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Bilateral cataract surgery with intraocular lens implant in a captive western lowland gorilla

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Bilateral cataract surgery in a gorilla

ABSTRACT

Background

We report a case of bilateral cataract surgery performed in a 21-year-old western lowland gorilla.

Methods

Phacoemulsification with intraocular lens insertion was performed using standard human surgical equipment.

Results

Visual function significantly improved. She subsequently mated and gave birth.

Conclusions

Cataract surgery enabled the birth of a baby gorilla.

Bilateral cataract surgery in a gorilla

INTRODUCTION

Cataract is the leading global cause of visual impairment in humans, although since the development of cataract surgery this is no longer the case in developed countries.[1, 2]

The western lowland gorilla (*Gorilla gorilla gorilla*) is one of the great apes classified as critically endangered by the International Union for Conservation of Nature.[3] As highly intelligent and social beings, non-human primates are heavily reliant on good vision for social interactions and survival.

We herein report the first cataract surgery performed on an adult western lowland gorilla in Europe.

SUBJECT AND METHODS

Humane Care Guidelines

Romina was treated humanely and received a high standard of veterinary care at all times.

Subject

A 21-year-old female western lowland gorilla, Romina, arrived in Bristol Zoo Gardens (BZG) in November 2001. Romina was born and hand reared at Rome Zoo, Italy, where despite having been together with a male friend for some years, no breeding activity had ever been observed. It was during a pre-export examination by BZG that Romina was first found to have poor vision and bilateral cataracts (Figure 1A and 1B).

Following agreement that cataract surgery would be attempted by JW and the BZG team with the University of Bristol School of Veterinary Science (SVS), Romina and her companion were transported to the UK ~~and cataract surgery planned for March 2002~~.

Pre-operative treatment regimen and anaesthesia

Bilateral cataract surgery in a gorilla

An oral regimen of 1000mg ciprofloxacin (Ciproxin; Bayer animal health) and 100mg carprofen (Rimadyl tablets; Zeotis Uk Ltd) was administered twice daily for 28 days. Romina was also trained to accept Maxitrol ophthalmic suspension (neomycin sulfate, polymyxin b sulfate and dexamethasone) (Maxitrol; Alcon laboratories (UK) Ltd) through the mesh of her enclosure using a catheter attached to a syringe containing the solution, applied to both eyes four times a day for 21 days.

On the day before surgery Romina was darted with a mixture of 750mg ketamine (Ketaset 100mg/ml solution; Zoetis UK Ltd) and 4mg medetomidine (Domitor 1mg/ml solution; Elanco companion Animal Health) and transferred to a crate, under general anaesthesia. Maxitrol was applied to each eye approximately every 2 minutes for 30 minutes and she received subcutaneous injections of 200mg marbofloxacin (10ml Marbocyl; Vetoquinol UK Ltd) and 100mg carprofen. Anaesthesia was reversed with atipamezole 20mg (Antisedan; Vetoquinol UK) and she remained in her crate overnight, ready for transport to SVS the next day.

Upon arrival at SVS Romina was darted once more. Intubation was performed with a 7.5mm endotracheal tube and anaesthesia maintained on 1.5% isofluorane/oxygen throughout the procedure.

Biometry and electrodiagnostic testing

Biometry and electroretinography (ERG) were performed under anaesthesia immediately pre-operatively. A-scan ultrasound biometry and keratometry values were recorded using handheld devices (Table 1). The SRK/T formula was used to guide choice of intraocular lens implant strength. Whilst this suggested a 12 dioptre lens in the right eye would achieve emmetropia, such a low power lens was not available. A 17 dioptre three-piece foldable silicone implant (6mm optic, overall length of 12.5mm) (Bausch & Lomb Soflex2 lens), the

lowest implant strength available, was therefore selected for the right eye. A 16 dioptre lens was subsequently selected for the left given the good visual outcome following right cataract surgery, with a predicted refractive outcome of -0.55 dioptre. A rapid protocol ERG was performed and compared with human reference values, indicating physiological retinal responses (Figure 1C).

Intraoperative considerations

Adequate pupillary dilatation was achieved with topical Cyclomydril (cyclopentolate and phenylephrine) (Cylomidril; Alcon). The operative site was cleaned with 5% betadine skin preparation and the eye draped. Surgery was performed through two corneal incisions, a 3.2mm incision at 12 o'clock and a 2mm incision at 2 o'clock. Capsulorhexis was performed aided by vision blue. Minimal phacoemulsification time was required as most of the lens was aspirated (Figure 1D). Cortical clean-up was routine. The three-piece foldable silicone lens implant was inserted into the bag (Figure 1E). The corneal wounds were hydrated and remained watertight without sutures.

Post-operative management

A subconjunctival injection of cefuroxime 0.5mls (Zinacef; GSK) and dexamethasone 0.5mls (Dexadresson injection; MSD Animal Health) was injected and chloramphenicol ointment (Pfizer Ltd) applied to the conjunctival sac post-operatively. Maxitrol drops were inserted into the eye four times a day for two weeks after the operation.

