CHAPTER III

MATERIAL AND METHODS

Participants

The experimental protocol was approved by the Institutional Research Boards of the Faculty of Medicine, Chiang Mai University. An informed consent was completed prior to the study (Appendix A and B). Thirty eight subjects were recruited from Maharaj Nakorn Chiang Mai hospital, Chiang Mai, Thailand, but only twenty two adolescent females met the following criteria and voluntarily participated into this study.

Inclusion criteria

1. Had been diagnosed as adolescent idiopathic scoliosis.

2. Had deformity curvature involving thoracic vertebrae either c-curve, or s-curve.

3. Did not regularly exercise 3 days/week for 6 weeks prior to the study.

Exclusion criteria

1. Had secondary causes of scoliosis such as injury, tuberculosis of bone, cerebral palsy, poliomyelitis or developmental dysphasia of the hip.

2. Had cardiopulmonary diseases such as heart disease, pneumonia, and etc..

3. Had neurological and musculoskeletal problems influencing on locomotion such as fracture of lower extremities, or ankle sprain.

4. Had a history of active or passive smoking status.

5. Could not complete all tests.

Demographic data (age, weight, and height), back pain history, active or passive smoking status, exercise behavior status, the diagnosis of scoliosis type, and the degree of the Cobb angle were recorded for each subject (Appendix C). According to SRS (15), the subjects were allocated into three groups: mild, moderate, and severe group.

Variables

Musculoskeletal variables:

- The Cobb angle of the thoracic curve

Pulmonary variables:

- pred FVC, pred FEV_1, FEV_1/FVC, MVV, MIP, and MEP

Cardiovascular variables:

- Pre-test heart rate (preHR), post-test heart rate (postHR), pre-test systolic blood pressure (preSBP), pre-test diastolic blood pressure (preDBP) pre-test systolic blood pressure (postSBP), and post-test diastolic blood pressure (postDBP),

Functional capacity:

- 6 MWD

Equipments

1. Anteroposterior X-ray film of thoracic spine

2. The spirometer: SensorMedics®, Yoba, Linda, CA, USA

3. The Mircro Respiratory Pressure Meter (MicroRPM) Respiratory Muscle Analysis with Puma Cat. No. 1000 software

4. Six-minute walk test setup

- Pulse oximeter

- Sphygmomanometer

- Stop- watch

- Borg Scale (1-10) (Appendix D)

- Two small cones

- A tape-measure

- A marking tape

- A chair

4. Thermometer

5. Weight scale

6. Height scale

Experimental setup

All tests were performed on the 4th floor, Department of Physical Therapy, Faculty of Associated Medical Sciences and at the Pulmonary & Critical Care, Department of Internal Medicine, Faulty of Medicine, Chiang Mai University. The laboratory environment was controlled at 18º to 24° Celsius. The pulmonary measurements and the 6 MWT were conducted by the trained physical therapist, according to ATS guidelines (31).

Experimental protocols

Subject preparation

All subjects were asked to wear the comfortable cloths and appropriate shoes. Having light meal in the early morning was recommended. Avoiding caffeine drinking and vigorous exercise within two hours before performing test were required. the instruction, the complications, and the contraindications of both the pulmonary measurements and the 6 MWT were given to all subjects (23, 31).

Cobb angle measurement

The anteroposterior X-ray photograph conducted within six months prior to the study was used for Cobb angle calculation. The X-ray was taken in standing position. No thoracic brace wearing was allowed during the X-ray. All Cobb angle were measured by the skillful physical therapist.

Pulmonary measurement

For flow-volume loop, the subjects were tested in sitting position with wearing a nose clip and making an airtight seal around a mouthpiece. During the test, they were asked to maintain the upright position. They were asked to perform three normal breathing and follow by the forced maximum inspiration and forced expiration for six second, consecutively. The test maneuvers were repeated for at least three times but not more than eight maneuvers with 1-minute rest in between. The best value of the pred FVC, pred FEV_1, and FEV_1/FVC were recorded.

