Radionuclides for Inflammation
Current Status and Future Aspects

PRACTICAL DOSIMETRIC CONSIDERATION AND IMAGING EVALUATION IN INFECTION SCINTIGRAPHY

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ABSTRACT

Timely identification and localization of infectious and inflammatory process are of critical importance in the treatment of patients presenting with suspicion of infection and inflammation. Whilst other radiological techniques (CT, MRI, US) are used for the localization of infectious foci, they rely merely on anatomical changes. Therefore, there has to be a reasonable elapse of time before the infection is diagnosed. In contrast, scintigraphic detection of infection and inflammation is a non-invasive method of whole-body scanning based on functional tissue changes. Several radiopharmaceuticals are currently employed for the scintigraphic imaging of infection and inflammation.

Especially in the case of bone and joint infection there is a choice among a number of radiopharmaceuticals available for the localization of the lesion.

In this study two radiopharmaceuticals are compared on dosimetric and diagnostic bases. The radiopharmaceuticals under evaluation are Ga67- citrate, and Tc99m- Anti-Granulocyte, Ga67-citrate being a traditional agent utilized for the detection of inflammation and Tc99m-Anti-Granulocyte being a relatively new radiopharmaceutical. Both agents were used for the detection of a suspected infectious lesion in the lower limbs.

INTRODUCTION

The investigation of bone and joint infection can be aided by a number of available radiopharmaceuticals (1, 2). In this study we are concerned with two alternative solutions.

Ga67- citrate is bound to plasma transferrin and lactoferrin in activated leukocytes and bacterial siderophores and it localizes not only in inflammatory processes but also in malignant lesions, therefore being also not specific for the diagnosis of infection. Skeletal uptake of Ga-67- citrate is related to both reticuloendothelial activity and bone turnover (4-6).

Tc99m - Anti-Granulocyte is partly bound to circulating granulocytes that are functionally normal and may target an infectious area.. The mechanism of accumulation of the radiopharmaceutical to the pathologic focus is, most probably, based on the migration of antibody - labeled circulating granulocytes to the focus because of their undisturbed chemotactic behavior. Additionally, the accumulation mechanism involves nonspecific related uptake of free antibody because of an increased capillary permeability at the focus, with subsequent binding to granulocytes (7-9).

MATERIALS - METHOD

The above mentioned radiopharmaceuticals are recommended for the detection of infection of the musculoskeletal system. Ga67-citrate is excreted by the renal and hepatobiliary systems. Ga67- citrate concentrates physiologically in the liver, much less in the spleen and in skeleton parts and owing to its excretion characteristics it exhibits a high activity uptake in the G.I. tract. Tc-99m Anti-Granulocyte normally concentrates to the liver, spleen, kidneys, and bladder, and in the bone marrow and it is excreted through the renal system. Table I concerns the physical characteristics of Ga67 and Tc99m, the injected activity and the time post injection of the image acquisition for the two agents.

Table I

Radiopharmaceutical	**Energy window used (KeV)**	**Half life**	**Activity injected**	**P.i. time (hrs)**
Ga67-citrate	93±20%	78.2hrs	5mCi	24, 48, 72
Tc99m-Anti-Granulocyte	140±20%	6.02hrs	20mCi	6, 24

Physical and imaging characteristics for the used radiopharmaceuticals

Based on the above, the organs of interest from a dosimetric point of view are the liver, spleen, kidneys, intestine and bone. From a physical point of view Ga67- citrate presents the disadvantage of a longer half-life, therefore a higher radiation burden.

The practical dosimetric and diagnostic comparison was based on four patients that were referred for a radionuclide scan on the suspicion of an infectious lesion in the lower limb. The patients were scanned with both of the above radiopharmaceuticals. Ga67- citrate was the second scan performed with a one-week time elapse from the first scan.

Dosimetric data on the two agents were calculated by MIRD values and MIRDOSE3 program, compared with the published literature and are presented in Table II.

Three regions of interest (ROI) were drawn on each one of the images of the pathologic area: One that encompassed the whole pathologic area, a ROI on a soft tissue area to obtain the background counts, as well as a ROI on a neighboring to the lesion area that presented a normal uptake, for the evaluation of the projection of the infectious area. From the measured counts an index representing the projection of the lesion for each radiopharmaceutical was calculated.

Table II

Target organs	Ga-67 citrate absorbed dose (mGy)	Tc99m- Anti-Granulocyte absorbed dose (mGy)
Liver	17,8	16,3
Spleen	20,7	21,5
Kidneys	16,3	14,1
Intestine	18,1	12,2
Skeleton	17,8	21,5

Absorbed dose data

RESULTS

The calculated indices, according to the radiopharmaceutical used are presented, in Table III. The indices represent the ratio of the counts in the pathologic area to the counts of a normal area adjacent to the lesion. Both numbers have subtracted the background counts, obtained from a soft tissue area. Theoretical dosimetric data concerning the organs that exhibit a normal uptake of the radiopharmaceutical have been presented in table II.

Table III

Patient	Ga 67- Citrate			Tc99m Anti-Granulocyte	
Hrs p.i.	24	48	72	6	24
#1	1.24	1.37	1.35	1	1.4
#2	1.10	1.22	1.80	4.7	3.8
#3	1.32	1.44	1.40	1.2	1.3
#4	1.05	1.12	1.10	3.5	3.1

Infection projection ratios

DISCUSSION

Viewing Table II, it is obvious that Ga67-citrate leads to increased absorbed dose in the gastrointestinal tract, while Tc99m - Anti-Granulocyte is characterized by a higher absorbed dose in the skeleton. Therefore, from a dosimetric point of view, Tc99m - Anti-Granulocyte has an advantage over the Ga67 - citrate. That happens because Tc99m is characterized by a shorter physical half-life than Ga67 and dosimetrically better energy characteristics.

As far as the projection of the infectious lesion is concerned Tc99m - Anti-Granulocyte is characterized by higher pathologic to normal ratios. According to the physiology of the lesion and the tissues involved in the infection, the projection ratios can reach values as high as 4.7 for Tc99m Anti-Granulocyte. Ga67-citrate presents higher background counts, requires a longer time span from injection to image acquisition and moreover it requires a longer acquisition time. Tc99m - Anti-Granulocyte provides the capability of higher activity to be injected to the patient, therefore leading to higher count numbers and permitting shorter acquisition times, as well as the ability to perform SPECT studies easily and conveniently.

Anti-Granulocyte antibodies are being evaluated regarding their ability to localize and demonstrate the full extent of infection or inflammation (7-10). The present study tries to deal with the issue from a dosimetric as well as a diagnostic point of view on lesions concerning the lower extremities. The results demonstrate a clear advantage of Tc99m Anti-Granulocyte over Ga67-citrate for the particular cases.

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