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دراسة هستولوجية وهستوكيميائية لغدة البروستاتا في الفأر الأبيض في أعمار مختلفة

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أجري في هذا البحث دراسة هستولوجية وهستوكيميائية لتطور غدة البروستاتا في الفأر الأبيض ٠

وقد وجد أن غدة البروستاتا عند الولادة تكون مكونة من مجموعات مصمتة من الخلايا محاطة بنسيج غير متميز ٠ وعند عمر ١٠ أيام تبدأ الغدة في التميز الى فصين بطني وآخر ظهري جانبي ٠ كما لوحظ أنه عند هذا العمر يبدأ ظهور تجويف في مجموعات الخلايا في الفص البطني بينما يتأخر ظهر التجويف في الفص الظهري الجانبي الى عمر ١٥ يوم ٠ كذلك يبدأ تحول النسيج الغير متميز الى نسيج ضام - وتظهر طبقة من العضلات اللاارادية الغير مخططة حول الحويصلات ٠

ومع تقدم العمر تظهر هذه الحويصلات مبطنة بخلايا عمادية ذات نشاط افرازي ملحوظ ويبدأ هذا النشاط الافرازي عند عمر ١٠ أيام في الفص البطني ، ١٥ يوم في الفص الظهري الجانبي ٠ وفي الفأر البالغ يلاحظ وجود فروق واضحة بين فصوص الغدة المختلفة في شكل وطريقة الافراز ٠ فيلاحظ أن طريقة الافراز تكون بطريقة بسيطة (*Merocrine*) في الفص البطني وتكون بطريقة افراز قمي *(Apocrine)* في بعض الأجزاء وافراز كلي *(Holocrine)* في بعض الأجزاء الأخرى من الفص الظهري الجانبي ٠

وفي العمر المتقدم وجد نقص في سمك الخلايا المبطنة للحويصلات وفي كمية الافراز والكربوهيدرات والبروتين وأنزيم الفوسفاتيز القاعدي والسكسنيك ديهيدروجنيز مما يشير الى نقص وخلل في نشاط الغدة في هذا العمر - ومن المحتمل تأثيره على عملية التناسل في الفأر في ذلك العمر ٠

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HISTOLOGICAL AND HISTOCHEMICAL STUDIES ON THE ALBINO RAT PROSTATE GLAND AT DIFFERENT AGES

(With 26 Figs.)

By
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SUMMARY

The present study was carried out to demonstrate the histological and histochemical structure of the prostate gland of albino rats during post-natal life and at the old ages.

The prostate gland of the newly born rats consisted of solid epithelial cords which were surrounded by undifferentiated mesenchymal tissue.

At the age of 10 days, differentiation of the prostate gland into ventral and dorsolateral lobe was observed.

The canalization of epithelial cords and the appearance of well defined acini was observed first in the ventral lobe at the age of 10 days and then the dorsolateral lobe at the age of 15 days. The mesenchymal tissue is differentiated into loose connective tissue and a thin layer of smooth muscle fibers around the acini.

With advancement of age, more differentiation was detected. The acini were lined with simple columnar to low cuboidal epithelium.

Signs of secretory activity in the prostate gland begin at the age of 10 days in the ventral lobe and at the age of 15 days in the dorsolateral lobe.

The adult prostate showed distinct differences between the ventral and dorsolateral lobe especially in the mode of secretion. Holocrine and apocrine mode of secretion was observed in the dorsolateral lobe, however, merocrine one was demonstrated in the ventral lobe.

In old aged rats, signs of decreased synthetic activity and impaired function were observed in both the ventral and the dorsolateral lobe of the prostate gland which may affect reproduction in these animals.

Histochemical observations of the prostate gland coincided with the histological changes at the different ages.

INTRODUCTION

The prostate gland is an important male accessory sex organ. Its secretion has a major role contribution in the seminal fluid which plays important role in retaining male fertility and

reproduction (DAVID, 1981). And the histological and histochemical studies have been made on adult prostate gland of domestic animals such as Balady Buck (AZIZA, 1974), Camel (ALI, et al. 1978) as well as in rodents (SALEH, 1976 and WONG, et al. 1985). However, there is paucity of literature dealing with histological and histochemical studies of postnatal development of albino rat prostate gland and also at old ages (SIKORSKI, 1982). Thus, this work was performed to study the histological and histochemical structure of albino rat prostate gland at different ages.

