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# The Effects of The Non-Fatal Electrical Injury on Caspase-3 Expression in Ovaries of Female Albino Rats: Histological and Immunohistochemical Study

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**Abstract**

**Introduction:** In the developing world, electrical injury presents a serious issue with high morbidity and mortality. Gonads are electrical current-sensitive organs because of their low resistance. Few studies have been done on the gonads, even though many have shown the effects of electricity on various body organs. **Aim:** This work aimed to detect the ovaries' histological changes and assess the immunohistochemical expression of caspase-3 at different intervals (immediate, 2h, 24h, 72h & 7 days) in female albino rats that have been exposed to a non-lethal electrical current. **Methodology:** Egypt, Minia, Faculty of Medicine, Department of Forensic Medicine and Clinical Toxicology is where the current study was conducted. It contained 60 female albino rats, each weighing between 200 and 250 g. To analyze caspase-3 histopathologically and immunohistochemically, sections from the ovaries were processed. **Results:** The studied animals' ovaries displayed the presence of ovarian trauma with significant histological abnormalities and a significant increase in caspase-3 expression. **Conclusion:** Caspase-3 elevated levels and the histopathological changes supported the theory that apoptosis was the main mechanism of the electrical injury to the ovaries. Future fertility may be affected by these changes, which may manifest as abnormal ovarian function. **Recommendations:** Further studies on the ovarian changes following electrical injury with different time intervals than those used in the present research are recommended.

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**Key words** electrical injury; forensic pathology; ovaries; apoptosis; caspase-3

## Introduction

Electrocution is described as death induced by an electric shock by which a person's body shows a sudden, violent response as a result of an electric current flow (Hardjanto et al., 2018). Most of the time it is accidental; it occurs in youngsters in a household or in adults as an occupation-related hazard that ranks as the 4th important factor in traumatic occupational deaths. Ventricular fibrillation is suggested to cause immediate death if it occurs following exposure to low-voltage electrical circuits. However, after high voltage circuits, it is believed that nervous system central suppression is the cause of death with resultant respiratory failure (Massey et al., 2018).

Electrical damage because of interaction with electric circuits has become a visible concern since electricity is widely used in our lives (Gentges and Schieche, 2018). This kind of harm may lead to a direct impact on the body by electric current or burns caused by ignited clothes through skin contact with warm dissemination or may cause injury from either related seriously strong withdrawals or related falls (Wang et al., 2005).

The extent of the injury is evaluated according to the electrical current's type and intensity, its pathway, contact duration, the damage site, and the physical circumstances under which the incident occurs (Duff and McCaffrey, 2001).

Incidents due to ≥1,000 voltage occur more often (57.71%) than those due to <1,000 voltage (42.29%). The fatality rate ranges from 2.35% to 26.7%, reflecting the seriousness of electrical accidents and the ease of access to specialized burn centers (Shih et al., 2017, Ding et al., 2020). Clinical sequelae of electrocution appear immediately, in hours, days, or even years afterward (Wesner and Hickie, 2013). Apoptosis is a biological process that requires ATP (Imamura et al., 2020).

For mammalians, apoptosis is essential in normal oogenesis or spermatogenesis and maintains the hemostasis of cells. It also sustains the balance between germ cells, Sertoli cells, and ovarian follicular cells (Aitken et al., 2011).

Apoptosis serves a vital regulatory role in the female reproductive tract's dramatic development and degeneration cycles. Apoptosis regulates the ovarian resting follicle stock size by causing significant attrition of the germ cell through fetal life (Glamoclija et al., 2005). Previous researches declared that apoptosis was the cause of testicular and ovarian germ cells death (Aitken et al., 2011).

Caspase-3 has been found to be an important component in apoptosis and may be a possible target for controlling cell death (Machnicka et al., 2012). That was accomplished by the cytoskeletal protein's proteolysis,

proteins of DNA repair, and suppression of caspase-activated deoxyribonuclease, which led to morphological alterations in the cells and subsequently apoptosis-related cell death. (Clark et al., 2000). Additionally, caspases have a basic role in apoptosis regulation within the seminiferous tubules (Almeida et al., 2013).

The current work was designed to detect the ovaries' histological changes and assess the immunohistochemical expression of caspase-3 at different intervals (immediate, 2h, 24h, 72h & 7 days) in female albino rats that have been exposed to a non-lethal electrical current. These intervals were used to determine whether the increase in survival time following exposure to the electric current had any impact on these alterations.

