Pulmonary Anthracosis in A Lion Tailed Macaque (*Macaca silenus*), An Endangered Primate Species – A Case Report

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Abstract

Anthracosis is the blackish pigmentation of the lung parenchyma and tracheobronchial tree. A female Lion Tailed Macaque aged 19 years was being kept captive in Thiruvananthapuram Zoo for 17 years. On 30th November 2019, the animal was found dead in the zoo and was subjected to a necropsy at the zoo hospital. The necropsy revealed diffused black deposits throughout the lungs on gross examination. On histopathological analysis, blackish deposits could be found throughout the lung parenchyma as free particles in addition to those observed in macrophages. Vehicular emissions seem to have caused the condition to develop. This is the first reported case of anthracosis in a Lion Tailed Macaque. The condition can adversely affect the health and life expectancy of Lion Tailed Macaques. The conservation status of Lion Tailed Macaques makes it important to prevent such pathologies from affecting the relatively smaller population of the species.

Keywords: anthracosis, Lion Tailed Macaque, carbon, silica, Mycobacterium

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INTRODUCTION

Lion Trailed Macaque (*Macaca silenus*) is an endangered primate species found in the western ghats of south India in Kerala, Tamil Nadu, and Karnataka (Singh *et al*., 2020). Lion Tailed Macaques are extremely rare. The total population in the world is only about 4000 and the population size is still decreasing (Singh *et al*., 2020). Lion Tailed Macaques are housed in Thiruvananthapuram Zoo and the zoo participates in the conservation breeding of the species. Lion Tailed Macaques are considered the flagship species of the zoo and are a major attraction.

Anthracosis is the blackish pigmentation of the respiratory system involving the tracheobronchial tree (Mirsadraee and Saeedi, 2005; Sigari and Mohammadi, 2009) and lung parenchyma (Yoon *et al*., 2012). The exact cause of anthracosis is still unknown. A literature review by Mirsadraee (2014) involving a plethora of studies shows that inhalation of dust and smoke is to be blamed. The major components causing anthracosis are carbon, free crystalline silica, mica, kaolin, and other silicates (Adamson and Prieditis, 1995; Klotz 1914; Naccache *et al*., 2008; Mulliez *et al*., 2003). Even aluminum and iron were found associated with anthracosis (Walker *et al*., 1987). The particles reaching the interstitium are deposited there and are taken up by the alveolar macrophages (Adamson and Bowden, 1981), which then transfer the particles to the lymph nodes of the lung (Corry *et al*., 1984; Lehnert *et al*., 1986). Long-term exposure to these agents is expected to be the reason for the development of anthracosis. In a study by Kim *et al*. (2009), it was found that it took on an average of 36.1 years for the development of anthracosis by exposure to wood smoke in human patients. The reports of anthracosis in humans recently have been predominantly from farmers (Mirsadraee and Saeedi, 2005) and housewives (Kim *et al*., 2009) and exposure to wood smoke was common in all the patients.

Reports on anthracosis in dogs (Fitzgerald *et al*., 2008) and sheep (Beytut, 2002; Amaravathi *et al*., 2016) can be found. Anthracosis in zoo animals have been reported by Ahasan *et al*. (2010) in several species of mammals and birds. Little is known about the occurrence, pathology, and consequences of anthracosis in Lion Tailed

Macaques. This study tried to put some light on these three aspects.

Thiruvananthapuram Zoo established in 1859, and presently stretching over an area of 14.58 hectares is one of the oldest zoos in Asia. It is located amidst Thiruvananthapuram city in the state of Kerala, India. The zoo is located near busy roads producing large amounts of vehicular pollution and industrial emissions. The air quality of the city as per a 2014 study, was in the "moderately polluted" category, and the average daytime SPM of 75 µg/m3 was estimated in Thiruvananthapuram city (Biju and Vijayan, 2014).

MATERIALS AND METHODS

The carcass of a female Lion Tailed Macaque, aged 19 years, formed the study material (Figure 1). The animal stayed in the zoo for 17 years. The zoo keeper reported the animal to be restless on November 29, 2019. No other animals in the herd were showing any such signs. The animal was weak and foul smelling due to maggot infestation in its anal and vaginal regions. Medical care was given to the animal, but its condition was still grave. The animal was found dead at 7 AM on November 30, 2019, at the zoo hospital.

Figure 1. Carcass of the Lion Tailed Macaque.

The carcass was subjected to a detailed necropsy at the Zoo immediately following the death of the animal. The necropsy was scientifically performed taking appropriate precautions and following the standard protocols. Gross lesions of all the organs were recorded. Representative samples of the lung tissue, along with other organ tissues were collected in 10% formalin for histopathological evaluation. These samples were then processed and tissue sections of four-micron thickness were cut out of the paraffin-embedded tissue blocks and stained using hematoxylin and eosin stains. These were then observed under a light microscope at 10x magnification.

RESULTS AND DISCUSSION

On necropsy, diffused black deposits could be observed throughout the lungs. Areas of emphysema, atelectasis and lung collapse were found along with this. The blackish deposits were found externally in the shapes of minute dots and rods of more or less the same size, scattered uniformly across all the lung lobes. The pigmentations were visible from the pleura itself (Figure 2).