MATERIAL and METHODS

A total number of 50 male albino rats were used in this study. The rats were newly born, 5, 10, 15, 21, 30, 60 days, 3-5 months and 30 months old. Each animal was anaesthesized with ether and the prostate gland was removed and fixed in 10% neutral formalin and cold acetone. The specimens were prepared for paraffin embedding. Sections of 7-10 u were obtained, and stained with haematoxylin and eosin, Van Gieson, orcein, Weigert elastic stain, PAS, mercury bromophenol blue and Gomori's method for alkaline phosphatase. Moreover, fresh cryostate sections were prepared and stained for succinic dehydrogenase. The techniques used for histological stains and histochemical methods were done according to PEARSE (1972) and DRURY and WALLINGTON (1980).

RESULTS

Histological structure of the prostate gland at different ages:

Newly born:

The prostate gland of newly born rat consisted of few number of solid epithelial cords whcih were separated by mesenchymal tissue (Fig. 1). Each cord consisted of poorly developed epithelial cells with condensed nuclei and little cytoplasm.

5 days age:

The prostate gland started to differentiate into separate lobes as indicated by the depressions in hte outer surface of the capsule. The lobes were ventral and dorsolateral lobes, however the glandular elements were still inthe form of epithelial cords surrounded by mesenchymal tissue (Fig. 2 & 3).

10 days age:

The prostate gland became more differentiated. The differentiation involved both the glandular and stromal elements, the stroma became more loose in consistency especially in the ventral lobe, while in the dorsolateral lobe the epithelial cords were still surrounded by a layer of smooth muscle intermingled with both collagenous and elastic fibers. As regards the glandular elements their differentiation started earlier in the ventral lobe by canalization of the epithelial cords (Fig. 4), the cells became simple coloumnar with rounded basal nuclei and somewhat vacuolated cytoplasm. Some acini contained homogenous acidophilic secretion.

15 days age:

At 15 days, the acini of the ventral lobe of the prostate became more differentiated. Some of the acini had wide lumina (Fig. 5) and lined by low columnar or even cuboidal epithel-

ium with some basal clear cells. They were occasionally seen among the lining epithelium. The stroma was much similar to the previous age. The dorsolateral lobe of the prostate differed from the previous age in that, they began to aquire lumina but others still had no lumina. The lining epithelium of these acini was simple columnar with basal rounded nuclei, pale basophilic cytoplasm and finely granular apical parts. The acini were surrounded by a layer of smooth muscle fibres (Fig. 5) and separated by connective tissue rich in blood vessels and connective tissue cells. The muscle layer was more thicker in the dorsolateral lobe than in the ventral lobe of prostate.

21 days age:

At this age, the stroma of the gland was thinner than the previous age and contains numerous connective tissue cells, blood vessels and free nerve endings. There was a decrease in the amount and thickness of collagenous fibers in comparison with the previous age. In the ventral prostate the acini were of variable sizes and shapes. The lining epithelium was more differentiated into simple columnar epithelium with rounded or oval basal nuclei and some clear cells. The lumen of some acini contained finely acidophilic granular secretion. All the acini of the dorsolateral prostate became patent. Their lining epithelium varied from pseudostratified columnar to simple columnar with rounded basal nuclei and basophilic cytoplasm. Also, the cytoplasm of the supranuclear part of the cells contained negative Golgi images and their apical cytoplasm was stained acidophilic. Some acini contained finely reticulated acidophilic secretion.

One month age:

The ventral prostate was well differentiated. Their acini had wide lumina which contained small amount of homogenous vaculated secretion and surrounded by small amount of connective tissue. The epithelial lining of the acini was highly differentiated and consisted of simple columnar cells (Fig. 6) with basal vesicular nuclei. Their cytoplasm was basophilic with supranuclear negative Golgi image and apical deeply acidophilic parts. Around the base of the acini there was a single layer of smooth muscle fibers. The dorsolateral prostate differed from the previous age in having more loose and delicate connective tissue. Their acini were increased in number, size and were arranged in groups and each acinus was surrounded by a thin layer of smooth muscle fibers. The lining epithelium varies from pseudostatified columnar to simple columnar type (Fig. 7) with basophilic cytoplasm, supranuclear negative Golgi image and apical granular acidophilia. The lumina of the acini contained homogenous acidophilic secretion and in some acini desquamated epithelium was observed.