## Materials and Methods

Animals

The current study involved 60 female albino rats; obtained from the university animal house, with an average weight of 200-250 gm. The Faculty of Medicine, Minia University, Minia, Egypt is the place where the study was conducted. For the experiment, all animals were confined to plastic cages at 22°C, with 50-60% relative humidity. They were exposed to a 12-hour cycle of light and dark. The animals received the standard laboratory food and were permitted free use of water.

Ethical approval

The Ethical Committee of the Faculty of Medicine, Minia University, Egypt confirmed this study and its guidelines were followed for the use and care of laboratory animals (Approval No 198: 4/2019).

Induction of electrical injury.

The rats in the studied groups were exposed to an electrical current through a device that transfers electrical energy consisting of a two-end, double-copper cable. The copper cable was peeled to a length of 1 cm on one end, and the other end was attached to a source of electric energy (transmitting an alternating current with 50Hz, 220V for one minute) (Kandeel et al., 2017). A plate was used to mount the animals with one clamp attached to its left hind leg and the other to its right.

Experiment design

During the present study, six groups of rats were used, each containing ten female rats. The control group (Gp 1; n=10): The rats didn't receive any electrical current and at the same time as their study counterparts, they were sacrificed. Groups 2, 3, 4, 5 and, 6, 10 rats each: We exposed these groups to an alternating current which is of non-fatal intensity (220v for one minute), and they we sacrificed them immediately, after 2h, 24h, 72h, and after 7 days respectively.

All rats were anesthetized deeply with sodium pentobarbital, and anode and cathode were used to deliver direct current. The right hind-leg and the left fore-leg served as the cathode and anode, respectively. Then electrocution of the rats was carried out for one minute with 220 V, 50 Hz. Finally, neck dislocation was performed by pulling the rats from tails after squeezing the neck of the rat with a towel and the rats died immediately.

The Histopathology:

Ovarian specimens from each group were taken for histological analysis. The ovarian tissues were embedded in paraffin after being fixed in phosphate-buffered 4% formalin (pH 7.4) for 24 hours. Hematoxylin and eosin (H&E) was used to stain the sections after they had been divided into 4-mm slices. A pathologist who was unaware of the treatment that the rats had received coded the slides and carried out a semiquantitative analysis of the sections. Next, the pathological alterations in these ovarian tissues were assessed (Helin et al., 2006).

Scoring of histopathological results:

The results of the microscopic evaluation were scored according to Saygin et al., (2011) grading into four grades semi-quantitatively; grade 1 = absent (no finding is detected in the fields), grade 2 = mild changes (There was evidence of any finding in <25% of the fields), grade 3 = moderate changes (There was evidence of any finding in 25-50% of the fields), grade 4 = severe changes (There was evidence of any finding in >50% of the fields).

Immunohistochemical Stain:

Deparaffinized sections were rehydrated, and to suppress the endogenous peroxidase activity they were treated for 20 minutes in hydrogen peroxide/methanol 0.3%. Then, we microwaved the sections after being submerged in citrate buffer (10 cc, pH 6). After that, to block the nonspecific protein binding sites, we incubated the sections with a protein blocking solution which is serum-free for 20 minutes in room temperature. An anti-caspase-3 antibody [R & T system (Biotechne brand)] in1:50 dilution at a 4° temperature was used to incubate the slices. After that, we incubated the slices with the secondary antibody, then 1–2 drops of diaminobenzidine were used to stain the sections and hematoxylin to counterstain them, then they were dehydrated, cleaned, and viewed under a light microscope. Positive controls for caspase-3 expression to indicate correct tissue preparation and staining were used. It was included in each staining run after being processed in the same way as the rat tissue samples.

For each run, one -ve control tissue was processed by eliminating the specific primary antibody and adding instead BPS in the staining procedure. This slide should not exhibit specific staining and serves to indicate non-specific staining. We examined the negative control slide to exclude the target antigen specific labelling by primary antibody. The negative control sections were examined for the absence of specific staining to confirm the lack of cross-reactivity of secondary antibody and other non-target cell components (Huang et al., 2012).

Statistical analysis

The SPSS application (version No. 20) was used to perform the statistical analysis on the data. To compare the means of three tested groups, one way ANOVA test with Post HOC Correction was applied. The results of histopathological changes were analyzed by using Fisher's exact test for qualitative data between the groups, SPSS version 20.

## Results

*Histopathological results*

The results of the histopathological changes detected in the rats' ovaries are shown in figure (1). Light microscopic examination of the ovaries revealed normal follicular size and number at all different phases of follicular maturation for the control group (group 1), as well as minimal hemorrhage and minimal congestion in the stromal blood vessels in group 2 (immediate group). Apoptosis with degeneration in some ovarian follicles, some congestion in stromal blood vessels, and hyaline changes were seen in group 3 (after 2 hours).

