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Research Article

Histomorphological Effects of Crack Cocaine on the Histology of the Lungs of Wistar Rats

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Abstract

Crack cocaine (or just crack) is an illegal drug which is made from cocaine. Cocaine is mostly an illegal drug that comes from the leaves of a plant called coca. When people smoke crack, they have a feeling called "being high." The aim of this study is to determine the histological effect of crack cocaine on the lungs of adult albino wistar rat. A total of forty (40) adult Albino Wistar rats of comparable sizes were used for this study. They were divided into four equal groups (A – D) with ten (10) rats each. Group A served as the control and the rats were given distilled water and feed only. In addition to feed and water, groups B rats were given 0.5 ml *crack cocaine extract* and *crack cocaine extract*, group C rats were given 2 ml *crack cocaine extract*, and group D rats were given 5 ml *crack cocaine extract* respectively. The drug administration was given daily for 14 days (2 weeks) and the weights of both the test and control animals was monitored before and after administration of crack cocaine extract. The administration of the *crack cocaine extract* was given orally. The results of this study show no significant ($p \geq 0.05$) alterations in the lung histology of test wistar rats administered with crack cocaine when compared with the non-cocaine administered group. In conclusion, it's important to emphasize that the use of cocaine has formerly been associated with adverse effects on lung histology, even in cases where immediate side effects may not be apparent which may be the case of this study. The potential alterations in lung tissue due to cocaine abuse can have far-reaching consequences on respiratory health.

1. Introduction

Crack cocaine (or just crack) is an illegal drug which is made from cocaine. Cocaine is mostly an illegal drug that comes from the leaves of a plant called coca. When people smoke crack, they have a feeling called "being high." The name "crack" comes from the cracking sound the

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drug makes as it is smoked. The cracking sound is caused by evaporating water escaping. In most parts of the world, production (making crack), possession (having crack), and distribution (selling or giving away crack) are illegal. Cocaine is the most potent stimulant of natural origin. It is extracted from the leaves of the coca plant (*Erythroxylon coca*), which is indigenous to the Andean highlands of South America. Its chemical name is [1R-(exo,exo)]-3-(Benzoyloxy)-8-methyl-8-azabicyclo [3.2.1] octane-2-carboxylic acid methyl ester, and its chemical sum formula is $C_{17}H_{21}NO_4$

It was first isolated in 1860 and introduced into clinical use as a local anaesthetic in Germany in 1884. Although synthetic local anaesthetics are much more widely used today, cocaine is, to some degree, still in use in dentistry and ophthalmology. In 1879 it began to be used to treat morphine addiction. Already by late Victorian times it appeared as a 'vice' in literature, e.g. as the *cucaine* injected by Sir Arthur Conan Doyle's fictional Sherlock Holmes — from which fact we may conclude that its use as a recreational drug began early.

Lungs are vital respiratory organs found in vertebrates, including mammals like humans and rats. They play a crucial role in the process of respiration, which involves the exchange of gases between the body and the environment. The primary function of the lungs is to facilitate the uptake of oxygen (O_2) from the air and the removal of carbon dioxide (CO_2) from the bloodstream. This gas exchange is essential for sustaining cellular metabolism and maintaining the body's overall balance.

The respiratory system is a complex network of organs and structures responsible for the intake of oxygen and the elimination of carbon dioxide, both byproducts of cellular activity. Among the key components of this system are the lungs, which serve as the main sites for gas exchange. In mammals, including humans and rats, the lungs are housed within the thoracic cavity, protected by the ribcage. The air we breathe contains oxygen, which is necessary for cellular respiration, a process that generates energy to power various physiological functions.

Crack cocaine abuse poses serious health risks and understanding its impact is crucial. This s focuses on how crack cocaine affects the testes of adult albino Wistar rats. This is important because the testes play a key role in male reproduction and any damage could lead to fertility issues and hormonal imbalances. Surprisingly, there's limited research on the histological effects of crack cocaine on the testes. By using rat models, we can ethically study these effects and potentially apply findings to humans.

These findings could have practical applications. They might help us develop interventions for crack cocaine addicts, addressing the specific harm to the testes. Moreover, this research contributes to our broader understanding of how drugs affect the body systematically, aiding public health efforts. This knowledge can also inform policies to prevent substance abuse and improve overall community well-being. In essence, this study fills an important gap in our knowledge about the impact of crack cocaine, potentially improving lives and guiding future research and policies.