In the ventral prostate of 2 months age an increase in the number of the acini and their differentiation into peripheral and central groups was detected in comparison with the previous age. Also, the dorsolateral prostate was more developed. An increase in the size of the acini and amount of secretion were observed in comparison with the previous age. The simple folds were observed in some acini. Some collagenous and elastic fibers were demonstrated around the acini and in the capsule of the prostate gland.

Adult:

The prostate gland of adult rat was large densely encapsulated structure, its ventral and dorsolateral lobes became more demarcated form each other. The parenchyma of the lobes was separated into smaller lobules by dense connective tissue septa while the interacinar c.t. was of the loose variety. The acini of the ventral prostate were of two types peripheral and central groups (Fig. 8). The peripheral acini were smaller in size and showed numerous folds than the central acini.

The glandular epithelium of both lobes varied from simple cuboidal type with few basal cells. The simple columnar epithelium was more evident in the peripheral acini. the central acini was lined with simple cuboidal to simple squamous according to the amount of secretion in their lumina (Figs. 8, 9 & 10). In the dorsolateral acini the cells showed signs of apocrine and holocrine secretion with appearence of numerous detached cells in their lumina (Figs. 11, 12 & 13) however the merocrine mode was observed in the ventral lobe of the prostate.

Old age:

The prostate gland of old age showed a varied picture in comparison with the adult. Regressive changes appeared first at the periphery of the gland and proceeded towards the central acini.

The lining epithelium of the ventral and dorsolateral prostatic acini was decreased in height (Fig. 14) and the amount of secretion inside their lumina was decreased with appearence of coagulated clumped material of variable densities in the lumen of some acini (Fig. 15). Also the detached cells were decreased in the dorsolateral acini. A decrease in the connective tissue fibers and perivascular cellular infiltration was observed among prostate acini.

Histochemical reactions of the prostate gland at different ages:

Polysaccharides:

The prostate gland of the newly born and 5 days age exhibited high positive reaction for PAS in the basement membrane and moderate reaction in the surrounding mesenchymal tissue. However, the cytoplasm of the epithelial cells showed negative reaction. At 10 days age a moderate positive reaction was seen in the cytoplasm of the epithelial cells in addition to the previous findings.

At 21 days, one month and two months-old rats an additional intense positive reaction for PAS was observed in the smooth muscle fibers surrounding the prostatic acini (Fig. 16).

Moreover, in adults high PAS-positive secretory materials were observed within the lumina, and apical part of the cytoplasm of the epithelial cells (Fig. 17).

In old aged rats, decreased intensity and amount of positive reaction for PAS was observed in comparison with the adults especially at the secretion inside the lumina (Fig. 18).

General protein:

In newly born and 5 days old rats, a high positive reaction for bromophenol blue was observed in the mesenchymal tissue around and among the developing prostatic acini of both lobes. The cytoplasm of the epithelial cells showed negative reaction and the nuclei showed moderate reaction (Fig. 19). At 10 and 15 days, additional slight increase of the positive reaction in the cytoplasm of the epithelial cells was observed. At 21 days, a decrease in the positive reaction for bromophenol blue was observed in the stroma of prostate in comparison with the previous age (Fig. 20). However, a high positive reaction was observed in the smooth muscle fibers surrounding the acini and a moderate reaction was seen in the cytoplasm of the epithelium of the ventral and dorsolateral prostatic acini. At one and two months a decrease in the amount of positive reaction for bromophenol blue was observed in the connective tissue stroma and muscle fibers surrounding the acini. The cytoplasm of the epithelial cells of both ventral and dorsolateral prostatic acini showed also positive reaction which was more concentrated in the apical parts of the epithelial cells. In addition, the secretion, inside the lumen of the acini, showed positive reaction. In adults, an intense positive reaction for bromophenol blue was observ-

ed in the cytoplasm of the epithelial cells and in the secretion inside the lumina of acini of both lobes of the prostate (Figs. 21 & 22).

However, in old ages the intensity of bromophenol blue reaction was relatively decreased.