Group 4 (after 24 hours) showed decreased number and size of some ovarian follicles with moderate congestion in the stromal blood vessels and moderate hemorrhage in stromal cells, while group 5 (after 72 hours) showed marked degeneration of the ovarian follicles with a decrease in their sizes, marked degeneration of stromal cells and marked congestion of the blood vessels with sever hemorrhage.

Group 6 (after 7 days) showed that there were an increase in the size of corpus luteum, severe degeneration in the number & size of the ovarian follicles and there was severe congestion in the stromal blood vessels with severe hemorrhage.

As regards, the decrease in the number of the ovarian follicles, there was no decrease in control group, mild decrease in group 3, mild to moderate decrease in group 4 and moderate to severe decrease in groups 5 & 6. Statistical analysis showed significant gradual decrease among the six groups (p value < 0.001) (Table 1).

Concerning the decrease in the size of the ovarian follicles, there was no decrease in groups 1 and 2, mild decrease in groups 3 and 4, mild to moderate decrease in group 5 and moderate to severe decrease in group 6. Statistical analysis showed significant decrease among the six groups (p value < 0.001) (Table 1).

As regards, the congestion in stromal blood vessels, there was no congestion in control group, mild congestion in group 2, mild to moderate change in group 3, moderately congested in group 4, moderate to severe in group 5 and severe congestion in group 6. Statistical analysis showed significant results as regarding the degree of congestion in stromal blood vessels (p value < 0.001) (Table 2).

In respect of stromal hemorrhage, hemorrhage was absent in the control group, mild in group 2, but it was mild to moderate in group 3, in groups 4 & 5 it was moderate to severe, and in group 6 it was severe. There were statistically significant results as regarding presence of stromal hemorrhage among six groups (p value < 0.001) (Table 2).

Regarding the presence of hyaline degeneration, there was no degeneration in group 1, mild degeneration in groups 2, 3 & 4, mild to moderate in group 5 and moderate to severe in group 6. Statistically significant results as regarding presence of hyaline degeneration among six groups were found (p value < 0.001) (Table 2).

*Expression of Caspase-3*

The tested cells showed Caspase-3 immunoreactivity in their cytoplasm (Figure 2). Caspase-3 expression within the tissues of the ovary showed a significant gradual increase. On comparing the percentage of caspase-3 expression in the tissues of the ovary, it increased significantly within the six groups ($p<0.0001$) (Table 3 & Chart 1). The expression of caspase-3 showed a highly statistically significant positive correlation with the time intervals ($p<0.0001$ and $r=0.984$) (Table 4 & Chart 2).

**Table (1): Comparison between the groups according to the decrease in the number of the ovarian follicles and the decrease in the size of ovarian follicles.**

| | | Control | Immediate | After 2h | After 24 h | After 72 h | After 7 days | P value |
|---|---|---|---|---|---|---|---|---|
| | | N=10 | N=10 | N=10 | N=10 | N=10 | N=10 | |
| **Decrease in the number of ovarian follicles** | Grade I | 10 (100%) | 5 (50%) | 0 (0%) | 0 (0%) | 0 (0%) | **<0.001*** |
| | Grade II | 0 (0%) | 5 (50%) | 10 (100%) | 5 (50%) | 0 (0%) | |
| | Grade III | 0 (0%) | 0 (0%) | 0 (0%) | 5 (50%) | 5 (50%) | |
| | Grade IV | 0 (0%) | 0 (0%) | 0 (0%) | 0 (0%) | 5 (50%) | |
| **P value** | | | | | | | |
| *Control* | | | ***0.033**** | ***<0.001**** | ***<0.001**** | ***<0.001**** | |
| *Immediate* | | | | ***0.033**** | ***0.004**** | ***<0.001**** | |
| *After 2h* | | | | | ***0.033**** | ***<0.001**** | |
| *After 24h* | | | | | | ***0.004**** | |
| *After 72 h* | | | | | | | |
| **Size of follicles** | GradeI | 10 (100%) | 10 (100%) | 0 (0%) | 0 (0%) | 0 (0%) | **<0.001*** |
| | GradeII | 0 (0%) | 0 (0%) | 10 (100%) | 10 (100%) | 5 (50%) | |
| | GradeIII | 0 (0%) | 0 (0%) | 0 (0%) | 0 (0%) | 5 (50%) | |
| | GradeIV | 0 (0%) | 0 (0%) | 0 (0%) | 0 (0%) | 0 (0%) | |
| **P value** | | | | | | | |
| *Control* | | | **----** | **<0.001*** | **<0.001*** | **<0.001*** | |
| *Immediate* | | | | **<0.001*** | **<0.001*** | **<0.001*** | |
| *After 2h* | | | | | **----** | **0.033*** | |
| *After 24h* | | | | | | **0.033*** | |
| *After 72 h* | | | | | | | |

