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Case Report: COVID 19-Vaccination of two Captive Adult Bornean Orangutans (*Pongo pygmaeus*)

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Abstract

SARS-CoV-2 was and still is a severe global issue. Vaccination seems to be efficient to keep this pandemic virus under control. However, reports about this virus in other mammals than humans are sparse and little information is available regarding the protection of zoo-housed great apes. We report vaccination of two adult Bornean orangutans (*Pongo pygmaeus*) with Comirnaty from BioNTech/Pfizer. A 57-year-old intact female Bornean orangutan could be closely monitored due to well-adapted medical training. Multiple blood tests showed no changes in hematology or blood-chemistry. Antibodies were detectable one month after the second vaccination and highly increased three weeks after the third shot. Both animals showed, next to mildly increased body temperature for one day, no side effects.

Keywords: SARS-CoV-2, orangutan, vaccine, antibody

Introduction

Since 2020 corona virus has been a global issue of great severity (Shivalkar et al., 2021; Allender et al., 2022). Several vaccines were developed for humans to decrease mortality and the number of hospitalizations (Kashte et al., 2021; Bok et al., 2021; Fathizadeh et al., 2021). For the vaccine used in this study, pharmacologists recommend a booster after 4 weeks, as well as after 1 year (Polack et al., 2020). While experimental studies documented antibodies to increase after vaccination in humans (Bonura et al., 2022), little is known about building antibodies in non-human primates (Capone et al., 2021). To date, there are very few published clinical reports of vaccination against SARS-CoV-2 in great apes. In humans increased risk of pain at injection

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site, headache and venous sinus thrombosis have been observed as side-effects after regular vaccination (Polack et al., 2020; Finsterer, 2022).

All apes at Vienna Zoo are regularly trained for medical procedures and have positive relationships with their keepers. During data collection for this case report the group consisted of one adult male and four females. Keepers as well as visitors are potential carriers of different infectious diseases (Sherman et al., 2021; Delahay et al., 2021). Unfortunately, visitors sometimes feed the animals through the barrier of the outside enclosure, which might increase the risk of infection.

Due to the increasing number of SARS-CoV-2 infections and the availability of vaccines, the two oldest orangutans at Vienna Zoo got vaccinated with Comirnaty (BioNTech/Pfizer). Both orangutans (male "Vladimir", ca. 50 years old and female "Mota", 57 years old) are trained to voluntarily receive intramuscular injections by hand.

We report the vaccination of two adult orangutans, which we consider as high-risk patients due to their age and the daily contact to humans.

Case presentation

Ahead of the first vaccination they underwent a shortened physical examination as well as a screening for SARS-CoV-2 with a rapid antigen test (NEWGENE Bioengineering). For this test a throat swab was taken of both orangutans. Both are used to saliva collection during routine medical training (Fig. 1).

Due to a higher preparedness for training we could run a fully bloodwork as well as SARS-CoV-2 antibody analyses for the female. Furthermore, we took a saliva sample of the female for a SARS-CoV-2 PCR-test as well as for SARS-CoV-2 antigen test, with negative results. General bloodwork was within normal limits, the antibody neutralization test was lower than 0,1% which is interpreted as a negative result. We also took daily measurements of the body temperature in both animals before and for two weeks after vaccination. The measurement routinely took place every day before morning feeding. We used a tympanic thermometer to estimate inner body temperature and screen our animals for possible hyperthermia (Mogensen et al., 2018) (Tab.1, Fig. 2).

The first vaccination was scheduled for 29th November 2021. Both animals showed no signs of side effects on the following days. Another bloodwork was scheduled three weeks after the first vaccination. There were no changes in the differential bloodcell count. We also performed another throat swab for PCR examination which again remained negative. Antibody inhibition showed 4,99%, every level under 30% must be considered negative, according to the laboratory reference.

Ahead of the second vaccination we repeated the throat swab and the SARS-CoV-2 antigen test, which again had negative results. We maintained the booster 4 weeks after the first shot on 28th December 2021. Due to different circumstances the male did not cooperate during training on this day and the team decided to dart him with a blowpipe. Measurements taken on the following day by use of a tympanic thermometer showed mildly increased body temperature for both animals. Both received Paracetamol 500mg (Mexalen – ratiopharm) once (Tab. 2).

