

Development of Ontology for the Diseases of Spine

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1. Introduction

This study focused on developing spinal ontology with frequently occurring spinal diseases in Koreans. It contains anatomy of spine, method of treatment, cause, classification information related with spine. Further, the spinal ontology can be linked to the simulation model for education of medical students and for the physicians and biomedical engineers by offering the necessary information in their fields.

2. Method

The authors are composed of a wide range of professional researchers; medical informatics, computer professionals and clinical experts such as nurses, a neurosurgeon, and 2 imaging specialists. The research was conducted in 5 phases as shown in Figure 1. ; (1) Review related to exiting ontology for the construction of the model, (2) Selecting the spine related diseases and the subject of the research at the same time, (3) Developing/Reviewing spinal ontology, (4) Creating OWL ontology in accordance to the clinician's feedback, (5) Review of the OWL ontology by the specialists.

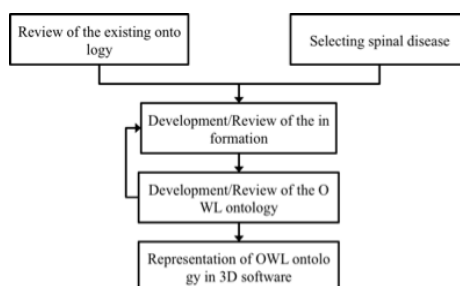


Figure 1. Process of building spine ontology

3. Result

3.1. Selected spinal diseases

The list of 20 selected diseases is presented in the Table 1. If scientific papers were referred in addition to text book, they were added as references in the Table 1.

[Table 1] The twenty selected diseases

Atlas fracture	Ossification of ligament flavum
Degenerative marrow change (Modic type change)	Osteoarthritis in facet joint (Pfirman grade)
Grading of lumbar disc degeneration [1]	Osteoporosis
Hangman's fracture	Osteoporotic Compression Fracture
HNP(Herniation of Nucleus Pulposus) [2]	Scoliosis
Infectious spondylitis	Spinal stenosis
Kyphosis	Spondyloarthropathy
Meningocele	Spondylolisthesis
Odontoid process fracture	Subaxial fracture(fractures in C3~C7)
OPLL(Ossification of Posterior Longitudinal Ligament)	Thoracolumbar spine fracture

3.2. Development of the ontology

The Figure 2 presents Protégé OWL ontology graph created from the spinal ontology of the twenty selected diseases. The Anatomical class represents the entire structure that composes the spine. There are 50 classes; 1 vertebral column, 5 vertebrae, 33 vertebrae and other 11 material of spine. Each of class has 6 properties. To express a sentence 'C1 cervical is part of cervical vertebra' in OWL Full model, we defined anatomical structures 'C1', 'cervical vertebra' as a class and <is a part of> as a property representing a predicate. <Disease> was defined as a superclass and the 20 selected diseases were treated as classes. As a result, 21 classes were formed for the concept of diseases and each class has 18 properties.

More than 100 images that were collected were linked to 20 diseases, one per each. The predicates that link images to the other part of ontology include <hasImageBeforeTx> and <hasImageAfterTx>.

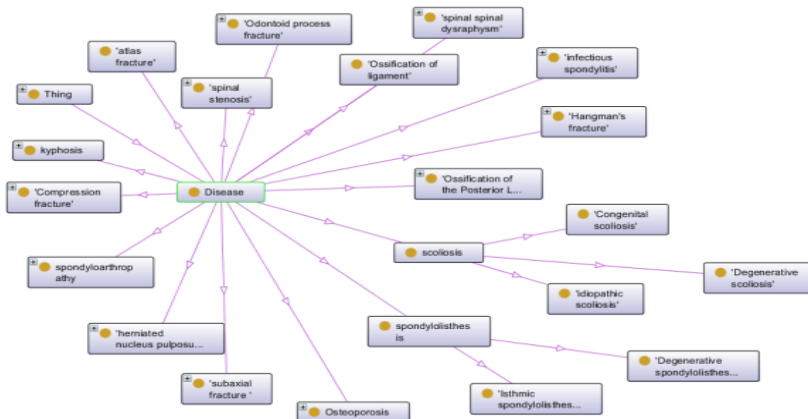


Figure 2. List of the spinal diseases shown in Protégé

4. Conclusions

We built the ontology of spine with links to the cause, symptoms, method of treatment of highly occurred spinal disease among Koreans, and anatomical information.

The completed spinal ontology expresses anatomical connection of the parts of spine and their vertical relationships as well as information on the diseases in the spine. It is easy to understand the structure and the diseases of spine by conceptualizing the anatomical structure of spine and show them in 3D images.

This study was completed by the use of literal object of OWL Full model by expressing the contents of the main reference dictionary and publications about spine literally. But in order for the computer to interpret the ontology, a new model with OWL DL or Lite is needed. Further studies need to include the process of the transformation of literal object into resource object through the structuralization process of items completed by literal object, further systematizing the concept. In addition, the review of class and property is necessary to show the anatomical information of spine and information of diseases specifically.

5. References

[1] MT Modic, JS Ross, "Lumbar degenerative disk disease", Radiology, 2007 Oct., 245(1), pp. 43-61.
 [2] S. Jeffrey, KRM Ross, Bryson Borg et al, "Diagnostic Imaging : Spine", Amirsys. Inc, 2010.