***Fisher's exact test for qualitative data between the groups, *: Significant level at P value < 0.05***

**Table 2. Comparison between the groups according to the congestion in stromal blood vessels in ovarian tissue, the stromal hemorrhage in ovarian tissue and the presence of hyaline degeneration.**

| | | Control | Immediate | After 2h | After 24 h | After 72 h | After 7 days | P value |
|---|---|---|---|---|---|---|---|---|
| | | N=10 | N=10 | N=10 | N=10 | N=10 | N=10 | |
| **Stromal blood vessels congestion** | Grade I | 10 (100%) | 0 (0%) | 0 (0%) | 0 (0%) | 0 (0%) | | **<0.001*** |
| | Grade II | 0 (0%) | 10 (100%) | 5 (50%) | 0 (0%) | 0 (0%) | | |
| | Grade III | 0 (0%) | 0 (0%) | 5 (50%) | 5 (50%) | 10 (100%) | | |
| | Grade IV | 0 (0%) | 0 (0%) | 0 (0%) | 5 (50%) | 0 (0%) | | |
| **P value** | | | | | | | | |
| *Control* | | | **<0.001*** | **<0.001*** | **<0.001*** | **<0.001*** | **<0.001*** | |
| *Immediate* | | | | **0.033*** | **<0.001*** | **<0.001*** | **<0.001*** | |
| *After 2h* | | | | | **0.004*** | **0.033*** | **<0.001*** | |
| *After 24h* | | | | | | **0.033*** | **0.033*** | |
| *After 72 h* | | | | | | | **<0.001*** | |
| **Stromal Hemorrhage** | Grade I | 10 (100%) | 0 (0%) | 0 (0%) | 0 (0%) | 0 (0%) | | **<0.001*** |
| | Grade II | 0 (0%) | 10 (100%) | 5 (50%) | 0 (0%) | 0 (0%) | | |
| | Grade III | 0 (0%) | 0 (0%) | 5 (50%) | 10 (100%) | 10 (100%) | | |
| | Grade IV | 0 (0%) | 0 (0%) | 0 (0%) | 0 (0%) | 0 (0%) | | |
| **P value** | | | | | | | | |
| *Control* | | | **<0.001*** | **<0.001*** | **<0.001*** | **<0.001*** | **<0.001*** | |
| *Immediate* | | | | **0.033*** | **<0.001*** | **<0.001*** | **<0.001*** | |
| *After 2h* | | | | | **0.033*** | **0.033*** | **<0.001*** | |
| *After 24h* | | | | | | **----** | **<0.001*** | |
| *After 72 h* | | | | | | | **<0.001*** | |
| **Hyaline degeneration** | Grade I | 10 (100%) | 5 (50%) | 5 (50%) | 5 (50%) | 0 (0%) | | **<0.001*** |
| | Grade II | 0 (0%) | 5 (50%) | 5 (50%) | 5 (50%) | 5 (50%) | | |
| | Grade III | 0 (0%) | 0 (0%) | 0 (0%) | 0 (0%) | 5 (50%) | | |
| | Grade IV | 0 (0%) | 0 (0%) | 0 (0%) | 0 (0%) | 0 (0%) | | |
| *P value* | | | | | | | | |
| *Control* | | | **0.033*** | **0.033*** | **0.033*** | **<0.001*** | **<0.001*** | |
| *Immediate* | | | | **1** | **1** | **0.004*** | **<0.001*** | |
| *After 2h* | | | | | **1** | **0.004*** | **<0.001*** | |
| *After 24h* | | | | | | **0.004*** | **<0.001*** | |
| *After 72 h* | | | | | | | **0.004*** | |

