Journal of Medicine and Medical Sciences Vol. 14(2) pp. 1-4, January, 2023
Available online https://www.interesjournals.org/medicine-medical-sciences.html

Research Article

Tissue Penetrability as a Function of Nanoparticle Delivery Mode

Roxana Florentina Sufaru[1,2*†], AnaMarina Rădulescu[1,2], Ruxandra Vatavu[1,2†], Anca Sava[2,3†], Liviu Ciprian Gavril[2†] and Cosmin Popa[2†]

[1]PhD Student, Doctoral School, Department of Morphofunctional Sciences I, Grigore T Popa University of Medicine and Pharmacy, Laşi, Romania

[2]Department of Morphofunctional Sciences I, Grigore T Popa University of Medicine and Pharmacy, Laşi, Romania

[3]Department of Pathology, Prof. Dr. Nicolae Oblu Emergency Clinical Hospital, Laşi, Romania

[†]These authors contributed equally to this work

Received: 09-Jan-2023; Manuscript No: jmms-23-86369; **Editor assigned:** 10-Jan-2023; Pre-QC No: jmms-22-86369 (PQ); **Reviewed:** 23-Jan-2023; QC No: jmms-22-86369; **Revised:** 1-Feb-2023; Manuscript No: jmms-22- 86369 (R); **Published:** 8-Feb-2023, DOI: 10.14303/2141-9477.2023.22

Abstract

The study conducted at CEMEX Iasi was carried out on 2 groups of Wistar rats to which nanoparticles loaded with contrast agent were administered intraperitoneally and nasogastrically. The two modes of administration offered a comparison in terms of tissue penetrability. Histological samples were obtained from organ sections (heart, liver, kidney, gingiva, testis) and analysed using the NIKON Y-FL ECLIPSE E600 immunofluorescence microscope at the "Professor Doctor Nicolae Oblu" Emergency Clinical Hospital in Iasi. In terms of immunofluorescence our study showed a difference only in the case of sections taken from the gingiva.

Keywords: Nanoparticles, Tissue Penetrability, Rhodamine

INTRODUCTION

Nanoparticles have been much studied recently, with various practical applications. Most therapeutic agents primarily target cells and tissues in an area of specific pathology. The key to therapeutic success is the targeted delivery at the cellular and subcellular level of different drug species. The most important obstacle to achieving drug efficacy is the non-specific distribution of the biologically active substance after administration (Chenthamara D et al., 2019).

In order to modify the distribution and control of drug release at the tissue level in the dento-maxillary sphere, nanotechnology products with penetration at the cellular and subcellular level are currently being tested (Patra JK et al., 2018). Most polymeric nanoparticles are biodegradable and biocompatible and are currently the method of choice for the controlled release of various drugs. They are also susceptible to surface modification by chemical transformations and have the potential for excellent pharmacokinetic control (Ahlawat J et al., 2018)

SCOPE

The aim of our study is to investigate tissue penetrability as a function of the mode of administration of contrast-loaded nanoparticles.

MATERIALS AND METHODS

The study will be conducted at CEMEX Iasi on 12 white, male Wistar rats weighing between 150 and 250 grams,

which will be reared under standard laboratory conditions (temperature 25°C, humidity 60%) and with standard rat nutrition for a balanced diet in minerals and vitamins.

In the first instance, the rats will be weighed so that each dose will be administered/kgc. The next step is to sedate the animal. Anaesthesia is performed using an anaesthesia system equipped with a vaporiser, transparent anaesthesia induction chamber and a flow meter. For rapid induction of anaesthesia, a mixture of air and oxygen will be used, with a concentration of 3.5% isoflurane, and maintained during procedures at a concentration of 2%.

We selected a group of 6 rats to be administered contrast-loaded nanoparticles intraperitoneally for 3 days.

During the first three days they will be administered Rhodamine in a single dose of 0.01 mg/kgc. Intraperitoneal injection is performed by inserting the needle into the lower 1/2 of the midline of the abdomen, above the pubic symphysis, ensuring that the needle does not penetrate into one of the abdominal organs **(Figure 1)**. We also selected a second batch of 6 male rats to be administered with Rhodamine-loaded nanoparticles on the nasogastric tube for 3 days to study the penetrability to all tissues.

During the first three days they will be administered Rodamine in a single dose of 0.01 mg/kg body. A small feeding tube will be used for nasogastric tube administration. The first step is to place the animal in sternal recumbency, followed by lifting the head and applying 2-3 drops of 0.5% proparcaine into the chosen nostril. In addition, a thin film of lidocaine is applied to both nostrils to reduce the stimulation caused by handling the nasal cavity.

