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## Analysis of Human Neck Image Using Pro/E and MATLAB

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**ABSTRACT:** Neck is robot part for human. The robotic platform of the neck bone was surrounded by muscles like steel spring the neck has a significant amount of movement and supports the weight of the head, but it is less protected than the rest of the spine, the neck can be vulnerable to injury and disorders that produce pain and restrict motion. It may result from abnormalities in the soft tissues the muscles, ligaments, and nerves as well as in bones and joints of the spine. The most common causes of neck pain are soft-tissue abnormalities due to injury or prolonged wear and tear. In rare instances, infection or tumors may cause neck pain. Neck pain may feel like a "kink," stiffness, or severe pain. Pain may spread to the shoulders, upper back, or arms, or it may cause a headache. Neck movement may be limited, usually more to one side than the other. Neck pain refers to pain anywhere from the area at the base of the skull into the shoulder. It is rare to predict the causes during movement of the neck. To avoid this situation, this paper proposes a design of biomechanical model of human neck for the purpose of analyse the movement of the neck to predict the fault in the neck using Pro/E software and CT scan neck image. This technique will be more helpful to analyse the stress and other faults in the neck during manual lifting of loads. This work may be extended to predict the analyse of the neck while driving the car and also software industries employees with continuous exposure with VDT.

**KEYWORDS:** CT Scan, Neck image, Biomechanical, Pro/E, Manual lifting

### I. INTRODUCTION

Manual Material Handling (MMH), especially lifting, poses a risk to many and considered the prime cause of back pain and various other joint impairments. This in turn leads to increased worker compensation and loss of productive man-hours. Approximately one third of all jobs in industry involve MMH. Low back pain is one of the most prevalent and costly work related injuries. The study of the lifting posture, the amounts of weight the man can safely lift are the areas concentrated on by Researchers. Of all Manual Material Handling (MMH) activities, lifting is considered to be a major cause for neck pain, low back pain and spinal injuries. Medical image processing is a field of science due to its advances technology and software breakthroughs. It plays a vital role in disease diagnosis and improved in medical area with patient care and helps medical practitioners to make decision in regard to the type of treatment. Various state-of-the-art equipments are available for human organs in digital form. Examples of such devices include X-Ray-based devices, Computed Tomography (CT), Magnetic Resonance Imaging (MRI), Ultrasound (US), Positron Emission Tomography (PET) and Single Photon Emission Computed Tomography (SPECT). In which, X-Ray is one the oldest and frequently used devices, as they are non-invasive, painless and economical. A x-ray makes images. of any bone in the body, including the hand, wrist, arm, elbow, shoulder, foot, ankle, leg, knee, thigh, hip, pelvis or spine. Most cervical problems are due to degenerative changes that occur in the discs and joints of the neck. Degenerative changes that affect the structures of the spine can cause the spinal canal to become too narrow, a condition called spinal stenosis. This may lead to pressure on the spinal cord. Bone spurs that stick into the spinal canal take up space, making the spinal canal smaller. They can press against the spinal cord or nerve roots. Pressure on the spinal cord from spinal stenosis can cause symptoms of myelopathy. Myelopathy may impair normal walking, hand and finger use, and bowel

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and bladder function. Doctors take these symptoms very seriously because severe myelopathy that is not treated may lead to permanent nerve or spinal cord damage. Pressure on nearby nerve roots can cause radiculopathy and may produce pain, weakness, or sensory changes in the area supplied by nerves that go from the cervical spine to the shoulder, arm, or hand. The disk acts as a shock absorber between the bones in the neck. In cervical disk degeneration the normal gelatin-like center of the disk degenerates and the space between the vertebrae narrows. As the disk space narrows, added stress is applied to the joints of the spine causing further wear and degenerative disease. The cervical disk may also protrude and put pressure on the spinal cord or nerve roots when the rim of the disk weakens. This is known as a herniated cervical disk. The neck is so flexible and it supports the head, it is extremely vulnerable to injury. Motor vehicle or diving accidents, contact sports, and falls may result in neck injury. The regular use of safety belts in motor vehicles can help to prevent or minimize neck injury. A "rear end" automobile collision may result in hyperextension, a backward motion of the neck beyond normal limits, or hyper flexion, a forward motion of the neck beyond normal limits. The most common neck injuries involve the soft tissues: the muscles and ligaments. Severe neck injuries with a fracture or dislocation of the neck may damage the spinal cord and cause paralysis. The main focus of this work is to automatically detect the reason for neck pain from plain diagnostic x-rays using a series of sequential steps. Fig.1 shows the schematic diagram of Human neck.