***Fisher's exact test for qualitative data between the groups, *: Significant level at P value < 0.05***

**Table (3): Comparison between different groups according to the percentage of caspase-3 expression in the ovaries.**

| | | Control | Immediate | After 2h | After 24h | After 72 h | After 7 days | P value |
|---|---|---|---|---|---|---|---|---|
| | | N=10 | N=10 | N=10 | N=10 | N=10 | N=10 | |
| **Caspase-3 expression** | **Range** | (3-5) | (9-14) | (19-24) | (31-36) | (44-50) | (65-69) | **<0.001*** |
| | **Mean±SD** | 4.1±0.7 | 12.1±1.5 | 21.9±1.8 | 34.2±1.8 | 47.8±2.1 | 67.3±1.6 | |
| **P value** | | | | | | | | |
| Control | | | **<0.001*** | **<0.001*** | **<0.001*** | **<0.001*** | **<0.001*** | |
| Immediate | | | | **<0.001*** | **<0.001*** | **<0.001*** | **<0.001*** | |
| After 2h | | | | | **<0.001*** | **<0.001*** | **<0.001*** | |
| After 24h | | | | | | **<0.001*** | **<0.001*** | |
| After 72 h | | | | | | | **<0.001*** | |

***One-way ANOVA test for quantitative data between the groups followed by post hoc Tukey's analysis between each two groups, *: Significant level at P value < 0.05***

**Table (4): Correlation between time intervals and caspase-3 expression in ovaries**

| | Time interval | |
|---|---|---|
| | **R** | **P value** |
| **Caspase-3 expression** | ***0.984*** | ***< 0.001**** |