To determine the appropriate size of the probe, measure from the distal end of the nasal cavity to the 13th rib. A sterile surgical marker mark is drawn on the nasogastric tube to know later how much needs to be inserted.

The first step is to gently lift the nostrils to ease the penetration of the probe. The probe is pushed through the chosen nostril and when it reaches the nasopharynx, the patient will start to swallow so that its penetration into the oesophagus is facilitated.

On the fourth day the animals will be sacrificed and the organs will be removed and stored in containers with paraformaldehyde to be studied by immunofluorescence microscopy. Euthanasia is a humane way of killing an animal with a minimum of physical and mental suffering. The method of euthanasia must be adapted for each age of the animal. The method must be painless, avoid the onset of convulsions and rapidly produce unconsciousness and death.

The organs removed are: liver, heart, gums, kidneys and testis **(Figure 2)**. Initially, the organs will be sectioned on ice using the LEICA CM1860 UV microtometer from the Emergency Clinical Hospital "Professor Doctor Nicolae Oblu" Iasi **(Figure 3)**. The steps of ice sectioning are: harvesting **(Figure 4)**, fixation **(Figure 5)**, embedding in ice **(Figure 6)**, sectioning **(Figure 7)** and slide display **(Figure 8 and 9)**.

The next two steps (fixation and embedding in ice) occur simultaneously, each organ fragment was placed on a metal support and covered with a fixative, containing a mixture of glycerol and resins that prevents the formation of ice crystals and increases the freezing speed. The tissue fragment is frozen in the cryostat at a temperature below -40°C until it becomes perfectly opaque. Then we continue with the fourth step, sectioning, in which we level the frozen tissue block, making 5.0 µm sections at -16°C. In the last step we etch the sections obtained, on glass slides using

Figure 1. Intraperitoneal injection with Rhodamine.

Figure 2. Organs harvested: kidney, heart, lung, gum, liver and testis.

Figure 3. LEICA CM1860 UV microtome at the Emergency Clinical Hospital "Professor Doctor Nicolae Oblu" Iasi.

Figure 4. Liver harvesting.

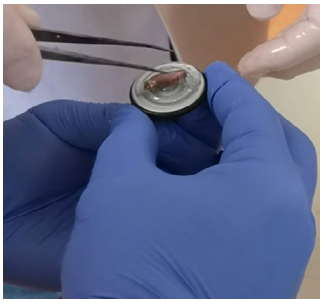

Figure 5. Fixing the organ fragment (liver).

Figure 6. Embedding organ fragments (liver, gum and kidney) in ice.

Figure 7. Sectioning the organ fragment (liver) on ice.

the anti-roll plate. Meyer albumin was used as an adjuvant in slide sectioning on ice.

To study the penetrability at tissue level we used the immunofluorescence microscope NIKON Y-FL ECLIPSE E600 from the Emergency Clinical Hospital "Professor Doctor Nicolae Oblu" Iasi using a 10 x /0.30 objective.

RESULTS

Following the histopathological examination of intraperitoneal

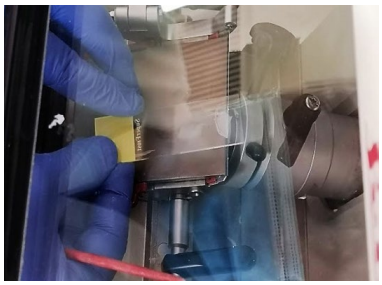

Figure 8. Display of the organ fragment (liver) on the slide.

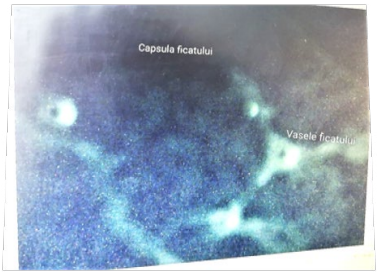

Figure 9. Liver: liver capsule and liver vessels.

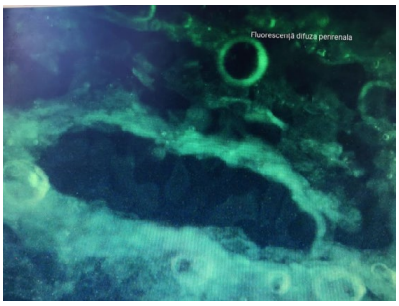

Figure 10. Kidney: perirenal diffuse fluorescence.