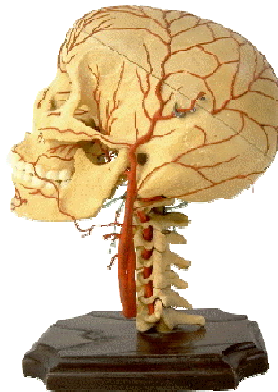


Fig. 1. Human neck Bones

## **A. BONE SPURS IN THE BACK AND NECK**

Bone spurs, also called osteophytes, are enlargements of your body's normal bone structure. As these enlargements progress, they may protrude into surrounding tissues, sometimes causing pain and other symptoms. Bone spurs can occur on virtually any bone, including on your vertebrae, but contrary to their name, they do not actually create a point. Rather, they are smooth structures that your body creates to repair itself after bones are exposed to pressure, stress, or rubbing over time. Bones conform to any pressure applied to them, and through the years, tendons (which hold muscle to bone) and ligaments (which hold bone to bone) can start to pull the bone from where it should be, stimulating the creation of bone spurs. As these protrusions grow and form, they sometimes impinge on a nerve, causing pain and debilitating symptoms. This figure is Bony Spurs in neck, colored X-ray. Bony spurs (osteophytes) grow from the vertebrae as a normal part of the aging process. They stabilize the spine when the discs of cartilage between the vertebrae shrink and become less flexible.

- Types of Bone Spurs
  - Neck Bone Spurs
  - Spine Bone Spurs
  - Cervical Bone Spurs
  - Lumbar Bone Spurs

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## B. NECK BONES

- There are 7 vertebrae (bones) in the neck.
- Together they form the upper-most section of the vertebral column which is known as the "cervical spine".
- They are labelled C1 to C7 with C1 at the top and C7 furthest from the head and adjoining the first vertebra of the next section of the spine.
- Only two of the vertebrae of the cervical spine also have individual names. They are C1 which is called the "Atlas" bone, and C2 which is called the "Axis" bone. The atlas and axis bones are labelled on the diagram (above-right).

Table 1. Shows the types of neck pains and its causes and Figure 2 shows the description of the neck image. Figure 3 Shows the CT scan Human neck image.

**Table. 1. Types of neck pain and its causes**

S.No	Neck Pain cause / syndrome	Description / Explanation(s)
1	Postural neck pain	Postural neck pain refers to pain in the neck and/or shoulders caused or exacerbated by postural habits such as holding the head/neck/shoulders in fixed protracted positions for long periods of time
2	Acute neck pain (unknown cause)	If a sudden movement of the neck results in severe neck pain possibly accompanied by arm pain, muscle spasm and/or restricted movement of the neck then the problem resolves itself without intervention or identification of the structural cause
3	Cervical spondylosis	Cervical spondylosis results from on-going 'wear and tear' of the cervical vertebrae and the intervertebral discs that separate them in the neck.
4	Cervical myelopathy	Cervical myelopathy is due to pressure on the spinal cord leading to dysfunction of the nerves below the area of pressure. It is therefore a condition of the nerves (spinal cord).
5	Rheumatoid arthritis (in the neck)	In general this can result in joints becoming painful, swollen, and stiff. Rheumatoid arthritis in the neck (cervical spine) often involves the atlantoaxial joint which is the articulation between C1 (the "atlas" bone) and C2 (the "axis" bone).
6	Klippel-Feil Syndrome - Rare	In general, thoracic outlet syndrome can affect nerves, result in pressure on blood vessels - affecting circulation, and cause pain, tingling, swelling and/or weakness.
7	Thoracic outlet syndrome - Rare	The thoracic outlet is the area between the rib cage and clavicle bone (which is also commonly referred to as the "collar bone").
8	Neoplasms in the neck area - Rare	" Tumours originating in the cervical spine (neck bones) are rare. When tumours are found in this area they are often found to have originated elsewhere in the body and are therefore said to be "secondary deposits".
9	Osteitis in the neck area - Rare	Osteitis is a general term for inflammation of bone. Osteitis in the neck area (called "cervical spine osteitis") is uncommon, but not unheard-of, in many developed countries.