Figure 2. Gross appearance of the lung of the Lion Tailed Macaque.

On histopathological examination, the blackish deposits were evident throughout the lung parenchyma. The deposits were found as free particles and also as those inside the mononuclear phagocytes. Focal areas of fibrosis of the interstitium and alveolar walls were observed (Figure 3). The condition was diagnosed as anthracosis from these findings.

The cause of death of the animal was found as cardiopulmonary failure due to blood loss and toxemia caused by excess tissue loss and fecal stasis by maggots.

This is the first report of anthracosis in a Lion Tailed Macaque. The cause of death was not Anthracosis. Usually, such pigmentation occurs when the rate of clearance of the exogenous material falls less than the rate of deposition (Kreyling, 1990). Anthracosis possibly have

several adverse effects on the health and life expectancy of Lion Tailed Macaques. Vehicular emissions seem to be the cause of the development of the condition in the animal.

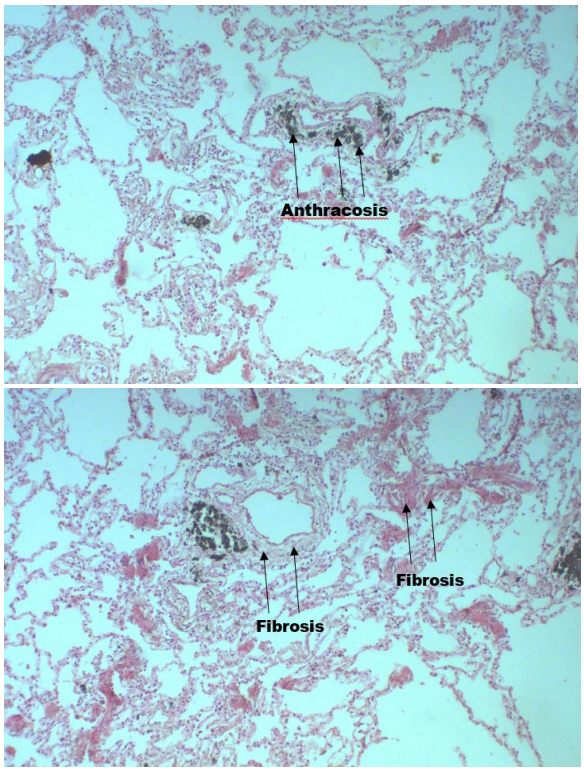

Figure 3. Histopathological section of the lung of the Lion Tailed Macaque (10x).

Anthracosis can cause conditions such as fibrosis and plaques which can affect the functioning of the lungs. In humans, anthracosis contributes largely to obstruction in large bronchi and this can cause cough and dyspnoea (Mirsadraee and Saeedi, 2005). Similar conditions can also be expected in Lion Tailed Macaques.

The presence of pleural anthracosis is a good indicator of lifelong exposure to pollutants in the air (Takano *et al*., 2019). Since the animal was observed of having pleural anthracosis, its exposure to air pollutants is obvious. A study by Biju and Vijayan, (2014) illustrates the various health problems faced by humans in Thiruvananthapuram city. The health problems were reported to be severe in terms of both mortality and morbidity. Being phylogenetically close relatives, similar problems can be expected in Lion Tailed Macaques and this warrants further studies.

Anthracosis is reported to make the affected predisposed to infections (Mirsadraee and Saeedi, 2005). Tuberculosis (*M. tuberculosis*) is found significantly in patients having anthracosis (Ghanei *et al*., 2011; Mirsadraee *et al*., 2011). A study by Fekri *et al*. (2010) found that the presence of tuberculosis was 2.6 times more in people with bronchial anthracosis than in those without. This is attributed to the effect of silica on the immune system. Since Lion Tailed Macaques had been reported to contracted tuberculosis, this should be considered seriously (Wilson *et al*., 1984). Further studies specifically including *M. bovis* are required to confirm the statement. Rhesus monkeys are reported to being contracted *M. tuberculosis* which shows the possibility of the same infection in Lion Tailed Macaques (Mätz-Rensing *et al*., 2015).

Other animals in the zoo might presently be having or are supposedly at risk of contracting anthracosis. Humans as well in Thiruvananthapuram city are vulnerable to the same. Further studies are required to analyze the risk as this is a concern of animal, human and environmental health. The natural habitat of Lion Tailed Macaques is the Western Ghats. The evergreen forest cover of western ghats has been reducing greatly (16.21% to 11.3% from 1985 to 2018 respectively) due to high anthropogenic pressure including activities such as mining (Ramachandra and Bharath, 2020). If these activities are not properly regulated, it might adversely affect the population of Lion Tailed Macaques further.

CONCLUSION

The adverse effect of climate change and pollution on biodiversity is a matter to be looked upon seriously. Pollution levels are rising in cities, and valuable animals are being confined to small areas in its zoos. These animals, breathing the same polluted air over and over, will progressively face conditions such as anthracosis much earlier in their life. This will reduce the number of possible lifetime breedings per animal further reducing the population of the species, and endangering the existence of such animals.

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