SUMMARY

Lasers especially the CO_2 laser are now widely used in surgery, but a little data are available for the effects of the plume (vapor) by-products resulting from laser surgery.

Many researchers have suggested that the smoke is extremely hazardous to the patient and the surgeons or operating room personnel. Some of them were suggested that the laser vapor might transmit viruses e.g.

- Human papilloma virus (HPV), intact HPV DNA was detected in vapor of CO_2 laser smoke.
- Human immunodeficiency virus (HIV) DNA was also present in the laser smoke as a result of vaporization of concentrated tissue culture pellets infected with HIV by CO_2 laser.
- Viable bacteriophage particles were detected as a result of vaporization of an agar substrate containing high titres of bacteriophage.
- Laser Smoke was capable of disseminating viable tumor tissue at least locally is an air born fashion, but other study was suggested that viable cells was unlikely present in the laser smoke.

The smoke particles of laser were found to be mutagenic to salmonella typhi. strain. Also, bacterial dissemination may occurs as a hazard of the laser smoke. Others suggested that the laser

smoke may be hazardous to the respiratory system, the smoke may lead to deposition of the fine particulate matter in the alveoli resulting in from extensive pathology. The laser smoke may also lead to decrease in the arterial PO_2, mild hypoxia and depressed tracheal mucus velocity.

In our study we try to find an answer to the question concerning the hazardous effects of the CO_2 laser smoke on the bronchopulmonary system. We use twenty rabbits of the same species divided into five groups (four rabbits each) and exposed to the CO_2 laser smoke for different periods of time the 1st group was exposed the CO_2 laser smoke for 10 minutes, the 2nd group was exposed the CO_2 laser smoke for 20 minutes, the 3rd group was exposed the CO_2 laser smoke for 30 minutes, the 4th group was the chronic group of exposure to the CO_2 laser smoke for 3-4 weeks and 5th group was the control group.

We use a glass chamber measuring 15 cm wide X 25 cm length X 12 cm height. The smoke was obtained by vaporization of human tonsils by the use of CO_2 laser apparatus at a power of 4 watts and 200 HZ frequency.

The rabbits were sacrificed at different periods of time then dissection of the respiratory system of rabbit was done and examined electron microscopically & histopathologically. We get the following results :

● At 10 minutes exposure to CO_2 laser smoke :

a- Electron microscopical results :

There are massive invasion of lymphocytes, loss of cilia and microvilli, sub-epithelial proprial edema, swollen collagenic fibrils,

numerous destructed mitochondria, macrophages having phagocytic bodies with various stages of deterioration and the neutrophils having large vacuolated granules and smaller specific granules.

b- Histopathological results :

Pulmonary inflammatory response as an interstitial congestion of the lung tissue, congested blood vessels with edematous thick wall and distended alveolar sacs and ducts.

● At 20 minutes exposure to CO_2 laser smoke :

a- Electron microscopical results :

There are : Darkly stained pyknotic nuclei, disturbed epithelial cells with destructed cytoplasmic organelles & mitochondria, intercellular irregular spaces, loss of microvilli & apical cilia with destruction of their apical borders, numerous oesinophilia with phagocytic vacuoles and hypochromatic nuclear lobes, nuclear vacuolation in pneumocyte type II and complete destruction of mitochondria & endoplasmic reticulum.

b- Histopathological results :

Interalveolar hemorrhage with hemosidirin deposits, dilated broncheoles, lymphocytic aggregation, focal areas of interstitial pneumonia and interstitial congestion with atrophy of some alveoli but dilated others.

● At 30 minutes exposure to CO_2 laser smoke :

a- Electron microscopical results :

Extruded pyknotic nuclei, destructed cilia of most of tracheal cells, numerous number of intercellular lysosomes, irregular

lobulated nuclei with abundant euchromatin & few heterochromatin, interalveolar phagocytic macrophages having intracytoplasmic phagocytic matter, hypochromatic nuclei, less lamellar bodies, sub-epithelial blood capillary surrounded with collagenic fibrils the cytoplasm of endothelial cell having a lot of vacuoles and Interstitial hemorrhage inbetween lung alveoli.

b- Histopathological results :

Detached endothelium with hyalinization swollen wall of blood vessels with peri-vascular edema, lymphocytic aggregation with lymphoid follicle formation, compensatory emphysema & interstitial pneumonia, thrombosed pulmonary capillaries, desquamation of the lining epithelium, intra-alveolar migration of phagocytic cells and the goblet cells becomes more thin with atrophic changes.

● Chronic exposure group to the CO_2 laser smoke :

a- Electron microscopical results :

Dividing basal cells while the other cells reveals pyknotic nuclei, sub-epithelial dividing cell with abnormal mitochondria, an abnormal goblet cell having destructed vacuolated nucleus, a special type of destruction to the nuclei in the form of boundary vacuolation, Some goblet cells having no nucleus due to karyolysis or karyorrhexis, an extruded pyknotic nucleus, complete extrusion may occur with vacuolated appearance of its place, degenerated, destructed mitochondria and endoplasmic reticulum, Atrophy of goblet cells with few mucus granules, peri-nuclear halo formation, irregular pyknotic nuclei with degenerative changes, active septal

macrophages having irregular nuclei with destructed engulfed particles, intracytoplasmic smoke black granules of variable sizes & shapes, abnormal aggregation of blood platelets, an active fibroblasts which forms new collagenic fibrils, abnormally formed collagenic fibrils, active macrophage engulfed carbon particles, squamous metaplasia the columnar ciliated epithelium was changed into flattened ciliated epithelium.

b- Histopathological results :

We get the following results : emphysema, thickened blood vessel walls with hyaline degeneration, abnormal chondrocytes, lung collapse & fibrosis, hyalinization of broncheoles & blood vessels and metaplastic changes in the form of :

- The endothelium showing patchy areas of perpendicular endothelial cells.
- Stratification of endothelium.
- Beginning of metaplastic changes of epithelial lining of broncheoles.
- Blebs protrusions in the apical border of most upper cells of metaplastic epithelium in the trachea.

● Statistical Results :

The following significant data were verified :

In electron microscopical study :

Nuclear changes :Cell division, nuclear vacuolation, extruded nuclei, nuclear destruction, pyknotic nuclei & hypochromatosis.

Cellular changes :lymphocytosis, loss of cilia & microvilli, destructed mitochondria, active fibroblasts, abnormal collagenic

fibres, smoke granules, increased intracellular lysosomes, goblet cell atrophy, squamous metaplasia & blood capillary roughness.

In histopathological study :

The following significant data were observed :

Emphysema, thrombosed pulmonary capillaries & arterioles, metaplastic changes, lymphocytic aggregation, hyalinization of blood vessel walls, inter-alveolar hemorrhage, interstitial congestion, destructed cilia, atrophic thin goblet cells, interstitial fibrosis, phagocytic cell migration and desquamation of epithelial cells.

On Conclusion :

Laser plume is considered as one of the complications of the surgical laser procedures. So, we must provide two suction set-ups for all upper aerodigestive tract procedures one to remove smoke and steam from the operative field, the other to remove blood and mucus from the wound. Positioning of the nozzle of smoke evacuator at a distance of two inches from the laser interaction site was founded to be adequate.

Filters should be used in the suction lines and several smoke evacuation systems must be used to capture emissions from these procedures. Also, a special high efficiency masks are required to catch laser plume particles.