RESULTS

Short-term outcomes

Visual improvement was noticeable from the first day after surgery to Romina's right eye. She could now recognise food presented to her from the far side of her cage without verbal

cues (Figure 1D). Upon being reunited with her fellow gorillas it was immediately apparent that she could now see well enough to run around and even play with the group.

Following cataract surgery to her left eye, Romina demonstrated good binocular vision by delicately picking up individual grapes left for her on the ground. Post-operative autorefraction revealed a -1 dioptre and -2 dioptre spherical equivalent in the right and left eyes respectively.

Long-term outcomes

Romina subsequently mated and gave birth to a female baby, Namoki, on 17th May 2005 (Figure 1F~~C~~), who in 2016 became mother to a healthy baby girl herself. To this date Romina shows no sign of posterior capsule opacification and neither of her progeny have developed cataracts.

DISCUSSION

There have been very few clinical studies of phacoemulsification in non-human primates.[4-7] Indeed, there are just two previously published cases of phacoemulsification in western lowland gorillas.[4, 6] De Faber et al described cataract surgery performed in two juvenile captive-born western lowland gorillas which resulted in good visual outcomes.[4] The surgical procedure was the same for both animals and very similar to our own report, although they additionally closed the larger 3.2mm corneal incisions with interrupted 9-0 nylon sutures to protect against eye-rubbing.[4] In the report of cataract surgery in a gorilla by Leiva et al,[6] as well as that of bilateral phacoemulsification in an orangutan by Montiani-Ferreira et al,[5] the corneal incisions were also sutured for this same reason. In our case however sutures were deliberately avoided to minimise irritation. Romina was only once seen to touch her eye following the first cataract operation and suffered no post-operative complications.

Romina was given a subconjunctival injection of cefuroxime and dexamethasone as well as a single dose of chloramphenicol ointment at the end of her operation, followed by a two-week postoperative course of Maxitrol drops containing a mixture of antibiotics and steroid. This regimen is standard procedure in human cataract surgery to prevent ocular inflammation and infection. In an effort to further decrease the risk of these complications, Romina was additionally treated preoperatively with local Maxitrol drops and a course of systemic quinolone antibiotics (ciprofloxacin and marbofloxacin) and non-steroidal anti-inflammatory drugs (carprofen). The dosages of all systemic medications were calculated as for humans based on Romina's weight.

The anatomy of the western lowland gorilla eye appears to be similar to the average human eye, ~~allowing comparison of ERG findings with human reference values and enabling the successful utilisation of human phacoemulsification surgical equipment~~ allowing comparison of ERG findings with human reference values and enabling the successful utilisation of human phacoemulsification surgical equipment.[8] Furthermore, selecting intraocular lens powers based on human formulae appears to yield good refractive outcomes. In the case of the two juvenile gorillas reported by de Faber et al the SRK2 formula (now obsolete in human biometry) was used, achieving refractive outcomes close to those predicted.[4] For our case the SRK/T formula was selected based on Romina's axial length, as for humans. Myopia was deemed preferable as good near vision is needed for social interaction. Postoperatively her right eye was less myopic than expected whereas her left eye was more myopic than the -0.5 dioptre target aimed for, suggesting the differences between predicted and measured refractive outcomes were due to inaccurate biometry readings.

Cataract surgery ultimately enabled Romina to mate and give birth to a healthy daughter. It was crucial to consider the possibility of inherited cataracts before entering Romina to the breeding programme. Her mother had been rescued from a circus where she was found to be

malnourished. Romina's early cataracts were therefore thought to have resulted from poor nutrition in utero. Importantly neither her daughter or granddaughter have developed cataracts. Romina herself still enjoys good vision to this date. By comparison both of the juvenile gorillas reported by de Faber et al developed posterior capsular opacification requiring treatment with Nd:YAG laser capsulotomy.[4]

In summary, we report the first cataract operations performed on an adult gorilla in Europe. This resulted in an excellent refractive and functional outcome, contributing to the preservation of this magnificent species.

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CONFLICT OF INTEREST

None

REFERENCES

1. http://www.who.int/blindness/causes/en/.

2. Lamoureux EL, Fenwick E, Pesudovs K, Tan D. The impact of cataract surgery on quality of life. *Curr. Opin. Ophthalmol*. 2011; 22: 19-27.

3. http://www.iucnredlist.org/details/9406/0.

4. de Faber JT, Pameijer JH, Schaftenaar W. Cataract surgery with foldable intraocular lens implants in captive lowland gorillas (Gorilla gorilla gorilla). *J. Zoo Wildl. Med*. 2004; 35: 520-524.

5. Montiani-Ferreira F, Lima L, Bacellar M, D'Otaviano Vilani RG, Fedullo JD, Lange RR. Bilateral phacoemulsification in an orangutan (Pongo pygmaeus). *Vet. Ophthalmol*. 2010; 13 Suppl: 91-99.

6. Leiva M, Pena T, Bayon A, de Leon M, Morales I. Phacoemulsification considerations in nonhuman primates. *J. Med. Primatol*. 2012; 41: 317-324.