***Pearson's correlation, *: Significant level at P value < 0.05***

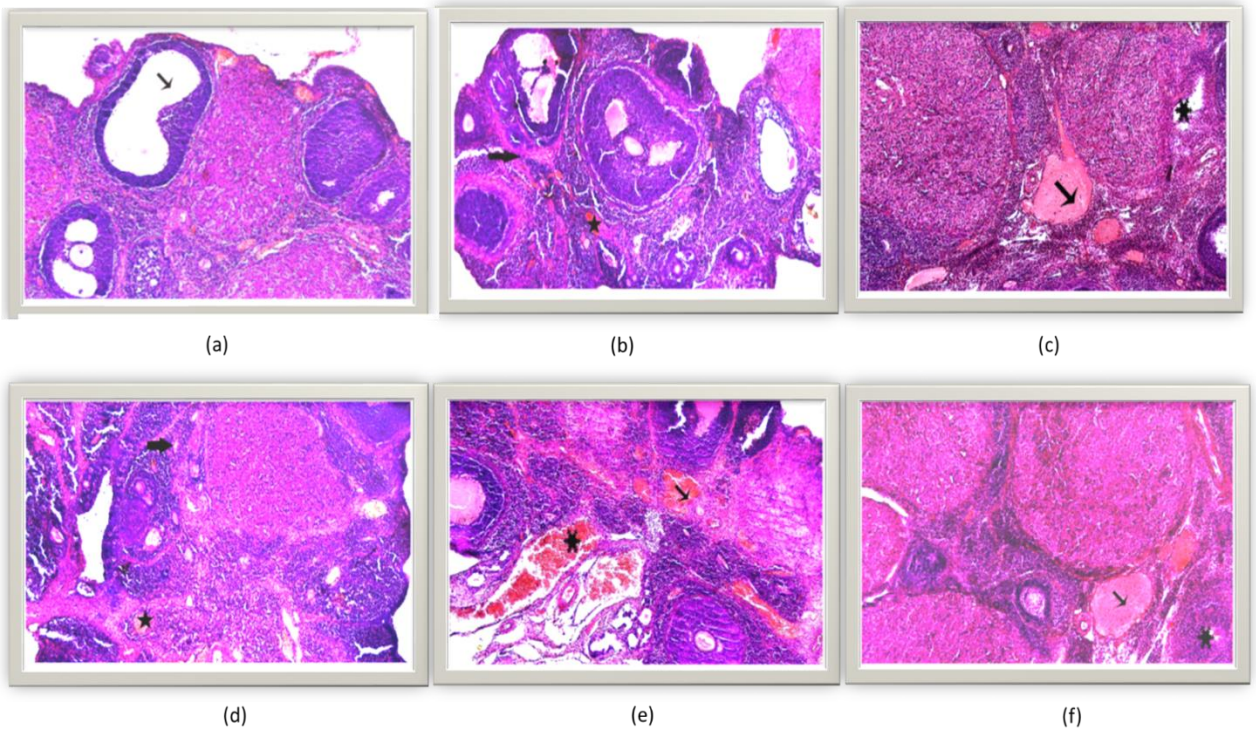


**Figure 1: the histopathological changes detected in the rats' ovaries:**
a: A photomicrograph section from an ovary of group 1 (control group) showing normal follicular size & number (→) in all different stages of follicular maturation (H&E X100).
b: A photomicrograph section from an ovary of group 2 (immediate group) showing minimal hemorrhage (*) & minimal congestion in stromal cells (→) with normal follicular size & number (H&E X100).
c: A photomicrograph section from an ovary of group 3 (2 hours) showing some congestion in stromal blood vessels & hyaline changes were found (→) and degeneration in some ovarian follicle (*) (H&E X100).
d: A photomicrograph of section from an ovary of group 4 (24 hours) showing moderate congestion in between stromal blood vessels, decreased size & number of some ovarian follicles (→) and moderate hemorrhage in stromal cells (*)(H&E X100).
e: A photomicrograph section from an ovary of group 5 (72 hours) showing marked degeneration of ovarian follicles with decrease in their sizes, marked degeneration of stromal cells and marked congestion of the blood vessels (*) with sever hemorrhage (→) (H&E X100).
f: A photomicrograph of section from an ovary of group 6 (7 days) showing increase in the size of corpus luteum, sever degeneration in the number & the size of the ovarian follicles (*) and there are sever congestion in stromal blood vessels with sever hemorrhage (→) (H&E X100).

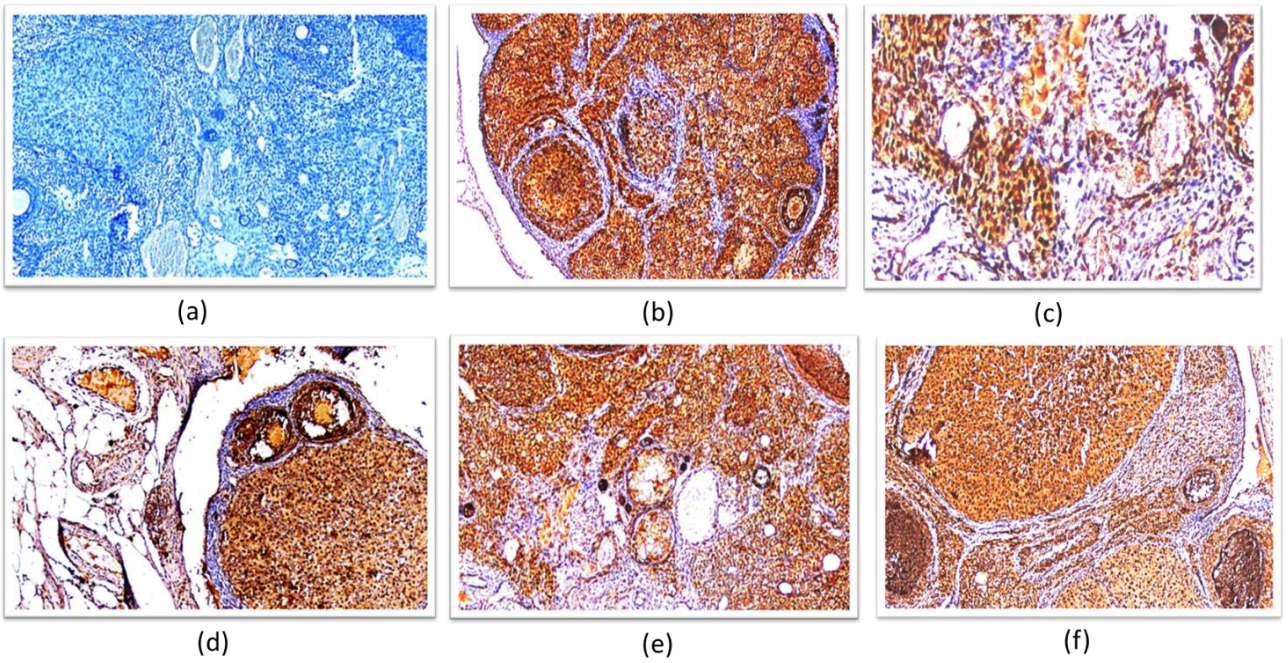


**Figure 2. Expression of Caspase- 3 in the rats' ovaries:**
a: Immunolabeling of caspase- 3 activity related to control group showing focal positive weak expression of caspase-3 in ovarian follicles with negative expression in the majority of ovarian tissue (streptavidin-biotin-immunoperoxidase X100).
b: Immunolabeling of caspase- 3 activity related to group 2 showing focal positive weak expression of caspase-3 in cells of some ovarian follicles with negative expression in other ovarian follicles (streptavidin-biotin-immunoperoxidase X100).
c: Immunolabeling of caspase- 3 activity related to group 3 showing positive moderate expression of caspase-3 in cells of many ovarian follicles (streptavidin-biotin-immunoperoxidase X100).
d: Immunolabeling of caspase- 3 activity related to group 4 showing positive moderate expression of caspase-3 in cells of many ovarian follicles (streptavidin-biotin-immunoperoxidase X100).
e: Immunolabeling of caspase- 3 activity related to group 5 showing positive strong expression of caspase-3 in cells of the majority of the ovarian follicles (streptavidin-biotin-immunoperoxidase X100).
f: Immunolabeling of caspase- 3 activity related to group 6 showing positive strong expression of caspase-3 in cells of the majority of ovarian follicles (streptavidin-biotin-immunoperoxidase X100).

