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# A Principal Component Analysis of Shape, Stress and $^{18}$F-NaF Markers on the Vertebral Lumbar

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## Background

Lower back pain can range from acute tissue inflammation to crippling pain, which can lead to serious future problems. Therefore it is important to diagnose the type and cause of pain for treatment.

The aim of this study is to find statistical relationships between spinal shape, 18F-NaF biomarkers and bone stress in the vertebral lumber region.

The study is carried out to provide supporting evidence and further understanding into lower back pain.

Host-mesh fitting, 18F-NaF PET Scans, Principal Component Analysis (PCA) and Partial Least Squares Regression (PLSR) techniques will be used for analysis.

*Figure 1 – Human Vertebral Column [1].*

## Method

Figure 2 shows the patient's scanned information is extracted and used to create a 3D representative shape model via the process of Host-mesh fitting. Host-mesh fitting [2] is a free form deformation method using a host morphing a generic subject to the desired characteristic. Then, the NaF hotspots are extracted from the PET scans and 3D population models of shape, bone stress and NaF uptake are created. Then, PCA and PLSR is performed on the population.

PCA [3] is a statistical method for analyzing large data sets and extracting main characteristics by co-variance. While PLSR [4], uses correlations to create a regression model between variables, which can be used to predict one variable from another. Therefore, PCA produced modes of variation for shape, NaF uptake and bone stress. While PLSR, found statistical relationships between shape and NaF uptake, shape and bone stress, and bone stress and NaF uptake.

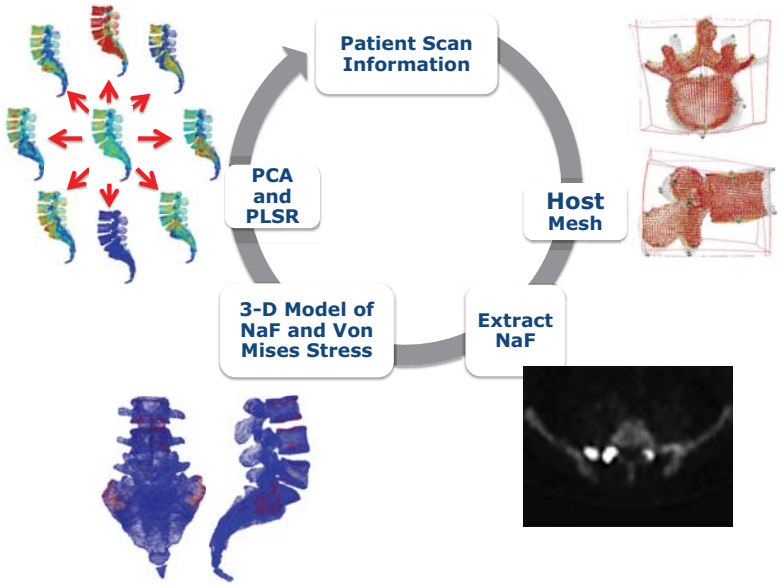


*Figure 2 – Showing the process taken to create a population model and analyze it using PCA and PLSR.*

## Summary

Analysis of the PCA and PLSR models, show that: (i) linear correlations exist between shape and NaF/Bone stress and (ii) both are mainly effected by sacral tilt. This indicates that a person's spinal shape effects their Von Mises bone stress, which then in turn causes higher NaF uptake due to bone remodeling.

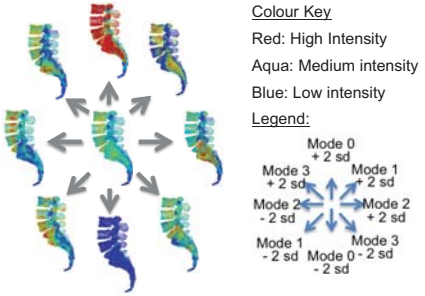


*Figure 3 – Predicted NaF from shape modes.*

For future, this pilot study will be trialed on a larger population with a more in-depth bone stress simulation and a non-linear regression model to improve accuracies.

## References

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## Acknowledgements

Thank you to everyone at ABI for their wonderful support.