7. Whitley R, Jacobson E, Lavach J, Gelatt K, Barrie K. Bilateral ultrasonic phacofragmentation and aspiration cataract extraction in a spider monkey (*Ateles geoffroyi*). 1980; 11: 58-60.

8. Liang D, Alvarado TP, Oral D, Vargas JM, Denena MM, McCulley JP. Ophthalmic examination of the captive western lowland gorilla (Gorilla gorilla gorilla). *J. Zoo Wildl. Med*. 2005; 36: 430-433.

Figure legends

Figure 1. Abnormal red reflexes ~~were noticed at Bristol Zoo~~ indicating bilateral cataracts (A). Dilated examination on the day of cataract surgery confirming~~ed~~ the presence of bilateral lamellar cataracts (B). Electroretinography was performed under general anaesthesia (C). Routine phacoemulsification (D) and insertion of the intraocular lens (E). ~~Following cataract surgery Romina's visual function significantly improved and she~~Post-operatively Romina was able to recognise food presented to her from the far side of the cage without verbal cues (F). She subsequently gave birth to a baby female gorilla, Namoki, on 17th May 2005 (G~~C~~).

Table

Bilateral cataract surgery in a gorilla

Table 1. Biometry measurements obtained pre-operatively using handheld keratometer and A scan devices.

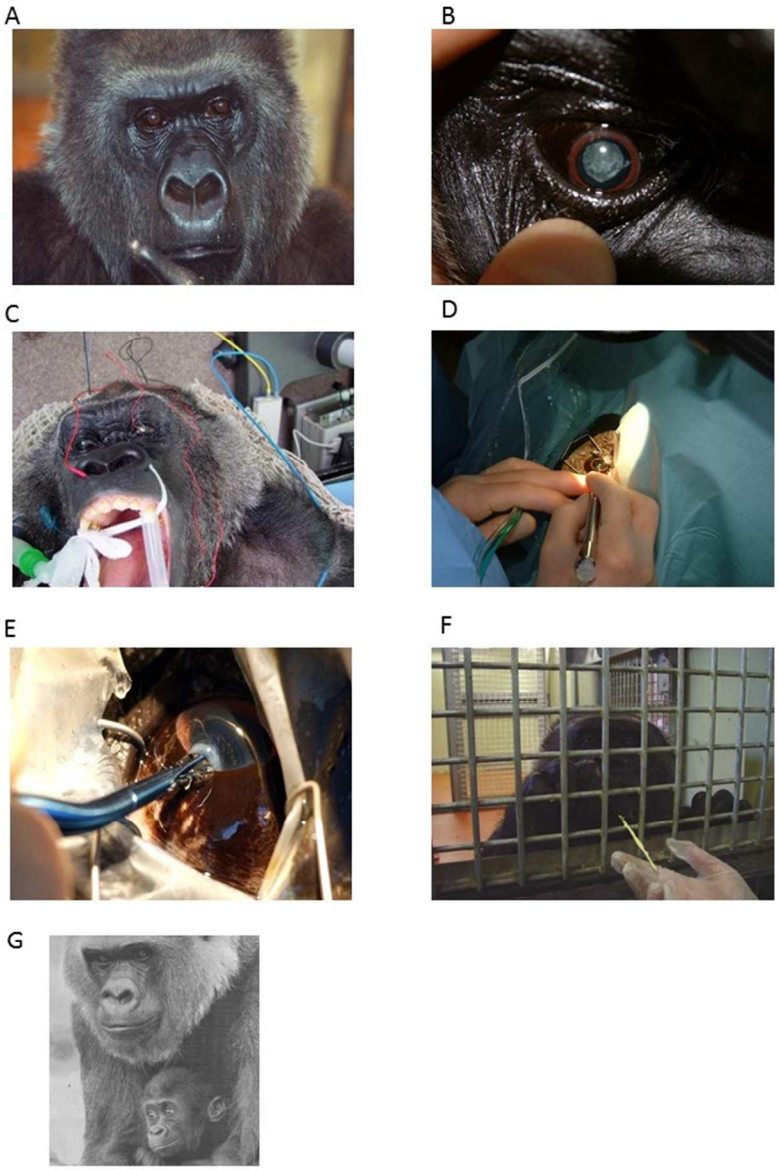

Figure 1. Abnormal red reflexes indicating bilateral cataracts (A). Dilated examination on the day of cataract surgery confirming the presence of bilateral lamellar cataracts (B). Electroretinography was performed under general anaesthesia (C). Routine phacoemulsification (D) and insertion of the intraocular lens (E). Post-operatively Romina was able to recognise food presented to her from the far side of the cage without verbal cues (F). She subsequently gave birth to a baby female gorilla, Namoki, on 17th May 2005 (G).

190x275mm (96 x 96 DPI)

	Right eye	Left eye
K1 (Dioptres)	45.25	43.62
K2 (Dioptres)	46.75	42.87
Axial length (mm)	25.69	25.27
Anterior chamber depth (mm)	3.87	3.86

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