2. Materials and Methods

2.1. Study Area

This study was carried out in Ekpoma, the administrative headquarters of Esan West Local Government Area of Edo State, Nigeria. The area proper lies between latitude 6° 45' North of Equator and longitudes 6° 5' and 6° 8' East of the Greenwich Meridian. Ekpoma area falls within the rain forest/savannah transitional zone of south western Nigeria. Ekpoma has a population of 172, 400 people. Majority of people in this area are civil servants, traders, business men and women, transporters, farmers, teachers/lecturers and students by occupation. Ekpoma is made up of many quarters, including Eguare, Iruekpen, Emaudo, Ujolen, Ihumudumu, Illeh, Uke, Uhiele, Ujemen, Ukpenu, Egoro, Emuhi, Igor and Idumebo (National Population Commission, 2012).

2.2. Experimental Animals/Housing Condition

Forty (40) Adult Albino Wistar rats of comparable sizes and weights were procured from the animal house and transferred to the experimental site where they were allowed two (2) weeks of acclimatization. They were housed in well-ventilated labeled wooden cages at the site of the experiment. The cages were designed to secure the animals properly especially from wild animals/insects and cleaned daily. During this period of acclimatization, the rats were fed growers' mash and water provided *ad libitum*. Animals were maintained and experimental procedures complied with the guide for care and use of laboratory animals (National Research Council, 1985).

2.3. Experimental Design

A total of forty (40) adult Albino Wistar rats of comparable sizes were used for this study. They were divided into four equal groups (A – D) with ten (10) rats each. Group A served as the control and the rats were given distilled water and feed only. In addition to feed and water, groups B rats were given 0.5 ml *crack cocaine extract* and *crack cocaine extract*, group C rats were given 2 ml *crack cocaine extract* , and group D rats were given 5 ml *crack cocaine extract* respectively. The drug administration was given daily for 14 days (2 weeks) and the weights of both the test and control animals was monitored before and after administration of *crack cocaine extract*. After the administration, the rats were put under light chloroform anaesthesia and the lungs were obtained. ANOVA was used to analyze the results of the weight and differences was considered significant at $p<0.05$ level of confidence. All data was expressed in table as mean ± standard deviation (SD).

2.4. Animal Grouping

The experimental animals were separated into four groups (A – D). Group A had ten rats (n = 10) while groups B – D had ten rats (n = 10) each using 4 big cages to house them. Group A served as the control and received only the normal feed (grower's mash) and water with no administration of *crack cocaine extract*, while Group B, C and D received different doses of *crack cocaine extract*and were equally fed with grower's mash and water.

2.5. Study Duration

The preliminary studies, animal acclimatization, drug procurement and preparation, actual animal experiment and evaluation of results, lasted for a period of three months. However, the actual experiment lasted for lasted for four (4) weeks: two weeks of acclimatization and two weeks administration of *crack cocaine extract* to the test animals.

2.6. Collection and Identification of Plant Materials

Fresh prepared aqueous crack cocaine extract was collected from a health facility. The aqueous extracts were identified and authenticated by experts.

2.7. Preparation of Plants Extract

The powder *crack cocaine* was weighed using the electric weighing scale and 100g was dissolved in 1 litre of distilled water and stirred at intervals for 24 hours (1 day). This was later reconstituted to give the required doses of 0.5 ml, 2 ml and 5 ml used in the present study.

2.8. Administration of Substance

Crack cocaine extracts were prepared to prepare the doses of 0.5 ml, 2 ml and 5 ml respectively for the experiment.

The administration of the *crack cocaine extracts* was given orally as follows:

- **Group A**(Control) received only normal feed (growers' mash) and distilled water daily for 28 days.
- **Group B** received 0.5 ml of *crack cocaine* extracts, feed and distilled water daily for 28 days.
- **Group C** received 2 ml of *crack cocaine* extracts, feed and distilled water daily for 28 days
- **Group D** received 5 ml of *crack cocaine* extracts, feed and distilled water daily for 28 days.

2.9. Ethical Approval

Ethical approval for the use and collection of samples from laboratory animals was obtained from the Ethics and Review Committee, College of Medical Sciences, Ambrose Alli University, Ekpoma.

