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**ANALYSIS ON THE EFFECTIVENESS OF THORACO-LUMBO-SACRAL ORTHOSIS
BASED ON THE BARTHEL INDEX IN PATIENTS WITH COMPRESSIVE FRACTURES
DUE TO OSTEOPOROSIS**

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According to the 2007 Indonesian Health Research Association, the prevalence of spinal trauma reaches 7.5 percent of the total population. The high number of patients with compressive fractures due to osteoporosis becomes the background of the increase in orthotic management. Thoraco-Lumbo-Sacral-Orthosis (TLSO) helps to manage the problem by reducing axial load and correcting excessive deformation of the spine. This research aims to analyze the TLSO by using the Barthel Index (BI) to assess functional abilities in patients with compressive fractures due to osteoporosis to perform Activities of Daily Living (ADLs). Random sampling with the cross sectional approach was used. Variables were divided into independent: the level of disabilities of patients with compressive fractures due to osteoporosis based on BI as the measure of the level of ability and independence to perform 10 ADLs, and dependent: the level of use of TLSO based on BI as the ability to reduce the level of disabilities. Twenty patients with compressive fractures due to osteoporosis fitted with TLSO participated in this study. Univariate analysis showed that the patients are over 50 years of age in which anatomical structures and physiological condition have declined, thus it is of high risk to have compressive fractures. Bivariate analysis indicated that there is no statistically significant relationship between the level of disabilities with the level of use of TLSO ($p: 0.403$). In contrast, there is significant relationship between the age of patients with their disabilities ($p: 0.015$). There are no contribution and relationship between the level of use of TLSO and the level of disabilities based on BI in patients with compressive fractures due to osteoporosis ($p: 0.403$). The largest significant contribution to the level of disabilities in patients with compressive fractures due to osteoporosis is by age ($p: 0.015$).

Keywords: Compressive fractures, Osteoporosis, TLSO, the Barthel Index

1. INTRODUCTION

Traumatic accidents may result in heavy damage on brain tissues, spinal cord, bones and other body tissues (Indonesian Health Research Association, 2007). As reported by the association, the prevalence of spinal traumatic incidents reaches 7.5% of the total population. The high rates of the incidents can result in serious injuries. One possible result would be loss of the ability to transfer and ambulate, because of the paralysis in both legs even all the extremities. Injury to the spinal cord in certain levels will cause malfunctioning of the body parts below the level of injury which is neurologically disconnected from the main central nervous system.

A study by Solomon and Appley in 1995 mentioned that 10% of cases of spinal fractures occur in thoracic segment, 4% in thoracolumbar segment, and 3% in lumbar segment, accompanied by neurological damage. The incident rate for spinal cord in the USA is estimated at 30 - 32/one

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million population or 3,000 - 9,000 new cases each year. This does not include people who died within 24 hours after injury. The prevalence is approximated at 700 to 900 cases each of one million population (200,000 to 250,000 people). Sixty percent of the injured are between 16 to 30 years of age and 80% are between 16 to 45. The most frequent etiology factors are motor vehicle accidents (45%), falls (21.5%), blast injuries or violence (15.4%) and sports accidents, usually diving (13.4%). The most recurrent neurological levels are C-4, C-5, and C-6 on the cervical spine, T-12 and L-1 or on the thoracolumbar connection (Garrison, 1995).

According to Schneider et al in 2004, the most frequent spinal fracture is of compression. Compressive fractures lead to the collapse of bone tissues, including vertebral bodies. Garrison, 1995 added that compressive fracture is caused by axial loading which is large enough to reduce the protective ability of the intervertebral discs and the presence of the dispersion of bone fragments will cause neurological disorders as well.

There is no one single cause of compressive fractures, although compression would indicate that fracture occurs because excessive pressure is placed on bone. If the vertebral body is too weak to withstand normal pressure, it will collapse. However, a common cause of compressive fractures is osteoporosis. In fact, spinal compressive fractures are most common type of osteoporotic fractures. Owing to the decreased and weaker bone mass, fractures can occur without any trauma at all. Osteoporosis is more common in women than men. This is due to effect of lower estrogen level in the body since the age of 35 years while male hormone, testosterone, falls at the age of 65. On the report of world statistics, 1 in 3 women is susceptible to osteoporosis (Schneiderman et al, 2004). As stated by Ian Carrick, NYU, The main disorder is the morphological change of the spine that causes excessively slumped forward shoulders and upper back (kyphosis).

