**Project: The Virtual Skeleton Database**

**WP 3: Statistical Finite Element Modeling for the VSD**
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**Introduction**
Biomechanical information as well as their variations in populations are important for implant design. Current tools rely on sparse data or on a limited number of cadaver tests. The objectives of this WP are:
- to extract mechanical information from medical images
- to include them in a statistical model
- to produce statistical “stiffness” models

Application to:
- implant design optimization
- patient-specific planning

**Methods**
Two main aspects have been specifically investigated:

1. **Correspondence establishment**
   In order to create a correct statistical model, correspondences have to be precise. Two methods are compared: an image-based and a mesh-based approach

   **IMAGE registration**
   - Rigid + affine
   - Diffeomorphic demons in non-euclidean domain
   - Smooth and invertible DVFs

   **MESH morphing**
   - Landmark based
   - Surface planar parameterization with radial basis functions
   - Node Laplacian smoothing

Nodes on the surface might lie slightly outside the bone boundaries defined on the images. Our solution was to extend the cortical bone layer in order to obtain a reliable bone stiffness

**Discussion and conclusion**
- An automatic pipeline to combine bone shape and mechanical information has been developed
- Further steps involve:
  - transition from a feasibility study to a validated process able to be used for specific applications
  - bone-implant evaluation based on the instances created by the model
  - application to plate design for toothless patients