2.10. Sample Collection and Analysis

Weight was measured before and after acclimatization. Similar weight measurements were done at the end of the treatment periods and the average weight recorded accordingly. Furthermore, the liver of each rat was obtained at the end of the experiment under chloroform anaesthesia and fixed in 10% formalin for histological processing.

2.11. Processing Schedule

The tissues were processed according to standard histological procedures. The fixed plastic cassette tissues in 10% formalin were automatically processed by passing them through different grades of alcohol as follows:

70% alcohol	2hrs
80% alcohol	2hrs
90% alcohol	2hrs
90% alcohol	2hrs
95% alcohol	2hrs
Absolute	2hrs
Xylene 1	2hrs
Xylene II	2hrs
Molten paraffin wax 1	2hrs
Molten paraffin Wax II	2hrs

After the last timing, the tissues were removed from their plastic cassettes and placed at the centre of the metallic tissue mould and then filled with molten paraffin wax. They were left to solidify after which they were placed in the refrigerator at 5°C for 15 minutes. After the blocks were cool in the refrigerator for the time stated above, the blocks were removed from the metallic case using a knife and after which the paraffin wax at the side of the blocks were removed. The blocks were trimmed and cut serially at 3 nm on a rotary microtome. The sections were floated in water bath at 55°C and picked up by the use of a clean frosted end slides. The frosted end slides were placed on the hot plate for 40 minutes for adequate attachment of the sections on the slides after which the sections were de-waxed, hydrated, air dried and stored in a slide box ready for staining.

2.12. Staining Procedure

Sections for general tissue structure were stained using Haematoxylin and Eosin staining technique.

1. The sections were de-waxed in 3 changes of xylene 5 minutes
2. The sections were hydrated through descending grades of alcohol (absolute, 95%, 80% and 70%).

3. The sections were stained in Harris haematoxylin 5 minutes
4. The sections were rinsed in running tap-water to remove excess stain
5. The sections were differentiated in 1% acid alcohol 3 seconds
6. The sections were blued in running tap water 10 minutes
7. The sections were counterstained with 1% eosin 1 minute
8. Sections were finally rinsed in water, dehydrated in ascending grades of alcohol (70%, 80, 95% and absolute)
9. The sections were cleared in xylene, air-dried and mounted with dibuthylphthalate propylene xylene (DPX).

The slides were examined under a light microscope at x100 magnification and photomicrographs were taken.

2.13. Data Analysis

All results were expressed as mean ± standard deviation (X ± SD). The obtained data was subjected to statistical analysis using SPSS (version 21). The test groups' values were compared with the values of the control group using One-way analysis of variance (ANOVA) at 95% level of confidence. Values of $P < 0.05$ were considered significant.

3. Results

3.1. Body Weight Changes of Rats at Various Intervals

Table 1 shows the body weight changes of rats in the test and control groups. The results were presented in mean ± standard deviation. At every stage of the weight determinations, the control group (Group A) presented body weight gain at first, second, third and final week after acclimatization, while the test groups (B, C and D) presented body weight loss in the different weeks after acclimatization respectively. Though, the difference in weight didn't show any significant difference ($p>0.05$) within the test groups, group D was observed to have a higher weight reduction, followed by group C and B respectively. The body weight of control animals (group A) before acclimatization and before sacrificing was 205.50 ± 0.50 g and 245.25 ± 0.50 g. Similarly, the body weight of the test animals in group B before acclimatization and before sacrificing was 215.50 ± 1.00 g and 200.55 ± 2.22 g, group C was 210.40 ± 1.29 g and 195.25 ± 3.24 g, group D was 225.55 ± 1.41 g and 190.25 ± 2.45 g respectively.

Table 1: Body Weight Changes of Rats at Various Intervals

Weight (g)	**Control (n = 10)**	**B (100mg) (n = 10)**	**C (200mg) (n = 10)**	**D (300mg) (n = 10)**
WBA	210.50 ± 0.50	220.50 ± 1.00	215.40 ± 1.29	230.55 ± 1.41
WAA	220.65 ± 0.50	217.75 ± 1.50	210.50 ± 0.42	225.45 ± 1.20
W2WK	225.45 ± 0.50	215.25 ± 1.35	205.85 ± 1.50	215.50 ± 1.84
W3WK	240.15 ± 1.71	210.50 ± 1.50	205.50 ± 1.15	205.35 ± 2.55
FW	250.25 ± 0.50	205.55 ± 2.22	200.25 ± 3.24	195.25 ± 2.45

WBA: Weight before acclimatization, **WAA:** Weight after acclimatization
W2WK: Weight at second week of cocaine extracts, **W3WK:** Weight at third week of cocaine extracts
FW: Final weight before sacrificing, Values are mean ± Standard deviation, **Wt:** weight (Grams), **n:** Number of sample.