Alkaline phosphatase:

In newly born, 5, 10, 15 and 21 days old rats, a highly positive reaction for alkaline phosphatase was observed in the mesenchymal tissue and smooth muscle fibers surrounding the prostatic acini (Fig. 23). A moderate positive reaction was demonstrated in the nuclei and apical parts of the epithelial cells and in the endothelial lining of the endothelial lining of the blood capillaries. However, a negative or faint positive reaction was seen in the cytoplasm of the epithelial cells (Fig. 23). Also a positive reaction for alkaline phosphatase was detected inthe secretion inside the lumina of the dorsolateral prostatic acini. At one month age the reaction was more or less similar to the previous ages, however, marked decrease in the positive reaction was observed in the apical part of the epithelial cells.

At 2 months age, an increase inthe positive reaction for alkaline phosphatase was observed in the basal part of the cytoplasm and nuclei of the epithelial cells and smooth muscle fibers (Fig. 24). The secretion in the lumina of ventral prostatic acini was negative for alkaline phosphatase, however, the secretion in the dorsolateral prostatic acini showed moderate positive reaction. In adults, a high positive reaction was observed in the apical and basal parts of the epithelial lining (Fig. 25) while the rest of the cytoplasm showed moderate positive reaction. Also a high positive reaction was observed in the secretion inside the lumina of the ventral and dorsolateral prostatic acini.

In old ages the alkaline phosphatase reaction was decreased.

Succinic dehydrogenase:

In newly born, 5, 10, 15 days old ages, a positive reaction for succinic dehydrogenase, in the form of blue formazan granules and diffuse reation in the muscle fibers around the prostatic acini was demonstrated. However, the epithelial cells showed negative reaction. At 21 days age, the positive reaction was more or less similar to the previous ages but the epithelial cells showed very fine granules. At one and two months age, the positive reaction was in the form of few granules in the epithelial cells of acini in addition of the diffuse reaction. Also the muscle fibers showed positive reaction. In adults, positive dark blue formazan granules were observed in the epithelial cells of the acini of both lobes as well as in the muscle fibers around them (Fig. 26).

In old ages the reaction for succinic dehydrogenase was relatively decreased.

DISCUSSION

In the present study, the prostate gland of newly born albino rat is composed of ventral and dorsolateral lobes. Each lobe was consisted of solid cords of epithelial cells surrounded by highly cellular mesenchymal tissue. The canalization of the epithelial cords of the ventral and the dorsolateral lobe occurred on the 10th day and on the 15th day of postnatal life respectively. This variation indicated that the two lobes differed in their sensitivity to extragonadal androgens (SAR, et al. 1970 and TIMMS, et al. 1976). However, the canalization occurred in guinea pigs on the 50th day of intrauterine life (ENGLE, 1926) and in the opossums on the

16th or 17th day after birth (MOORE, 1941). This variations in the time of canalization are most probably due to species differences. On the other hand, the present study revealed that together with the process of canalization, the dense mesenchymal tissue surrounding the epithelial cords differentiated gradually into the loose variety and this is accepted to support, connect and allow the further development and enlargement of prostatic acini. Moreover, a part of this mesenchymal tissue differentiated into smooth muscle fibers encircling the acini of both lobes. These muscle fibers would serve to assist evacuation of the prostatic acini. This coincided with the reports of FLICKINGER (1972) and TIMMS, et al. (1976). The difference in the thickness of muscle layer in both ventral and dorsolateral lobe may be related to the anatomical position of each lobe as well as to the nature of secretory materials in their acini which contained detached cells in the dorsolateral acini whereas in the ventral lobe it consisted of homogenous or vacuolated material.

The present results also revealed that, during the process of development of the prostate, the lining epithelium of acini gradually acquired the general features of protein-secreting cells and this point to the functional activity of these cells and their involvement in secretion of protein, the main component of prostatic secretion (MANN, 1964).

It was also found that the maximal differentiation and maturation of the prostatic lining epithelium is observed in adult age. This may be attributed to the rise of circulating hormone secreted by mature gonads (DAVID, 1981).

In adult the prostate presented two types of acini in both lobes, peripheral having simple folds and lined with tall columnar cells and central lined with low columnar or even cuboidal epithelium and distended with secretion. This classification was also described by SIKORSKI (1982) however, the functional correlation regarding this difference was not reported by this author. Also this classification is not mentioned by PRICE, 1963; or SALEH, 1976 on their report on rat prostate.