Spinal orthosis functions to help solve the problems in this case, particularly reducing the axial loads as well as correcting and supporting the change in shape of the overloaded spine. As defined by Thomas Howard in 2010, orthosis is an orthopedic device designed for correcting, straightening, as well as propping body parts. The term refers to exoskeletal appliance mounted on the part of the body and has been called as brace. Based on The American Academy of Orthopedic Surgeons and the American Orthotic and Prosthetic Association, the types of orthosis are named after the joints that they pass through. According to extremities, orthosis is divided into upper and lower extremity orthoses. The upper extremity orthoses are classified into several types in accordance with their joint control. One of the types is Thoraco-Lumbo-Sacral Orthosis (TLSO) that is often used for the management of compressive fracture, particularly in lumbar spine.

The Barthel Index (BI) is a measure tool for the functional ability to perform Activities of Daily Living (ADLs), which is simple and very effective in the assessment of physical development. As stated by Douglas G. Carroll, M.D., Baltimore City Medical Society, 'BI is a simple index of independence useful in scoring improvement in the rehabilitation of the chronically ill'. From the statement, it is clear that BI can measure the physical ability of patients with chronic conditions. Problems caused by the compressive fractures of lumbar vertebra include motor weakness of both lower limbs, neurological deficits such as sensory disorders in the form of tingling and numbness, potential complications such as respiratory disorders, decubitus, limited range of joint motion and muscle contracture, as well as the presence of pain, limitation to transfer and ambulation such as bed mobility, shifting, standing and walking. In addition, there is a decrease in the ability of physical activity in the social environment, such as productive activity and recreation. Within long-term rehabilitation programs, all the rehabilitation team members are involved with the purpose of observing the use of orthopedic tools for patients. The long-term rehabilitation programs include providing orthosis, physical exercises and education regarding the

function of these devices for both physical and psychological benefits for the patients (Judy Buwana, Handicap International, 2011).

In this study the author analyzes the use of TLSO in patients with compressive fractures due to osteoporosis in evaluation of the functional ability as well as ADLs of these patients using the BI and modified BI.

2. RESEARCH METHODOLOGY

The theoretical framework was adopted from The International Classification of Functioning, Disability and Health (ICF) by the World Health Organization (WHO), 2007. ICF models do not have hierarchical direction but can be used and understood in all directions.

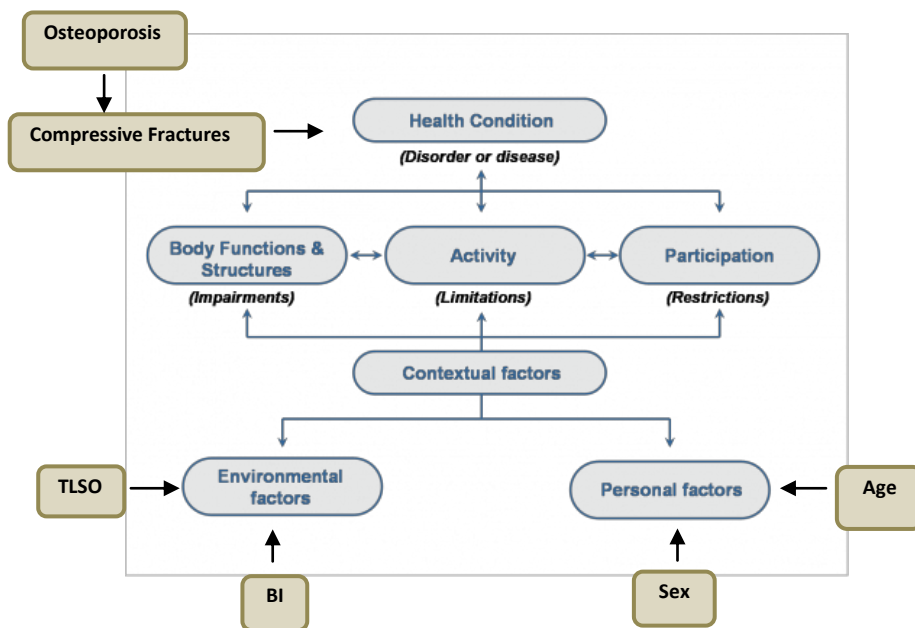


Figure1. Modified ICF, WHO 2007

Quantitative-descriptive study with the cross-sectional method was used. The research framework is described as follows:

