1. INTRODUCTION

1.1 Background

Scoliosis is a complex condition characterised by a three-dimensional spine dislocation paired with vertebral rotation[1]. Adolescent Idiopathic Scoliosis was a frequent condition in 2012, with an incidence of 0.47-5.2 percent. The female-to-male ratio ranges from 1.5:1 to 3:1 and increases significantly with age[2]. According to the most significant research on school scoliosis screening in Malaysia, 8966 volunteer school students aged 13-15 were recruited for scoliosis screening, with a prevalence rate of 2.55 percent [3]. Even in Surabaya, Indonesia, 6.37% of pupils from 784 schools who underwent scoliosis screening tests had it[4]. Not treating Scoliosis can negatively affect body posture sufferers and lead to complications. Based on this information, many people worldwide require scoliosis treatment[5].

Scoliosis treatment involves surgically correcting the scoliotic spine into optimum shape using implant rods and screws. Implant rods and screws apply corrective forces and support the generated spinal loads during surgical correction[1]. Pedicle screw fixation has become a popular surgical instrumentation technique for treating spinal deformities. Because of the enhanced bone-implant connection, surgeons can execute more correction manoeuvres and apply appropriate corrective forces while translating and rotating the malformed spine.[6].

Corrective forces were applied to implant rods through screws to bend the spine properly. Scoliosis correction was achieved; nevertheless, the corrective forces operating on screws were significant enough to distort the implant rod following scoliosis surgery. As a result of a deformed implant rod after the surgical treatment in long-term use, excess three-dimensional forces occurred at each implant screw. By analysing the magnitude of corrective forces acting on the spine, understanding the biomechanics of scoliosis correction could help avoid clinical complications and achieve higher precision surgical correction. Thus, investigating the biomechanical changes (particularly forces applied to the screw of the implant rod) following the surgical procedure is critical for understanding the biomechanics of scoliosis correction[7-8].

According to Gunasekaran from Hindawi - BioMed International Journal in 2022, 967 articles on the corrective mechanism of spine deformity due to Scoliosis are from Scopus, Science Direct, PubMed & Medline, and WorldCAT. From the selected fifteen trusted research articles, nearly all of the research works with the help of commercial finite element analysis tools [9]. One research about Spinal Deformities, handled by Yuichiro Abe, mentioned the magnitude of estimated correction force by applying force to the implant rods and screws. This research collected patient data and further analysed using the finite element analysis performed by ANSYS 11.0 with the result of forces acting on Y-Z plane[10]. Other research by Remel Salmigo also mentioned corrective force analysis for Scoliosis from implant rod deformation and performed finite element analysis by ANSYS 11.0 with the result of forces acting on the X-Y plane[7]. Based on this research, a study was conducted using a complete spine model to determine the correction force to be an estimation force applied to the pedicle screw in both the X-Y plane and Y-Z plane. The calculation is performed by using the initial and ideal position of the spine for Scoliosis and analysing the generated acting force by finite element method with MATLAB.

1.2 Objectives

The objectives of this study are:

1. To get a numerical model for calculating static forces working on a one-dimensional space frame structure model from a specific or desired position by finite element method.
2. To obtain the ideal Cobb Angle from the numerical model.
3. Evaluate the number of penetration points of generated corrective forces acting during scoliotic spine fixation.
4. To Choose which screw placement is the best number of penetration points of generated forces.

1.3 Outcome

This study is helpful to get the estimation results of the magnitude of the loads acting on the spine as an alternative consideration for scoliosis surgeons to reduce the risk of failure during the correction process when surgery is ongoing on the spine for people with Scoliosis.

1.4 Problem Scope

The problem scopes of this study are:

1. The study was conducted in the form of Scoliosis of the spine only (vertebrae and disc), and no implants and other organs were involved, such as muscles and ribs.
2. The forces act directly on the neutral axis of the vertebral body, where the screws are placed at the axis. For the placement, the screws are assumed united at the neutral axis.
3. Each base and end of both vertebral body and disc is assumed to have a circle area.

1.5 Report Outline

This study consisted of five parts. The first part is the introduction which covers the background, objectives, outcomes, problem scope, and the outline of this study. The second part is the literature review which explains the fundamental theories that support this study. The third part, including the methodology, research stages, and research procedures of this study, will be described. Furthermore, in the fourth part, the method's result will be analysed and validated with other fundamental studies and the literature review. Finally, in the last part, the fifth part, the conclusions of this study will be stated and explained.