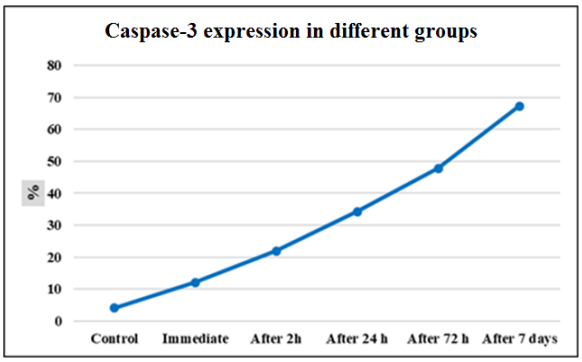


**Chart 1. Comparison between groups according to the percentage of caspase-3 expression in the ovaries.**

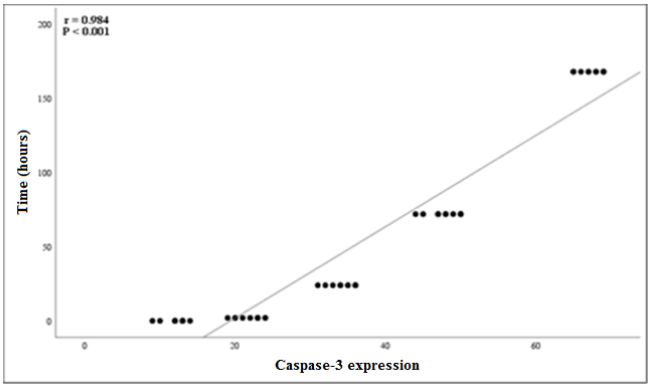


**Chart 2. Correlation between the time intervals and caspase-3 expression in the ovaries.**

## Discussion

Electrical injury is defined as the damage induced by generated electrical current passing through the body. The majority of electrocution deaths are unintentional, whereas homicide and suicide deaths are uncommon. Many individuals are daily exposed to different sources of electricity (Mondello et al., 2018).

For apoptosis, two pathways are commonly suggested; intrinsic and extrinsic pathways, which are mitochondrial-dependent and cell-surface death receptor-dependent, respectively (Fadeel and Orrenius, 2005). On the other hand, the endoplasmic reticulum stress was documented as the cause of apoptosis, and

its stress is initially induced by the depletion of the intraluminal free calcium concentration (López et al., 2009).

The ovarian function and development of the ovary depend on apoptosis which is an essential component. In fact, it is the process that keeps the biological clock in women ticking. Apoptosis is an essential component of ovarian function and development. Indeed, it is the mechanism that makes the female biological clock tick. Apoptosis mostly affects the oocyte during the fetal stage, on the other hand, it involves the granulosa cells of the developing follicle in adulthood (Hussein, 2005).

Farag and Dhama, (2016) explained that the effect of electrocution on tissues was mainly due to apoptosis. Additionally, they investigated the alterations in the expression of genes related to apoptosis along with the fragmentation of DNA as electrocution biomarkers. One of these biomarkers was caspase-3, which has an essential role in the apoptotic process.

Caspase-3 expression has been found in the humans' ovary (Matikainen et al., 2001), and the existence of the active form of caspase-3 makes it a valuable and reliable marker for the detection of apoptotic cells in addition to linking it to follicular atresia (Fenwick and Hurst, 2002).

In the present study, 60 female albino rats weighing 200-250 gm were included. This study aimed to detect the histopathological changes in the ovary and to evaluate the caspase-3 expression in the ovaries of the rats which are electrically injured by a non-fatal current, and to demonstrate both immediate and delayed impacts of the electrical current on the ovaries. The rats under study were subjected to a non-fatal electrical current for one minute and all of them survived till the scarification time.

The same amount of electrical current used in the present study was previously tested in Li et al., (2015), which included 24 rats. After exposure to the current, 8 rats and were categorized as the fatal electrocution group, and the survivors were the electrical injury group. They showed that the testes of electrically damaged rats had significantly increased the FABP1 and gastrin R expression levels, indicating trauma of the testes in electrically injured rats, and these findings suggest that such changes would be manifest as aberrant testicular function.