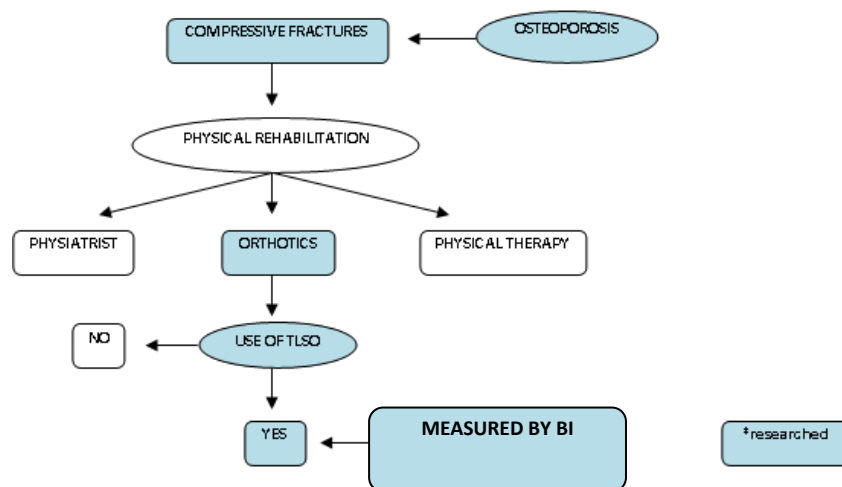


Figure2. Research Framework

Variables were divided into dependent: as the level of disabilities of patients with compressive fractures due to osteoporosis based on BI, and independent: as the level of use of TLSO based on BI. The dependent variable was operationally defined as the measure of the level of ability and independence to perform 10 ADLs. The instrument in use for measurement is the Barthel Index. The results were classified into high (if total score < 100 BI) and low (if total score = 100 BI) with nominal scale. The independent variable referred to the ability to reduce the level of disabilities (10 ADLs). The measure instrument used is the modified Barthel Index. The total score was modified and categorized as follows:

- High, if total score = 24-30
- Medium, if total score = 14-23
- Low, if total score = 10-13

The population for this study was patients with compressive fractures due to osteoporosis. The number of samples was 20 patients with compressive fractures due to osteoporosis who met the criteria selected by random method.

$$n = \frac{Z^2 P(1-P)N}{d^2(N-1) + Z^2 P(1-P)} \quad (1)$$

Lemeshow's sample size:

N: population

n: sample

Z: standardized normal deviation 95% (*Z* = 1.96)

P: expected variable proportion *P* = 0.5

d: clinically expected variation (precision) = 0.1

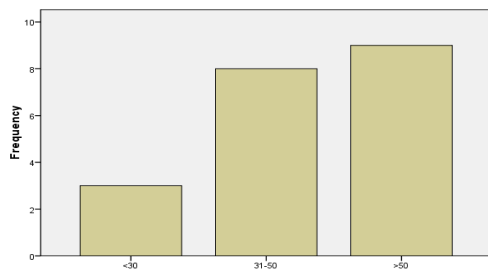
The selection was using random sampling method, that is, every member or unit of the population has equal opportunity to be selected as a sample. Instruments used were the Barthel Index and questionnaire. This questionnaire contains questions related to 10 ADLs. Data processing and analysis included editing, coding, scoring, tabulating and entry data.

Statistical analysis employed included univariate: as the characteristics of sample by arranging frequency distribution table in form of tables, graphs or charts based on independent and dependent variables, and bivariate: as the relationship between dependent & independent variables with Chi-Square test.

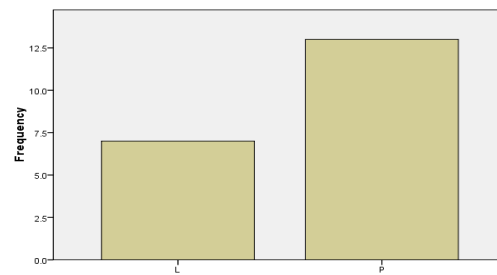
3. RESULTS

3.1. Univariate Analysis

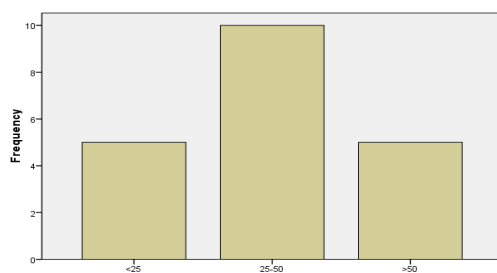
Data on frequency distribution of age were analyzed by grouping/classification; <30 years, 31-50 years, > 50 years (elderly). The frequency distribution for sex shows that female subjects were approximately twice in number in this study. Half of the sample subjects had medium level of disabilities, while high level of use of TLSO was seen in more than half number of the subjects.