Apart from this, both animals showed normal behavior and good appetite. We repeated the blood test to look for antibody levels for the female three weeks after the second shot. The inhibition showed 6.97%, which is a non-significant increase and still negative.

The following month remained uneventful with regards to the vaccinations. The male orangutan struggled with orthopedic/neurologic issues which had been a known medical condition for years. In the summer of 2022, one of the younger females gave birth to a healthy offspring. No signs of behavioral changes or stress within the group were noticeable.

Fig. 1: Throat swab procedure during medical training session at Vienna Zoo. Photo: S. Keiblinger

Every now and then, keepers were sick and tested positive for SARS-CoV-2. If keepers felt sick, they did not enter the orangutan house. The old vaccinated female never showed signs of illness.

The next booster vaccination was scheduled one year after the first shot. At the end of September 2022, ahead of the vaccination, we repeated the full bloodwork. The routine bloodwork,

Tab. 1: Body temperature measurements for both animals around first vaccination.

Date	Temperature in °C (tympanic thermometer) 1,0; Vladimir	Temperature in °C (tympanic thermometer) 0,1; Mota	Notes
13.11.2021	36,1	35,0	
14.11.2021	36,0	35,2	
15.11.2021	35,9	35,8	
16.11.2021	-	35,6	
18.11.2021	35,8	35,6	
19.11.2021	36,1	36,0	
20.11.2021	35,8	35,9	
21.11.2021	36,1	35,6	
22.11.2021	36,3	35,4	blood
23.11.2021	36,1	35,2	
24.11.2021	35,8	35,6	
25.11.2021	36,0	35,4	
28.11.2021	36,0	35,2	antigene test
29.11.2021	35,9	35,8	**first shot**
30.11.2021	35,6	35,4	
01.12.2021	35,9	35,0	
02.12.2021	36,0	35,4	
03.12.2021	35,2	36,1	
04.12.2021	36,3	35,2	
05.12.2021	36,1	35,6	
06.12.2021	36,2	36,4	
07.12.2021	35,4	35,7	

including blood chemistry and differential bloodcell count, was again within normal limits. Contrary to the results from January 2022, the antibody inhibition showed 42,14%, which was higher than 30% and therefore must be considered positive.

Another vaccination was administered on 30th September 2022 again per hand injection during medical training. No side effects where noticeable at this time. The orangutans were alert and showed no increase in tympanic temperature. Eleven weeks after the third shot, the blood examination for antibodies in the female showed an inhibition of 599.40 %, which is the highest level measured so far (Fig. 3).

Fig. 2: Hand injection in cooperative care as a result of medical training at Vienna Zoo. Photo: S. Keiblinger

Tab. 2: Body temperature after second vaccination.

Date	Temperature in °C (tympanic thermometer) 1,0; Vladimir	Temperature in °C (tympanic thermometer) 0,1; Mota	Notes
07.12.2021	35,4	35,7	
08.12.2021	36,7	35,9	
09.12.2021	36,1	35,5	
10.12.2021	36,2	35,6	
15.12.2021	36,2	-	
16.12.2021	-	-	blood
21.12.2021	36,0	35,7	
23.12.2021	36,0	35,9	
25.12.2021	35,8	35,6	antigene tested
28.12.2021	36,7	36,3	**second shot**
29.12.2021	37,1	37,0	both 1 Mexalen
30.12.2021	36,1	35,5	both normal
02.01.2022	35,9	36,2	
03.01.2022	36,0	36,1	
04.01.2022	36,9	36,5	
05.01.2022	36,7	36,7	
06.01.2022	36,9	36,2	
07.01.2022	36,8	36,3	
08.01.2022	36,6	36,4	
09.01.2022	36,8	36,5	
18.01.2022	-	36,1	blood

The male orangutan “Vladimir” had a long period of conservative treatment of very bad orthopedic and neurologic conditions of his lumbar spine and hind limbs. In the following, he was euthanized on 14th February 2023. The blood we collected on this day was also used for SARS-CoV-2 antibody testing. Almost 20 weeks after the last vaccination, the inhibition in the male Bornean orangutan was at 9.10%, which must be considered negative.