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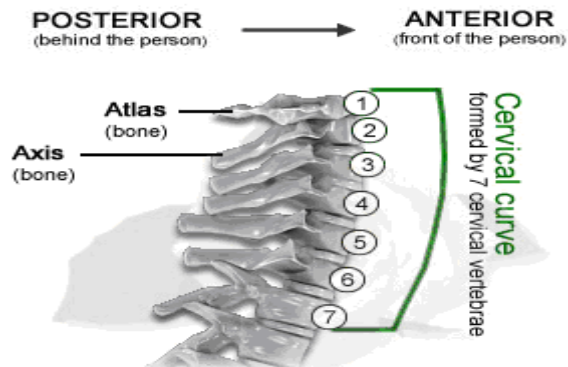


Fig. 2. Description of the neck



Fig. 3. CT Scan neck image

The empirical quantities of the spinal components used in Shirazi-Adl's study [6] are shown in Table 1.

**Table 1: Empirical Quantities of Spine**

Material	Young's Modulus (Mpa)	Cross Section Area(mm <sup>2</sup> )
Anterior Longitudinal	7.8	63.7
Posterior Longitudinal	10	20.0
Ligamentum Flavum	15	40.0
Transverse	10	3.60
Capsular	705	60.0
Interspinus	10	40.0
Superspinus	8	30.0
Iliolumbar	10	26.4

Literature review shows that a few researchers have applied FEM for analysis of lumbar L2/L3 and cervical spine [7]. However, studies on the combined L1/L2/L3/L4/L5/S1 (FSU), FEM analyses are not found to have been done.

## II. MODELLING AND ANALYSIS OF FSU

Finite Element modeling is the modeling of a continuous system, which has an infinite number of degrees of freedom, using a representative geometry of that system made up of a finite number of smaller elements and node points. The more elements in the

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model, the more accurate it is. The material properties, displacements and other system characteristics are represented by mathematical functions between nodes. This finite element model can then be used to determine the stress, strain, and displacement of the structure resulting from external loading [5]. Once the Finite Element Model has been created and the system characteristics have been established in the model, a global stiffness matrix can then be formed for the whole structure. Given the forces and boundary conditions, the unknown displacements at each of the node points can then be used to determine the stresses and strains acting on each element [5]. Initially, the Finite Element Models have been applied to aircraft structures and then FEM rapidly spread to Civil Engineering and Mechanical Engineering. FEM is gaining acceptance as a valuable tool to study static, dynamic as well as cyclic problems. Only recently FEM has been seriously applied to Biomechanical problems.

The following assumptions are made while modelling FSU:

1. Vertebrae is considered as having elliptical cross section. Actually this is an improvement over Hutchinson-Littlefield model [8]. Ellipse gives a closer approximation.
2. Upright standing posture is assumed for modelling.

With the advent of Magnetic resonance imaging (MRI), one can measure internal organs and bones with high resolution and accuracy. MRI is a non-invasive imaging approach. Cross sectional size of L1 lumbar vertebra are measured from an adult subject using MRI scan. It is found to be 40mm Major and 32 mm minor. Based on the anthropometric proportions, other dimensions are arrived at.

There are host of software for 3D modelling and here Pro/Engineer is preferred because of its simplicity and seamless integration with analysis package Pro/ Mechanical. Whole FSU is modelled in parts and assembled according to the properties of Lumbar spine. Assembled model is transferred to Pro/Mechanica environment.