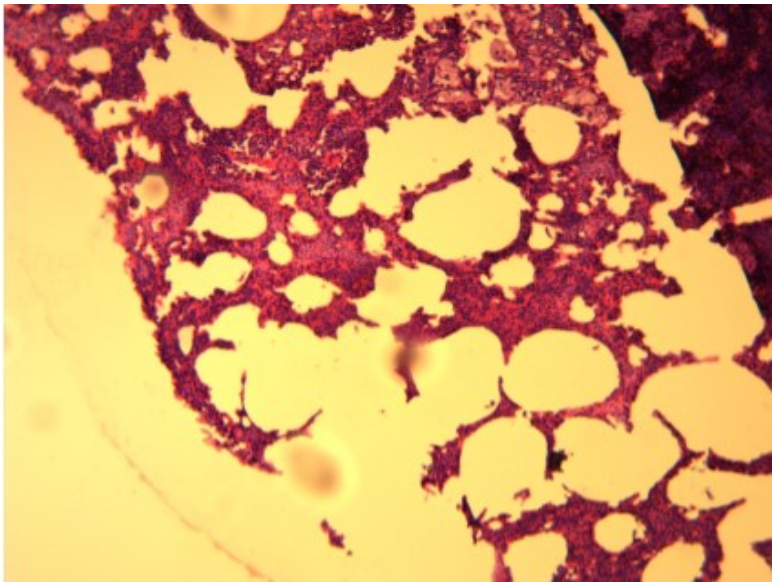

Figure 1: Lung Control X100

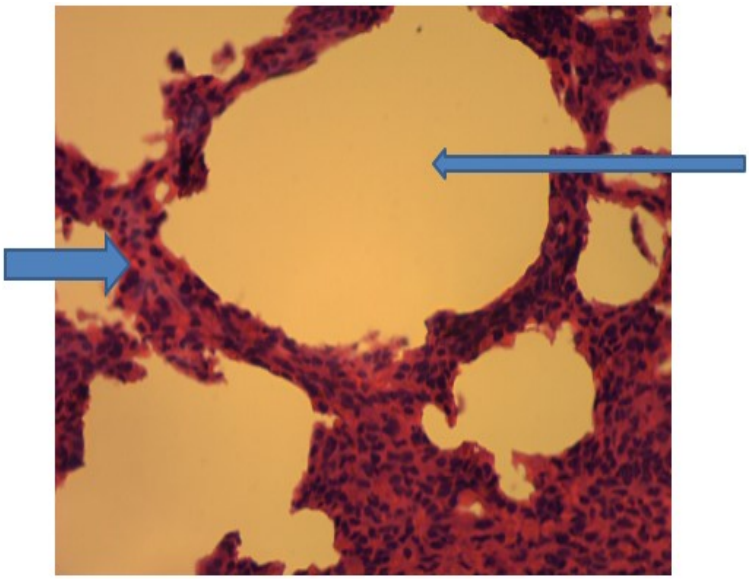

Figure 2: Lung Control X400: Section Of The Lung Shows Normal Alveoli Space (Thin Arrow) Lined By Interstitium (Thick Arrow)