This variation in the two types of the acini may be due to that central acini act as reservoir for secretory material while the peripheral acini have a secretory function. however, TAM, et al. (1985) explained that this variation in the shape of the acini may be due to that the peripheral ones are more subjected and sensitive to the circulating male hormones than those of the central acini.

In the present study it was found that the nature of secretion differed in both lobes of adult prostate. It was acidophilic and homogenous with some vacuoles in the acini of ventral prostate however, it contains numerous detached intact and necrotic cells in the dorsolateral prostatic acini. This coincided with the results obtained by GUNN and GALUD (1957), SALEH (1976) and SIKORSKI and KIMIEC (1982).

The features of glandular epithelium confirmed the presence of holocrine and apocrine mode of secretion in the dorsolateral lobe and a merocrine one in the ventral lobe. This coincided the reports of GUNN and GALUD (1952), SALEH (1976) and SIKORSKI and KIMIEC (1982) and contradicted the reports of DAHL, et al. (1973).

The decrease in the thickness of epithelial cells and in the amount of the secretory materials in the prostate of old albino rat, indicated the decrease in activity and involution of the prostate.

Similar observations were obtained by SIKORSKI (1982) in aged rats and after deficiency of male sex hormone by castration (TVETER, 1973) and after injection of antiandrogenic compou-

nd (DAHL and KIGAERHEUM, 1974). On the other hand the reports of BARTSCH (1980) demonstrated hyperplasia of the cells lining the acini of prostate of old men.

The involution in the prostate of old-aged albino rats most probably results and participates in the decrease in male fertility and reproduction.

The positive reaction for PAS indicated the presence of polysaccharides which increased in amount with the increase of age. The increase of polysaccharides was especially seen in the lining epithelium and the secretory material. The present results confirm those obtained by SALEH (1976) in rat. The polysaccharides content of rat prostate may be the precursor of fructose of prostatic secretion as suggested by SCHANTZ (1964). However, variations in the nature of polysaccharides in the prostatic tissue were detected in different animals species as reported by AZIZA (1974), GUPTA and SINGH (1982) and ROY, et al. (1985).

In old rats, the decrease in the amount of polysaccharides most probably leads to deficiency in the fructose content of prostatic secretion with subsequent decreased viability of sperms which may be the cause of impaired fertility.

The positive reaction for bromophenol blue in the prostate of young ages was more intense in the mesenchymal tissue or stroma than in the epithelial cells. However with the further development and differentiation the epithelial cells and the secretion inside the lumina of prostatic acini showed high intense reaction indicating the increase in the amount of protein. The higher content of protein in the mesenchymal tissue in younger ages is needed for differentiation. However, in more developed and differentiated prostate the presence of protein in large amount within the epithelial cells and in the secretion is corresponding with the secretory and functional activities. This coincided with the features of the cells involved in protein synthesis (DEAN and WURZELMAN, 1985). In the prostate of old rats the decrease in the amount and intensity of positive reaction for bromophenol blue indicated the decrease in the amount of protein which probably decreased and impaired the functional activity of prostate.

In the present study, the alkaline phosphatase was demonstrated in two main sites in the prostate gland of albino rat which indicated two different functional types of the enzyme. Its presence in the stroma of prostate of most postnatal ages is needed for active transport of material necessary for development and differentiation (BERN, 1949). On the other hand, its presence in the glandular epithelium as well as inthe secretion in other ages indicated that it is an important constituent of prostatic secretion and consequently of semen as reported by BERN (1949) and SIKORSKI (1982). The decrease in alkaline phosphatase in the prostate of old rats indicated decrease in the activity of transport across the cell membrane and consequent impairment in the function by aging.

The presence of positive reaction for succinic dehydrogenase in both developing and mature prostate indicated the presence of this enzyme at the site of mitochondria in the cells of those tissues (PEARSE, 1972). The present results were in accored with that of SIKORSKI (1982) and ROY, et al. (1985). However, in the prostate of old rats the succinic dehydrogenase enzyme was decreased probably due to decreased secretory activity and impairment of prostatic functions.