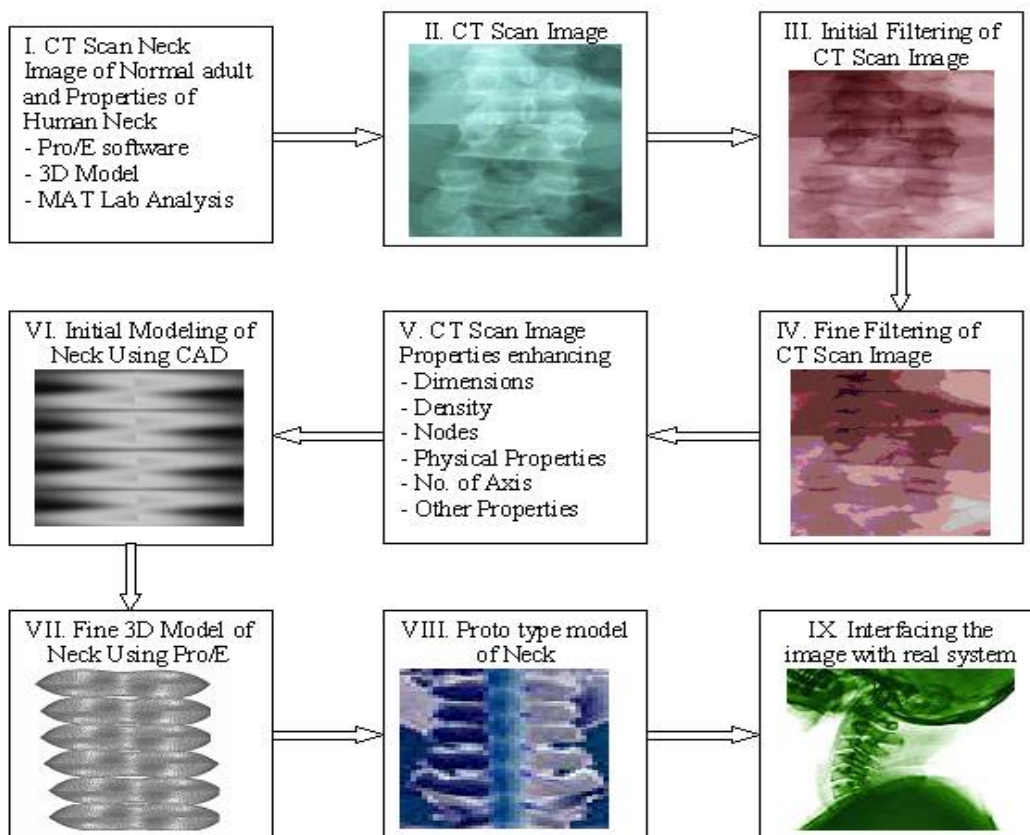


Figure.4. Development of Biomechanical Model of Neck Image Using Pro/E

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From the above conditions forces along spine direction are

$$F - ES - B \cos \theta - W \cos \theta = 0 \quad \text{---- (1)}$$

Moment:

$$ES \times l = Bb + Ww \quad \text{---- (2)}$$

Where,

ES = Erector spinae muscle force

F = Disc compressive force

B = Force from upper body weight

W = Force from lifted weight

l = Length of moment arm from ES

b = Length of moment arm from centre of gravity of the body weight

w = Length of moment arm from lifted weight

$\theta$  = Angle made by the force of body weight with erector spinae muscle force

$$B = 0.65 \times M \times g$$

Where,

M = The body mass of the individual

g = Acceleration due to gravity

From literature, for a grown up normal adult

$$l = 6 \text{ cm}, b = 25 \text{ cm}$$

$$\theta = 52^\circ \text{ (Helander et al 1984)}$$

Let,

$$w = 40 \text{ cm}, M = 63 \text{ Kg}$$

### III. RESULTS AND DISCUSSION

The model is analysed using PRO/E. The FSU model has been first generated for upright position with only body weight condition. The segments from L1 through L5 are modelled for a normal adult. Fig.4 shows the deformation of the model for lifting a load of 10Kg & 20kg.



### IV. CONCLUSION

Although epidemiological studies have suggested possible causes, the actual mechanism by which the lumbar spine is injured during load cycle resulting in low back pain, remains unknown. However, the response of the disc to loading conditions that occur during lifting is difficult to measure in vivo and in vitro methods and has not been investigated so far. Therefore, a finite element model that can predict the loading behaviour of Functional Spinal Unit (FSU) has been

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developed. The finite element model of the FSU is found to confirm with the earlier works using cadaveric method [8], thus proving the usefulness of this methodology for biomechanical modelling. The effort to be taken for the in vivo and in vitro data collection and analysis are reduced multi fold in the finite element modelling. The study can be extended to include the loading of the muscles. Same FE model can be extended to all Sagittal plane lifting activity. Thus, the study established the viability of FEM methodology for analysing FSU.

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