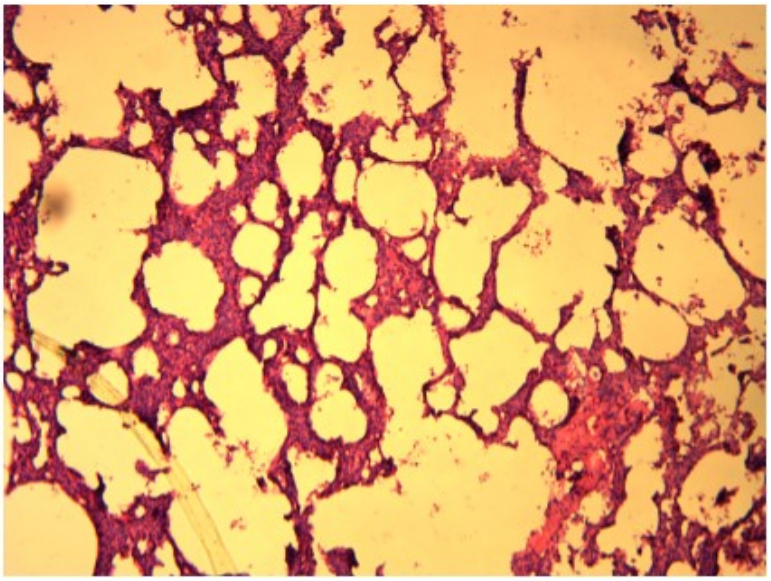

Figure 3: Lung A X100

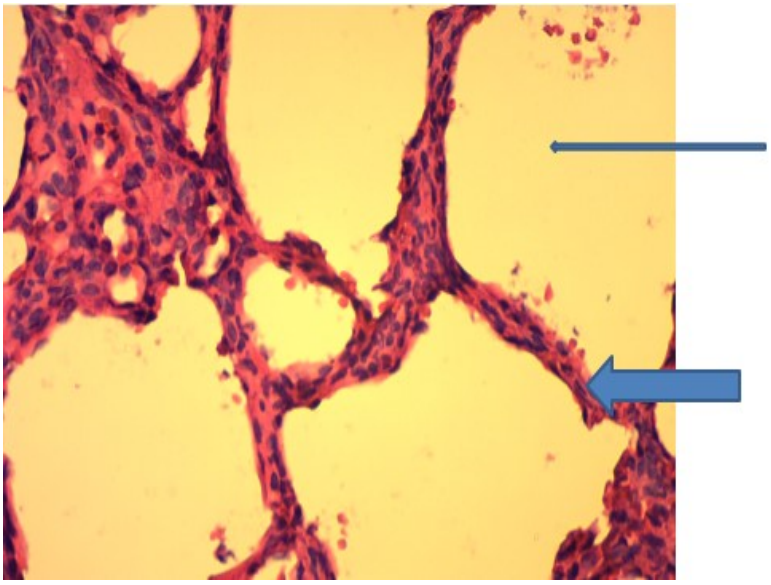

Figure 4: Lung A X400: Section Of The Lung Shows Normal Alveoli Space (Thin Arrow) Lined By Interstitium (Thick Arrow)