In conclusion it was found that the histological and histochemical structures of the prostate of all postnatal ages are adapted to their function at these ages. Moreover, the decrease in thickness of epithelial cells and amount of secretion in the prostatic acini of old rats together with the decrease in the amount of polysaccharides, protein, alkaline phosphatase and succinic dehydrogenase indicated and impairment in function of prostate of these animals which consequently affect the quantity and quality of the seminal fluid.

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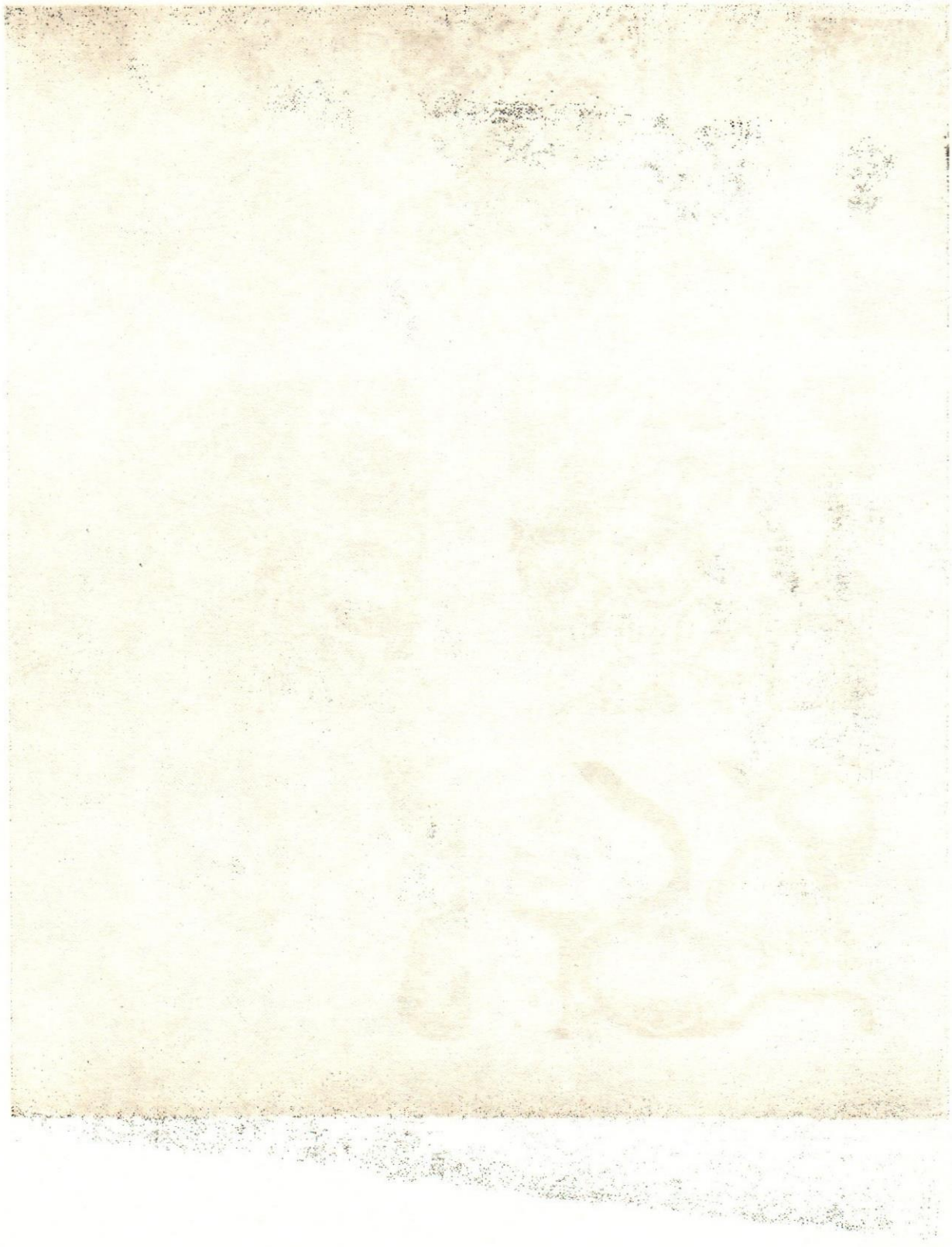

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