The present study on the ovaries detected that the caspase-3's field percentage showed an increase which was statistically significant ($p<0.001$). Immunohistochemistry test results supported any necrosis or apoptosis discovered during the histological examination.

Comparatively to the control group (group 1), the electrocuted groups (groups 2, 3, 4, 5 & 6) had a positive immune response for caspase-3 in the ovarian cells' cytoplasm and within some nuclei. The positive immune reaction for caspase-3 could be attributed to its important role in cell apoptosis.

This is in accordance with Saygin et al., (2011) study which demonstrated that electrical injury triggers apoptosis. They investigated Caspase-3 in the testicular tissues, and there was an increase in its expression according to the degree of injury.

In the present work, group 6; after 7 days, had the highest expression of caspase-3 as comparing it to the other groups, but the control one had the lowest expression. This finding matched that of Kandeel et al., (2017), who studied the effect of non-fatal electrical current on the Purkinje cells and reported that apoptosis had a role at the pathogenesis of both immediate and long-term impacts of electric damage to Purkinje cells. They found that the number of caspase-3 positive cells was significantly higher in the non-fatal electrocution groups than in the non- electrocution (control) group. They also found that the expression was increased in the cerebellar tissues at 4 hours after non-fatal electrocution more than that in the immediate and the 2 hours groups.

Additionally; in the present study, the increase in the apoptosis percentage after electrical injury was directly proportionate with the prolongation of the survival time. Also, the histopathological findings were shown to be linked with the caspase-3 staining as seen in the changes in the follicular size, congestion of the stromal blood vessels and the hemorrhage in stromal cells.

## Conclusion

In conclusion, the altered levels of caspase-3 in the current study demonstrated the existence of ovarian trauma in the studied rats exposed to non-fatal electrical injury, and the current alterations may be manifested as an abnormal ovarian function that could affect future fertility.

## Recommendations

Further studies on the ovarian changes following electrical injury with different time intervals than those used in the present research are recommended.

## Disclosure statement:

The authors declare no competing interests

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# آثار الإصابة الكهربائية غير المميتة على إبانة كاسبيز-٣ في مبايض إناث فئران الألبينو: دراسة هستولوجية وكيميائية مناعية

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## الملخص العربي

**المقدمة:** تمثل الإصابة الكهربائية مشكلة خطيرة في العالم النامي مع ارتفاع معدلات المراضة والوفيات. إن الغدد التناسلية هي أعضاء حساسة للتيار الكهربائي بسبب مقاومتها المنخفضة، وقد تم إجراء القليل من الدراسات على الغدد التناسلية على الرغم من أن العديد منها أظهر تأثيرا للكهرباء على أعضاء الجسم المختلفة. **الهدف:** يهدف هذا العمل إلى الكشف عن التغيرات النسيجية للمبايض وتقييم التعبير النسيجي المناعي كاسباز-٣ في الجرذان البيضاء بعد التعرض لتيار كهربائي غير مميت على فترات مختلفة (فوري ، ساعتان ، ٢٤ ساعة ، ٧٢ ساعة و ٧ أيام). **طريقة البحث:** أجريت الدراسة الحالية في قسم الطب الشرعي وعلم السموم السريري، كلية الطب، المنيا، مصر. احتوت هذه الدراسة على ٦٠ أنثى من الجرذان البيضاء، وزن كل منها ما بين ٢٠٠ و ٢٥٠ جرام. وقد تمت معالجة أقسام من المبايض لتحليل كاسباز-٣ من الناحية النسيجية والمناعية .النتائج: أظهرت مبايض الحيوانات المدروسة وجود إصابة في المبيض مع تشوهات نسيجية كبيرة وزيادة ملحوظة في تعبير كاسباز-٣. **الخلاصة:** لقد دعمت مستويات كاسباز-٣ المرتفعة والتغيرات النسيجية المرضية النظرية القائلة بأن موت الخلايا المبرمج كان هو الآلية الرئيسية للإصابة الكهربائية للمبايض. وقد تتأثر الخصوبة المستقبلية بهذه التغييرات، والتي ربما تظهر على هيئة وظيفة غير طبيعية للمبيض. **التوصيات:** يوصى بإجراء المزيد من الدراسات حول تغيرات المبيض بعد الإصابة الكهربائية بفترات زمنية مختلفة عن تلك المستخدمة في البحث الحالي.

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