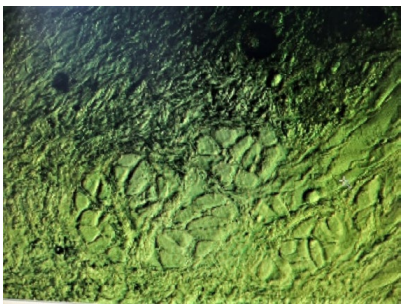

Figure 11. Gingiva: striated muscle.

administration of nanoparticles loaded with contrast medium we observed in the liver capsule and vessels **(Figure 10)**. Also both in case of intraperitoneal and nasogastric administration the liver in comparison with the other organs shows a more prominent fluorescence due to numerous macrophages.

In the kidney, diffuse perirenal fluorescence is observed **(Figure 11)**; in the gingiva, the striated muscle of the gingiva and its surface epithelium are easily observed **(Figures 12 and 13)**.

Histopathological examination of the organs taken from

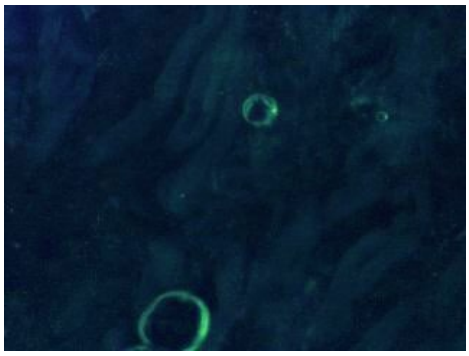

Figure 12. Gingiva: surface epithelium.

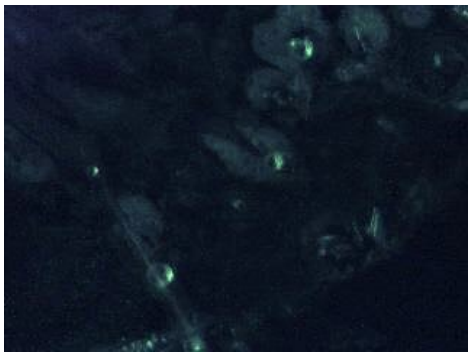

Figure 13. Gingiva.

rats in the nasogastric tube group showed similar immunofluorescence to that obtained in the group in which the contrast-loaded nanoparticles were administered intraperitoneally. This was observed in the heart, liver, kidney and testis.

The only difference is noted in the gingiva where the presence of immunofluorescence is less visible.

DISCUSSION

Nanoparticles can be administered by various routes, including intravenous and intraperitoneal injection, oral administration and pulmonary inhalation. The intravenous route provides an almost instantaneous response and allows broad control of the rate of drug contribution to the body.

The main advantage of intravenous administration of drugs is the rapid onset of action and the complete bioavailability of the drugs, even when the dose level is low. There are many risks associated with the intravenous route due to direct exposure of the drug in the systemic circulation. It is painful for the patient, costly and requires the assistance of experienced personal nurses (Tan ML et al., 2010).

Oral administration is the most common route of drug administration, with a high level of patient acceptance. Oral administration is the most preferred route of drug administration due to greater comfort, avoidance of pain, efficacy, high patient compliance and reduced risk of infection. Disadvantages of intraperitoneal administration such as tissue damage, pain, adverse reactions and poor patient compliance are arguments in favour of oral administration. In addition, oral administration of peptide or protein frequently suffers from the acidic environment and the enzyme system of the Gastro Intestinal Tract (GIT), which leads to degradation of the protein, thus decreasing its therapeutic value. Therefore, several essential approaches have been tried to enhance the stability of protein and peptide drugs and increase absorption.

CONCLUSION

Relating to the purpose of our study we can say that tissue penetrability depending on the mode of administration of contrast loaded nanoparticles shows similar results. Comparing intraperitoneal and nasogastric administration a difference in permeability was observed only at the level of the gingiva.

ACKNOWLEDGEMENT

None

CONFLICT OF INTEREST

None

REFERENCES

1. Chenthamara D, Subramaniam S, Ramakrishnan SG, Krishnaswamy S, Essa MM, et al. (2019). Therapeutic efficacy of nanoparticles and routes of administration. Biomat Res. 231.
2. Patra JK, Das G, Fraceto LF, Campos EVR, Rodriguez-Torres M del P, et al. (2018). Nano based drug delivery systems: recent developments and future prospects. J Nanobiotechnol. 16.
3. Ahlawat J, Henriquez G, Narayan M (2018). Enhancing the Delivery of Chemotherapeutics: Role of Biodegradable Polymeric Nanoparticles. Molecules. 23: 2157.
4. Das S, Chaudhury A (2011) Recent advances in lipid nanoparticle formulations with solid matrix for oral drug delivery. AAPS PharmSci Tech. 12: 62-76.
5. Tan ML, Choong PF, Dass CR (2010) Recent developments in liposomes, microparticles and nanoparticles for protein and peptide drug delivery. Peptides. 31: 184-193.