Comparative Evaluation of the role of Scintimetric Characterization by Dr. V. Siva’s Retention Ratio and the Triple Phase Bone Scan in the Skeletal Fracture Assessment

Sivasubramaniyan V* and Venkataramaniah K
Sri Sathya Sai Institute of Higher Learning, Prasanthinilayam, Andhra Pradesh, India

*Corresponding author: Sivasubramaniyan V, Doctoral Research Scholar, Sri Sathya Sai Institute of Higher Learning, Prasanthinilayam, Andhra Pradesh, India, Tel: +07758535734; Fax: +01892634829; E-mail: sam.nahas@nhs.net

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Abstract

Aim: This prospective analysis of the findings of bone scans done for skeletal fracture assessment was undertaken to compare the findings of the triple phase bone scan and the scintimetric characterization by Dr. V. Siva’s retention ratio in the assessment and evaluation of the skeletal fracture.

Materials and method: In this total study population of 39, had 19 males and 20 females. The 3 phases were acquired immediately after the intra-venous injection of 25 mCi of Tc99m MDP in a dynamic fashion centering over the fracture site. The dual head gamma camera e-Cam was used. The static Skeletal phase image and the 4 hr whole body bone scan images were acquired 4 hrs after injection. The images were processed, and the results were tabulated. The 24 hr static Skeletal phase image was acquired the next day. The 4/24 hr Dr. V. Siva’s retention ratios were calculated using the region ratio protocol and tabulated.

Results: The 3-phase bone scan analysis revealed that 18/39 46% were of malignant nature and 21/39 54% were of benign or non-malignant causes. The Scintimetric Characterization of the malignant lesions by Dr. V. Siva’s retention ratio was 12.8 ± 1.79 and that of the Non-malignant lesions was 5.8 ± 2.41 indicating the gross difference between the two groups. The statistical analysis also confirmed the significant difference between the two groups. There was absolute concordance between the Triple phase bone scan findings and the Scintimetric Characterization by Dr. V. Siva’s retention ratio in 30/39=77% of patients and the discordant between the two was noted in 9/39=23% patients.

Conclusion: It can be concluded that the Scintimetric Characterization of fracture site by Dr. V. Siva’s Retention ratio along with the Triple phase bone scan findings helps in the proper identification of the underlying pathological process in as high as 23% of the study.

Keywords: Skeletal fractures; Triple phase bone scan; Scintimetric characterization; Dr. V. Siva’s Retention Ratio; Comparative evaluation

Introduction

The utility of Triple phase bone scan in the assessment of sport injuries and focal skeletal injuries has been reported by Rupani [1]. Nagle [2] has dealt with the cost-effective ness of focal skeletal bone scan imaging against the whole-body bone scan.

The usefulness of the bone scintigraphy in the assessment and evaluation of carpel bone fractures is well documented by Umitt [3]. Tiel-van Bumm [4] have evaluated the hot spot in carpel injury by Computerized Tomographic evaluation and established the correlation between the two modalities. All these studies give a vivid description about the imaging findings in a qualitative manner resulting in continued nonspecific nature of this highly sensitive study.

As a measure of increasing the sensitivity Israel [5] have reported a delayed 24 hr imaging followed by the ratio calculation of 24 hr/4 hr values of Lesion/Bone counts at the specified point of time. It could not find wide clinical usage because of the decimal nature of the values.

Hence a modified Dr. V. Siva’s retention ratio derived by the ratio of 4 hr Lesion count/24 hr Lesion count has been proved to be useful in the Scintimetric evaluation of delayed union of fractures [6].

This prospective analysis of the findings of bone scans done for skeletal fracture assessment was undertaken to compare the findings of the Triple phase Bone scan and the Scintimetric Characterization by Dr. V. Siva’s retention ratio in the assessment and evaluation of the skeletal fractures.

With the approval of Hospital ethics committee in all the skeletal fracture evaluation patients routine whole-body bone scan was preceded by the triple phase bone-imaging. It was followed by the fourth phase 24 hr imaging of static focal imaging and whole-body imaging.

Materials and Methods

In the total study population of 39, had 19 males in the age range of 10 to 65 years (19/39=49%) and 20 females in the age range of 7 to 70 years (20/39=51%). The Blood flow phase and the Blood pool phase images were acquired immediately after the intravenous injection of 15
to 25 mCi of Tc99m MDP in a dynamic fashion centering over the fracture site or region of interest.