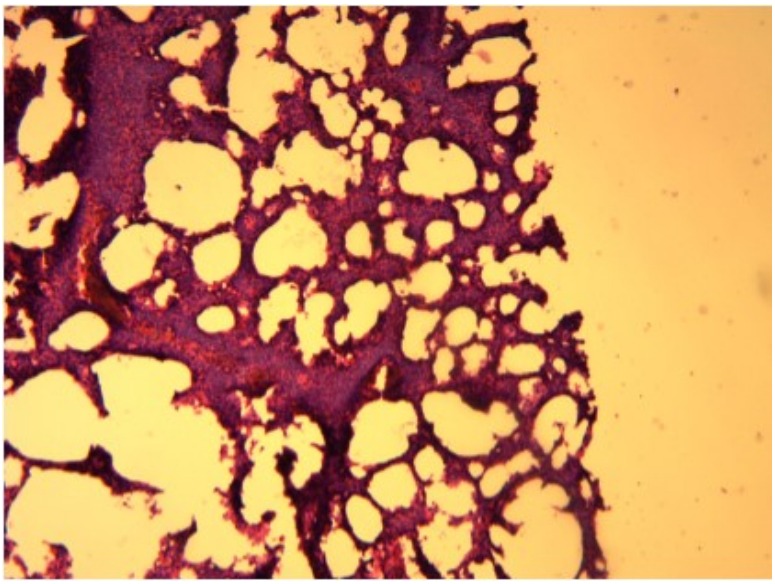

Figure 5: Lung B X100

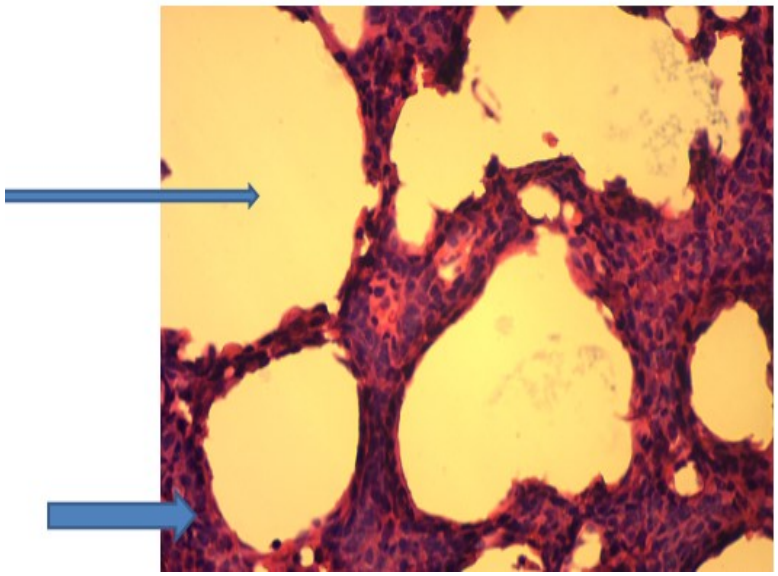

Figure 6: Lung B X400: Section Of The Lung Shows Normal Alveoli Space (Thin Arrow) Lined By Interstitium (Thick Arrow)

4. Discussion

Derived from the leaves of the coca plant (Erythroxylum coca), which is indigenous to South America, cocaine emerges as a natural stimulant. For centuries, native populations in the Andes region have masticated coca leaves as a strategy to alleviate altitude-related discomfort and enhance vitality. Cocaine undergoes chemical extraction from these leaves and manifests in diverse presentations. It can adopt the guise of a powdered form, commonly recognized as ”coke” or ”blow.” This finely powdered substance, with its crystalline and white appearance, is often insufflated through the nose, although it can also be dissolved and introduced via injection [1]. Crack cocaine, a highly concentrated rendition of cocaine, is created through chemical alteration involving baking soda or ammonia in the processing of powder cocaine. This process results in the formation of diminutive rocks or crystals that are consumed through smoking. Freebase cocaine, akin to crack cocaine, undergoes a comparable transformation, albeit using distinct chemical methods. It, too, is administered through smoking [2].

Numerous investigations have demonstrated that the utilization of cocaine can exert a significant and adverse influence on diverse facets of an individual’s well-being. These effects span from immediate repercussions to enduring outcomes. Cocaine, a potent stimulant substance, wields its influence over the central nervous system, potentially giving rise to an extensive array of physiological, anatomical, and psychological health challenges. Additionally, it can lead to distortions in the structure and function of various other organs.

Since its appearance in the end of the 1980, crack cocaine has become the most frequently abused substance preceded only by marijuana [3]. This phenomenon has resulted in a variety of pulmonary complications not previously considered such as pulmonary barotrauma, pulmonary haemorrhage and obliterative bronchiolitis. However, cough, haemoptysis, pneumothorax, pneumomediastinum, pneumopericardium and haemothorax are the most common complications of inhaling crack cocaine vapour. These complications are presumed to be benign and self-limited [4].

