPA).

Sclerosing agents

The use of sclerosing agents to induce permanent sterility has been described in male cats for intra-epididymal and intratesticular injections (Pineda and Dooley 1984; Jana and Samanta 2011; Oliveira et al. 2013). First results were described in 1984 using an aqueous solution of 4.5% chlorhexidine digluconate for injection into the caudae epididymides. These injections resulted in a lasting oligospermia or azoospermia in seven of eight cats, but with transient scrotal swelling and pain for up to 2 weeks (Pineda and Dooley 1984).

Following an intratesticular injection of zinc gluconate, spermatogenesis was suppressed (azoospermia) in 91% (10/11) of toms on day 60 (the remaining cat had a reduced total sperm count and motility) and in 73% (8/11) on day 120 with the other two toms showing necropermia or poor semen quality (Oliveira et al. 2013). Furthermore, testicular size was significantly decreased, and penile spines were either decreased (55% on day 120) or absent (36% on day 120) (Oliveira et al. 2013). Although plasma testosterone concentrations were not significantly different from untreated controls, apparent effects on behaviour (e.g. reduced urine marking, vocalizing, fighting with other cats) were observed (Oliveira et al. 2013). In contrast, a single injection of 20% calcium chloride resulted in significant dose-dependent degenerative changes of the testicular tissue. Coagulative necrosis, fibrosis, hyalinization and disintegration of germ cell association within the tubules and a complete loss of germ cells were observed (Jana and Samanta 2011). Furthermore, interstitial Leydig cells were degenerated, and, as a consequence, steroidogenesis was disrupted, resulting in low serum testosterone concentrations (Jana and Samanta 2011).

According to the current state of the art, intratesticular injections can be considered an interesting treatment option. They induce delayed (for 4–6 weeks), but prolonged (or permanent?) infertility in adult male toms with (calcium chloride) or without (zinc gluconate) permanent reduction in peripheral testosterone concentrations and all related conditions without anaesthesia, need for sterile conditions and recovery care (Jana and Samanta 2011; Oliveira et al. 2013).

Immunocontraception, gonadotroph ablation and targeted gene silencing

Classical targets for immunocontraception are GnRH, the GnRH receptor, LH, FSH and their receptors as they can be used theoretically in males and females (for review see Munks 2012). In females, the use of zona pellucida (ZP) proteins has also been described for immunological suppression of oestrus (Levy 2011; Munks 2012). None of these vaccines have been successfully developed or commercialized. In lieu of a permanent non-surgical sterilant, which is not yet available or near on the horizon, the ideal contraceptive for feral/free-roaming cats would be a single application of a drug resulting in a long-term contraception without side effects.

Recently, GnRH-immunocontraception showed some success (Levy 2011). Following a single injection of GonaCon™ (USDA, Pacarello, ID, USA), a specific GnRH vaccine, 93% of the vaccinated cats remained infertile for the first year following vaccination, 73% for the second year, 53% for the third year and 40% for 4 years (Levy et al. 2011). Furthermore, the time to conception was significantly higher in treated animals (39.7 vs. 4.4 months, $p < 0.001$) (Levy et al. 2011). Mean duration of efficacy following a single injection varied between 5 months and >5 years, pointing to 'short-term' and 'long-term' responders. However, injection induced persistent granulomatous injection site masses in 5 of 15 treated cats 2 years after the initial vaccination (Levy et al. 2011). In male cats, the same vaccine induced infertility in 67% (6 of 9) of male cats only as determined by semen analysis (Levy et al. 2004). Some toms ($n = 6$) produced high titres of antibodies ('responders') resulting in basal testosterone, small testes ($n = 6$) and tubular atrophy ($n = 5$) or immotile spermatozoa ($n = 1$), whereas the other three toms did not ('non-responders'). This clearly indicates that the available GnRH vaccines are not an option in male cats as the outcome is unpredictable.