The dual head gamma camera e-Cam with SPECT capability was used. The static Skeletal phase image and the 4 hr whole body bone scan images were acquired 4 hrs post injection time. The images were processed, analyzed and the results were tabulated. The triple phase bone scan findings were tabulated as shown in Table 1 to differentiate the probable cause of the fracture.

| Blood flow phase | Blood pool phase | Skeletal phase | Disease condition |
|------------------|------------------|----------------|------------------|
| Increased        | Increased        | Increased      | Infection        |
| Nil              | Increased        | Increased      | Degeneration     |
| Nil              | Nil              | Increased      | Neoplastic       |

**Table 1: Triple phase bone scan findings pattern.**

The 24 hr static Skeletal phase image was acquired the next day 24 hr post injection time. The maximum counts in the focal hotspot of the fracture site in both the 4 hr and 24 hr images were calculated using Region Ration protocol and the values tabulated. The 4/24 hr Dr. V. Siva’s retention ratios were calculated and tabulated for analysis. The pattern recognition of triple phase bone scan findings is shown in Table 1.

| Age | Clinical          | B flow | B pool | Skeletal | 3 pbs impression | Dr. V. Siva’s retention ratio |
|-----|-------------------|--------|--------|----------|------------------|-----------------------------|
| 65  | Stress #          | positive| positive| positive |                  | 8                           |
|     | Infection         | negative|        |          |                  |                             |
| 60  | ST#               | negative| Negative| positive | Pathological #    | 10                          |
| 19  | Osteom            | negative| Negative| positive |                  | 5                           |
| 58  | Swelling          | negative| Negative| positive |                  | 11                          |
| 35  | Non-union         | negative| positive| positive |                  | 5                           |
| 40  | #FN               | negative| Negative| positive |                  | 7.9                         |
| 81  | # D11             | negative| positive| positive |                  |                             |
| 10  | ? OM              | negative| Negative| positive |                  |                             |
|     |                   |         |        |          |                  |                             |
| 25  | #FIT              | negative| positive| positive |                  | 2.4                         |
| 48  | Non-union         | negative| Negative| positive |                  |                             |
| 26  | Stress #          | positive| positive| positive |                  |                             |
| 10  | Epiphyseal injury | negative| Negative| positive |                  |                             |
| 61  | Lt. hip Injury    | positive| positive| positive | Infective        | 16.1                        |
| 64  | Non-union         | positive| positive| positive | Infective        | 7.2                         |
| 18  | Non-union         | positive| positive| positive | Infective        | 8.5                         |
| 10  | Non-union         | negative| Negative| positive |                  | 12.5                        |
| 48  | Path #            | positive| positive| positive | Infective        | 7.1                         |

**Table 2: Male data sheet.**

**Results**

The triple phase bone scan findings and the corresponding Dr. V. Siva’s retention ratio were tabulated separately for the males and females of the study group as shown below in the Tables 2 and 3.
The triple phase bone scan analysis revealed that 18/39 46% were of malignant nature and 21/39 54% were of benign or non-malignant causes. The Scintimetric Characterization of the malignant lesions by Dr. V. Siva’s retention ratio was 12.8 ± 1.79 and that of the Non-malignant lesions was 5.8 ± 2.41 indicating the gross difference between the two groups. The statistical analysis also confirmed the significant difference between the two groups. This difference was statistically as shown by the Figure 1.

There was absolute concordance between the Triple phase bone scan findings and the Scintimetric Characterization by Dr. V. Siva’s retention ration in 30/39=77% of patients and the discordant between the two was noted in 9/39=23% patients.

Figure 1: The student t Test results between the A-malignant and B-benign scintimertic values with p value of <0.0001 shown as box plot.
Discussion

The low sensitivity of the triple phase bone scintigraphy in the evaluation of stress fractures as reported by Barabar [7] could be due to the absence of quantitative evaluation and the individual phase curve analysis applied. This limitation was avoided in our study by the scintimetric characterization approach. Davenprt [8] have concluded that the addition of 4th phase or 24 hour delayed imaging after directed triple phase bone scan was non-contributory and unnecessary. The only qualitative analysis of the triple phase and 24 hr delayed imaging devoid of scintimetric characterization bound to be non-contributory. The utility and usefulness of the delayed 24 hr imaging was enhanced by the scintimetric characterization of skeletal hot spots by Dr. V. Siva’s retention ratio had been documented by us [9].

The 77% concordance proves the utility of addition of scintimetric evaluation in the assessment of causative factor of the fractures. The 23% discordance noted in the 9 out of 39 cases involved 4 infective, 4 neoplastic and 1 traumatic cases. Careful analysis of the infective cases revealed that the high scintimetric values were encountered in highly virulent and active disease status.

Those pathological fractures which showed lower values were due to underlying benign bone conditions like fibrous dysplasia and the metastatic and malignant lesions showed higher values. Similarly, in trauma cases those showed high scintimetric values were found to be associated with vascular injuries. The addition of scintimetric characterization helps in sub classification of underlying causative factors as well.

Conclusion

The systematic pattern approach of the triple phase bone scan evaluation coupled with the scintimetric characterization by Dr. V. Siva’s ratio analysis is bound to remove the nonspecific nature of the highly sensitive study. However, this study is limited by its single institutional study protocol nature. This has to be further evaluated by multicentric trial for confirming its utility. It can be concluded that this concept is worth further testing and evaluation.

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