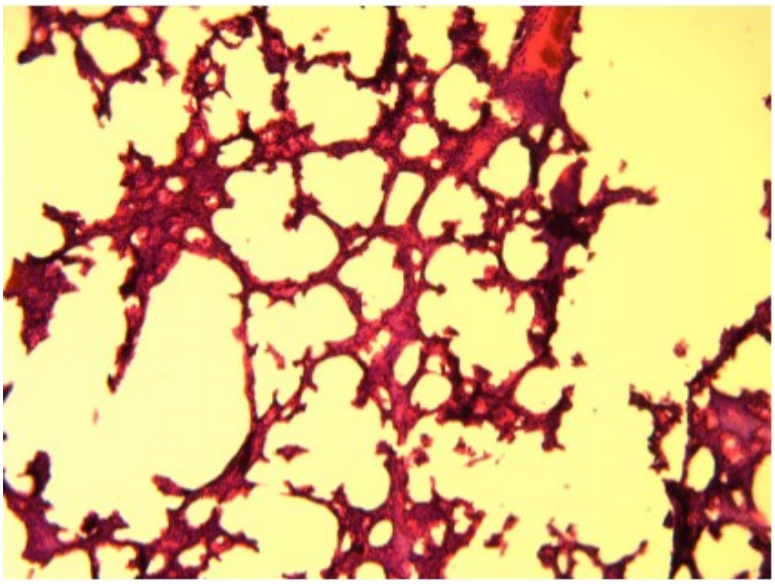

Figure 7: Lung C X100

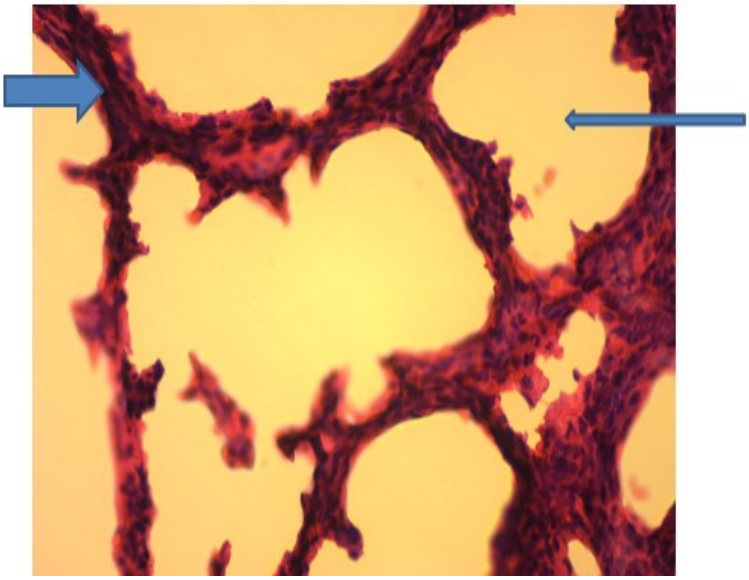

Figure 8: Lung C X400: Section Of The Lung Shows Normal Alveoli Space (Thin Arrow) Lined By Interstitium (Thick Arrow)

Contrary to the general beliefs and findings of most study that administration and consumption of cocaine cause tremendous damages to major organs and general health of an individuals, the findings of this study prove otherwise. According to the histological findings of this study, the dose-dependent administration of cocaine causes no histological alterations in the lungs. The aforementioned findings of this study contradict the findings of [5] whose study on "Pulmonary histopathology in cocaine abusers" observed acute and chronic hemorrhage, interstitial pneumonitis/fibrosis, congestion and intra-alveolar edema among cocaine abusers. Another study by [6] also resonates with the findings of [5], in cocaine exposed exposed groups, descriptive lung histological analysis showed increased alveolar cellularity owing to an increased number of macrophages. These presented a pale brownish cytoplasm, with black granules occasionally visible. There was a mild, variable, non-eosinophilic peribronchiolar and perivascular inflammatory cell infiltration. There was no acute lung edema, signs of recent hemorrhage or interstitial fibrosis, or signs of pneumonia. The alteration in lung histology among individuals who abuse cocaine can be attributed to fact that Cocaine use can contribute to the development of pulmonary edema, where fluid accumulates in the lung's air sacs. This accumulation impairs lung function and oxygen exchange.

5. Conclusion

In conclusion, it's important to emphasize that the use of cocaine has formerly been associated with adverse effects on lung histology, even in cases where immediate side effects may not be apparent which may be the case of this study. The potential alterations in lung tissue due to cocaine abuse can have far-reaching consequences on respiratory health. While there might be instances where individuals perceive no immediate side effects, this should not be misconstrued as an absence of harm. Cocaine's impact on lung histology can lead to changes such as alveolar damage, impaired oxygen exchange, pulmonary edema, inflammation, and compromised respiratory function. These alterations may not manifest as overt symptoms initially but can progress to more serious respiratory conditions over time.

Individuals should minimize exposure to secondhand smoke, including cocaine smoke, can also have detrimental effects on lung health and health practitioners should educate patients on the danger of drug abuse Patients struggling with drug abuse or drug addiction should endeavor to seek help from health practitioners or support groups. The most effective way to prevent the detrimental effects of cocaine on lung histology is to avoid using the drug altogether. Recognize the potential risks associated with cocaine use and make a commitment to prioritize your respiratory well-being.

Article Information

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Disclaimer (Artificial Intelligence): The author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.), and text-to-image generators have been used during writing or editing of manuscripts.

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