Regarding ZP vaccines, the major problem about their use in all early studies was that these proteins are quite species-specific and, as a consequence, vaccines against porcine, bovine, mink or ferret ZP proteins had no influence on feline ovarian follicle development (Gorman et al. 2002; Levy et al. 2005; Munson et al. 2005). Recombinant feline ZP (fZP) vaccines, however, were also only capable to achieve incomplete contraception (Eade et al. 2009). Additionally, the oestrus cycle is not suppressed by ZP vaccines leaving the queens vulnerable to conditions like pyometra (Levy 2011). Recently, the group of Michael Munks developed promising vaccines for contraception in cats with an attenuated feline herpes virus strain (FHV-1) expressing fZP proteins or other proteins required for reproduction (Munks 2012). The FHV-1 included should cause no disease but be capable of eliciting antibodies that result in sterilization. Herpes virus specific latency and periodic reactivation should help for an individual, non-revaccination-associated booster of antibody production.

For further details on immunocontraception, gonadotroph ablation and targeted gene silencing, excellent reviews of the present status quo are available (Levy 2011; Dissen et al. 2012; Munks 2012; Struthers 2012).

Melatonin

In cats, cyclicity is influenced by daylight hours ('long-day breeder'), and light exposition of <14 h results in prolonged anoestrus as has been shown by several investigators (Prescott 1973; Leyva et al. 1989; Michel 1993). Michel (1993) describes that <8 h light per day induces anoestrus, whereas prolonging the light duration up to 14 h results in cyclical ovarian activity after 15.6 ± 0.5 days – even out of season.

As decreasing photoperiod is related to high endogenous melatonin concentrations and followed by decreased sexual activity, exogenous melatonin can be used to mimic the situation. In the first studies, melatonin was administered orally for 30–35 days 3 h before lights-off and effectively and reversibly suppressed oestrus without any side effects (Graham et al. 2004). However, although it was effective, oral melatonin administration is impractical for daily routine in cats (Graham et al. 2004). Melatonin is available on the veterinary market and licensed as an 18 mg implant for oestrus induction in sheep, a 'short-day breeder' (Melovine[®]; CEVA Santé Animal, Libourne, France). So, further studies were conducted showing that the use of the melatonin implant is a promising option for short-term post-ponement of oestrus, while preserving the future reproductive potential (Gimenez et al. 2009; Faya et al. 2011), but not to delay puberty (Faya et al. 2011). The duration of efficacy seemed to depend on the stage of oestrous cycle when animals were treated with a prolonged duration of efficacy in interoestrus compared with oestrus (113.3 ± 6.1 vs. 61.1 ± 6.8 days) (Gimenez et al. 2009). In a more recent study, Faya et al. (2011) investigated 41 anovulatory cycles of 28 queens comparing oral (4 mg/cat/day, $n = 12$) to implant (18 mg, $n = 17$) melatonin treatment in interoestrus. Both interoestrous interval ($p < 0.01$) and treatment to oestrous interval ($p < 0.05$) were significantly longer in both melatonin groups compared with untreated controls, but did not differ between oral and implant treatment (interoestrous intervals were as follows: 63.8 ± 5.4 days, implant; 63.0 ± 5.3 days, oral; and 19.2 ± 1.4 days, untreated, respectively).

Gonadotropin-releasing hormone agonists and antagonists

Both GnRH agonists and antagonists, directly interfere with the hypothalamic–pituitary–gonadal axis in males and females. Physiologically, GnRH secretion is pulsatile, and the frequency and height of pulses are – in a species-specific matter – responsible for upregulation of the GnRH receptors. In case of a higher and constant release of GnRH, for example, by application of a slow-release GnRH implant, internalization and downregulation of pituitary GnRH receptors occur following an initial stimulation. As not all effects induced by slow-release GnRH-agonist implants could be explained hereby (Hazum et al. 1980; Conn et al. 1987), Smith et al. (2012) summarized that GnRH receptor modification fails to explain all changes induced by GnRH agonists (Smith et al. 1983; Crowder et al. 1986; Horvath et al. 2002; Pawson et al. 2008; Counis et al. 2009). Uncoupling of the associated intracellular signal-

ling systems (McArdle et al. 1995; Willars et al. 1996, 2001) and changes in the cellular composition of the pituitary gland (Smith et al. 2012) are considered further mechanisms for the mode of action.