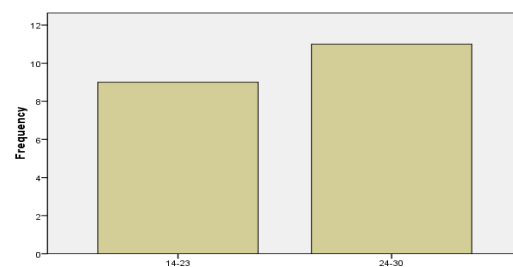
Frequency Distribution (FD) of Age:
 <30: 15%, 31-50: 40%, > 50: 45%



FD of Sex:
 M: 35%, F: 65%



FD of Level of Disabilities:
 <25: 25%, 25-50: 50%, > 50: 25%



FD of Level of Use of TLSO (BI):
 14-23: 45% (med), 24-30: 55%(high)

3.2. Bivariate Analysis

From Table 1, it shows that the most statistically significant cofactor which contributed to the level of disabilities is age, while the other cofactors show no significant relationship (p value >0.05).

Table1. Bivariate Analysis showing Chi-Square and p value

Bivariate Analysis	Pearson Chi-Square	p value
Use of TLSO and disabilities	1.818	0.403
Age and level of disabilities	12.333	0.015
Age and level of use of TLSO	3.446	0.179
Sex and level of disabilities	0.569	0.719
Sex and level of use of TLSO	0.642	0.109

4. DISCUSSIONS

4.1. Univariate Analysis

It appears that the elderly are of risk factor in this case. After the age of about 35 years, bone materials in the body are a lot more lost than produced. Low bone mass due to abnormally reduced calcium and bone elements cause the bones to become brittle and porous. In older age, the anatomical structures and physiology of a person starts to decline, including the strength of bone formation activity (WHO). Analysis on the frequency distribution of sex showed that sex is a subjective measure in determining disabilities. It appears that women are at greater risk than men to the exposure of compressive fractures due to osteoporosis. This is due to the influence of estrogen

level which begins to decline since the age of 35 years, while testosterone starts to decline after the age of 65 (WHO, 1994).

Data analysis on the frequency distribution of disabilities illustrated that orthosis, TLSO in particular, is a functional device which is most widely used for compressive fractures. Analysis on the use of TLSO described how effective the use of assistive devices such as orthosis to solve the problems which are experienced by patients with compressive fractures due to osteoporosis. Based on NYU Medical Center, 1987 Spinal Orthotics Manual, TLSO has various functions, such as immobilization and reduction of pain from fractures/dislocation.

4.2. Bivariate Analysis

The relationship between age and the disabilities gives p-value of 0.015 ($p < 0.05$), which means that there is contribution and relationship between age and the level of disabilities.

Precisely, age factor has major contribution to disabilities. It can be seen from the results that more than 80% of respondents were aged over 30 years and of the statistical results of the level of disabilities, all 20 respondents were categorized as high (FD of Level of Disabilities: BI < 100), thus age has close relationship and influence on the level of disabilities and is conditional on the level of use of TLSO (FD of Level of Use of TLSO: 45% medium, 55% high).

In this study, multivariate analysis could not be performed to see the independent variables that most contribute to and relate to the level of disabilities and the level of use of TLSO, because only one variable is significant in bivariate analysis, which is age.

5. CONCLUSIONS AND RECOMMENDATIONS

The results of this study showed that age plays an important role in the case of compressive fractures due to osteoporosis. It is suggested, at the age of above 35, to consume more calcium and reduce excessive weight which can cause compression on the spine. Exercise is also one solution to prevent bone calcification and increase joint range of motion. The use of TLSO in orthopedic treatment helps in the reduction of compressive stress and immobilization to accelerate healing process. In Orthotics and Prosthetics (O&P) field, innovation related to materials and component designs for functional spinal orthosis must be improved, especially TLSO, for spinal trauma so that it can meet the individual needs of patients.

For further research study: sites must be expanded to recruit more subjects for statistical significance. Case control methods can be applied by comparing the level of disabilities before the use of TLSO and the level of use of TLSO in patients with compressive fractures due to osteoporosis. BI must be modified so that applicable for the study (i.e.: ADLs of patients with compressive fractures due to osteoporosis).

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