SARS-CoV-2 antibodies / progression

Date	Value	Normal value
2021/11/22	< 0,1% IH	< 20
2021/12/16	4.99 % IH	< 20
2022/01/22	6.97 % IH	< 30
2022/09/23	42.14 % IH	< 30
2022/12/16	599.40 % IH	< 30

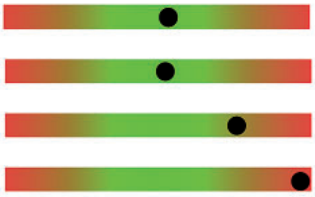

Fig. 3: Summary of SARS-CoV-2 antibody levels over the time span of this case report. There was a significant increase of antibodies in the female.

Discussion

This is a clinical case report of a vaccination against SARS-CoV-2 in captive Bornean orangutans. This topic should be considered as very important, due to the conservation status of Bornean orangutans (Ancrenaz et al. 2016; Molyneaux et al. 2022), as well as the possibility of transmission of disease between different mammals and humans (Sharun et al. 2021; Sherman et al. 2021; Delahay et al. 2021).

There were light clinical changes visible after the second vaccination (rise of body temperature). Otherwise the apes showed no abnormalities. The increase in antibody levels in one adult orangutan underpins the assumption, that non-human primates can build inhibiting units against SARS-CoV-2. No clinical signs were noticeable during the data collection for this case report. In the male orangutan we could not see antibody levels as high as in the female. This could be due to the different way of administration of the second vaccination (via blowpipe), although the male exhibited light hyperthermia one day after the second shot. We consider the general condition of the animal, as well as the daily treatment with different medications because of known orthopedic problems, to be possible reasons for the lower antibody level.

Due to the regular contact to keepers during daily routine an infection is not excluded. We consider the risk of a transmission as low, because of the lack of clinical signs. Besides, the keepers were regularly tested for SARS-CoV-2 and did not enter the orangutan enclosure when they felt sick. Furthermore, we cannot completely exclude the possibility, that these animals got contact to the coronavirus and built antibodies because of an acute infection, but did not show any clinical signs.

To date, there is still a lack of data about this topic, so further investigations are necessary. It certainly is beyond the scope of a single case report to give treatment recommendations. Still this case report should raise awareness for possibilities to protect Bornean orangutans, a critically endangered species (Ancrenaz et al. 2016), in human care. The use of vacccinations for humans in high-risk non-human primate individuals should however be considered on a case-by-case basis weighing possible risks and benefits.

Conclusion

A COVID-19 vaccination in two Bornean orangutans was safe and seems to be a safe and promising procedure to protect the zoo-housed population of a threatened species against this viral disease, which is the cause of a worldwide pandemic. There were no detectable severe side effects after the two orangutans were vaccinated. The results of a shortened clinical examination as well as appetite, body temperature and blood values were within normal limits. Measured blood antibody levels in the female orangutan enabled us to expect proper protection against SARS-CoV-2.

Zusammenfassung

SARS-CoV-2 war und ist ein schwerwiegendes globales Problem. Die Impfung scheint wirksam, um dieses pandemische Virus unter Kontrolle zu halten. Allerdings sind die Berichte über dieses Virus bei anderen Säugetieren als dem Menschen jedoch spärlich, und es gibt nur wenige Informationen über den Schutz von in Zoos untergebrachten Menschenaffen. Wir berichten über die Impfung von zwei erwachsenen Borneo-Orang-Utans (*Pongo pygmaeus*) mit Comirnaty von BioNTech/Pfizer. Ein 57-jähriges nicht infiziertes Borneo-Orang-Utan-Weibchen konnte aufgrund einer gut angepassten medizinischen Ausbildung genau überwacht werden. Mehrere Blutuntersuchungen zeigten keine Veränderungen in der Hämatologie oder Blutchemie. Antikörper waren einen Monat nach der zweiten Impfung nachweisbar und drei Wochen nach der dritten Impfung stark erhöht. Beide Tiere zeigten, abgesehen von einer geringfügig erhöhten Körpertemperatur für einen Tag, keine Nebenwirkungen.

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