Gonadotropin-releasing hormone antagonists directly interfere with the binding of GnRH to its respective receptor (Vickery 1985) causing an immediate block of the hypothalamus–pituitary–gonadal axis without provoking an initial increase in FSH and LH release. Long-term use has also been identified to result in downregulation of pituitary GnRH receptors (Hazum et al. 1980; Conn et al. 1987; Fraser 1988; Tarlatzis and Bili 2004; Murase et al. 2005).

Gonadotropin-releasing hormone antagonists

Whereas four studies are available about the use of GnRH antagonists in queens (Pelican et al. 2005, 2008, 2010; Risso et al. 2010), only one study describes the use in tom cats (Garcia Romero et al. 2012) so that it can be stated that at the moment, GnRH antagonists are predominantly of scientific interest and – although results are promising – are lacking broad clinical experience. In the tom, a single subcutaneous (SC) injection of acycline (330 µg/kg) caused a significant reversible impairment of spermiogenesis, spermatocytogenesis and motility for 2 weeks, but had no influence on gross testicular and tubular characteristics including Sertoli and Leydig cells (Garcia Romero et al. 2012).

In cats, Pelican and coworkers (Pelican et al. 2005, 2008, 2010) compared the effects of the GnRH antagonist antide (two injections of 6 mg/kg 15 days apart) to a progestin implant, levonorgestrel, on ovarian function for biotechnology means. Antide synchronized follicular phases but did not induce complete ovarian downregulation (Pelican et al. 2008). Both treatments reversibly inhibited spontaneous ovulations (Pelican et al. 2005, 2008), but did not influence corpora lutea (Pelican et al. 2008). Their results indicate that progestin treatment was more effective regarding the number of follicles and embryos compared with the GnRH antagonist.

Risso et al. (2010) treated seven queens in 17 cycles with a single injection of acycline (330 µg/kg, SC) in oestrus and housed the queens with an intact tom to test for ovulation and pregnancy rates. Treatment resulted in cessation of oestrus after 7.0 ± 1.3 day compared with 7.0 ± 1.7 day in untreated controls. Ovulation rate was 2 of 17 (acycline treatment) and 7 of 7 (control), and pregnancy rate was 1 of 7 (acycline treatment) and 7 of 7 (control) resulting in the authors' conclusion that GnRH antagonist can prevent ovulation. Treatment in pregnancy, however, had no effect on its duration and consequently no significant effect on luteal function.

Slow-release GnRH-agonist implants

Gonadotropin-releasing hormone agonists offer an alternative for short- and long-term contraception of female and male cats without injection site issues. Several studies are available about their use in queens and toms, and they are also already widely used in clinical practice – although not licensed for this indication.

Use in the adult tom

Treatment with a 4.7 mg deslorelin implant resulted in significantly reduced testosterone (T) concentrations; however, the time point when basal T levels were reached was quite variable (Goericke-Pesch et al. 2011; Novotny et al. 2012). Five of 10 toms reached basal T after 3 weeks, and nine of 10 reached basal T after 11 weeks (Goericke-Pesch et al. 2011). Although the remaining tom showed behavioural changes similar to a castrated male and to the other toms with basal T, he only reached basal T after 28 weeks (Goericke-Pesch et al. 2011). As a consequence of downregulation of testicular endocrine function, testicular volume was significantly decreased, penile spines disappeared and a loss of or significantly reduced sexual behaviour (including urine marking) was observed (Goericke-Pesch et al. 2011; Novotny et al. 2012). In contrast to the male dog, the effects on spermatogenesis were also quite variable (Goericke-Pesch et al. 2011, 2013c, 2014; Novotny et al. 2012) with an arrest of spermatogenesis on all levels possible (spermatogonia, spermatocytes, round or elongating spermatids), or also fully elongated spermatids being observed in some animals (Novotny et al. 2012). A significant decrease in total sperm count was also reported (Novotny et al. 2012). Mean duration of efficacy of a single 4.7 mg implant was 551.9 ± 90.1 days varying between 432 and 705 days in seven toms (Goericke-Pesch et al. 2014). When recommending it in breeding toms, it has to be considered that the duration of efficacy was significantly prolonged in one tom (more than 3 years, unpublished case). All effects induced were completely reversible as indicated by a significant and rapid increase in T concentrations, testicular volume, the reappearance of penile spines and sexual behaviour after the end of efficacy or implant removal (Goericke-Pesch et al. 2011, 2014; Novotny et al. 2012). Also, semen quality improved significantly compared with the situation observed during effective treatment (Novotny et al. 2012), and fertility was fully regained (Goericke-Pesch et al. 2014). When recommending the use of a deslorelin implant for contraception of toms in a cattery, the breeder always has to be informed about the high individual variability of onset and duration of efficacy of treatment. In these toms, injection of the implant into the umbilical area to shorten the duration of efficacy by implant removal – if needed/wanted – is strongly suggested.

Use in the adult queen

All studies published on the use of slow-release GnRH-agonist implants for contraception in queens so far indicate that the implants offer a suitable alternative for short- and long-term contraception in pre-pubertal and pubertal animals (Munson et al. 2001; Rubion et al. 2006; Ackermann et al. 2012; Risso et al. 2012; Toydemir et al. 2012; Goericke-Pesch et al. 2013a).

Application in oestrus resulted in an increase in progesterone (P4) indicating ovulations occurred (Rubion et al. 2006; Goericke-Pesch et al. 2013a). Additionally, oestrous induction following treatment is

possible in adult queens (Munson et al. 2001; Rubion et al. 2006; Ackermann et al. 2012; Toydemir et al. 2012; Goericke-Pesch et al. 2013a) with the lowest risk observed in interoestrus (with high progesterone, P4) compared with post-oestrus (basal P4) and oestrus (Goericke-Pesch et al. 2013a). During treatment, single oestradiol peaks have been described with or without oestrous signs (Munson et al. 2001; Goericke-Pesch et al. 2013a). The induced oestrus might be fertile, and consequently, mating might result in the establishment of pregnancy going to term or resulting in abortion as previously described in the bitch (Wright et al. 2001; Kutzler et al. 2009; Romagnoli et al. 2009). Furthermore, if pregnant queens are treated during initial pregnancy, luteal function might not be affected, resulting in normal parturition. However, in a case report describing this condition, all but one kitten died due to lack of maternal care and lactation (Goericke-Pesch et al. 2013b).

The duration of efficacy varied between 483 days (16 months) and more than 1102 days (>37 months) (Goericke-Pesch et al. 2013a). Regarding reversibility, Ackermann et al. (2012) reported successful oestrus and ovulation induction 10 days after short-term contraception (implant removal after 90 days). Regarding long-term contraception, we could show that fertility is fully regained in all mated animals. Seven of eight queens conceived in the first post-treatment cycle and the remaining queen in the third oestrous. Litter size, lactation and maternal behaviour were normal (Goericke-Pesch et al. 2013a,b).

Except for slight local reactions at the application site, no treatment-related side effects were reported (Goericke-Pesch et al. 2011, 2013a, 2014; Toydemir et al. 2012). In the authors' opinion, neither anaesthesia nor sedation is necessary for treatment, making it an easy and safe alternative to surgery for short- and long-term contraception in adult cats (Goericke-Pesch 2010; Goericke-Pesch et al. 2011, 2013a,b,c, 2014; Novotny et al. 2012).

Conclusion

Various scientific and clinical options exist for suppression of fertility in adult cats. However, to find the optimum treatment for each individual, it is necessary to differentiate between feral and privately owned animals, the owner's wish for temporary or permanent suppression of fertility and the sex of the animal that should be treated.

Although surgical spaying and neutering are still the methods of choice for permanent suppression of fertility in healthy male and female cats, there is a huge need of further research. New methods for hormonal contraception are very promising regarding short- or long-term contraception in animals with increased anaesthetic risk or intended for breeding later. Available, effective and easy to use are melatonin implants for short-term postponement of oestrus in adult queens and slow-release GnRH-agonist implants containing deslorelin (Suprelorin®) for short- and long-term contraception in male and female companion and breeding cats. As the duration of efficacy is highly variable and

long-term contraception is not always the breeder's wish, application of GnRH-agonist implants into the umbilical area as described in the bitch, but also in the cat, and removal of the implant when wanted/needed, seems to be a suitable alternative to shorten the duration of efficacy.

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Conflicts of interest

None of the authors have any conflicts of interest to declare.

Author contributions

SGP reviewed the literature and wrote the manuscript, and AW and PG reviewed the manuscript.

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