After the flow-volume loop was complete for at least five minutes. The MVV maneuvers were started. The subjects were asked to perform five normal breathing and follow by rapid and deep breathing for 12 seconds. The test was performed twice with at least 1-minute rest in between. The best value was used for further analysis.
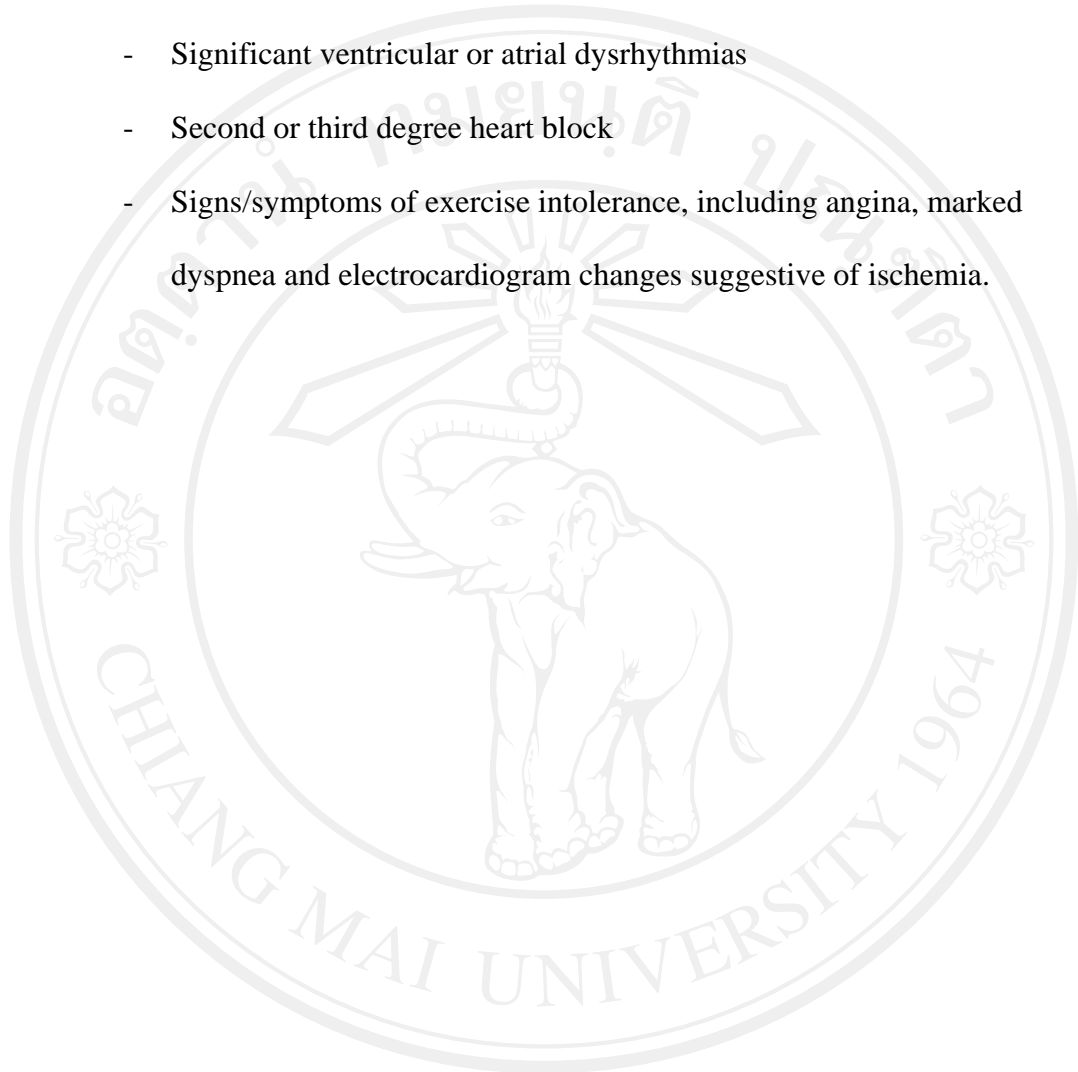
Next, the MIP and MEP maneuvers were performed. The MIP was measured from the RV followed the maximum expiration. Thus, the subjects were asked to exhale as much as they could, then rapidly inspired and hold for at least one second. For the MEP maneuvers, the subjects were asked to fully inhale and follow by rapid exhalation. The 10-MIP and 10-MEP maneuvers were tested with at least 1-minute rest in between. The best value of each variable was recorded.

The six-minute walk test

All subjects were asked to perform 6 MWT in the morning. They were asked to sit and rest before the test for 10 minutes. Their preHR, preBP, pre-satO$_2$, and Borg score were obtained prior to the test. They were asked to walk as far as possible with a self-selected speed. The test procedures were followed the ATS guidelines. The postBP, postBP, post-satO$_2$, and Borg score immediately after the test were recorded. Also, the walking distance was recorded. When the vital signs were returned to baseline, the second trial was performed. The test procedures were repeated. The best walking distance was used for further analysis. For safety reason, vital signs were measured before the subjects left the laboratory. According to the American College of Sport Medicine (ACSM) guidelines, if any of the following symptoms occurred, the 6 MWT would be stopped (63):
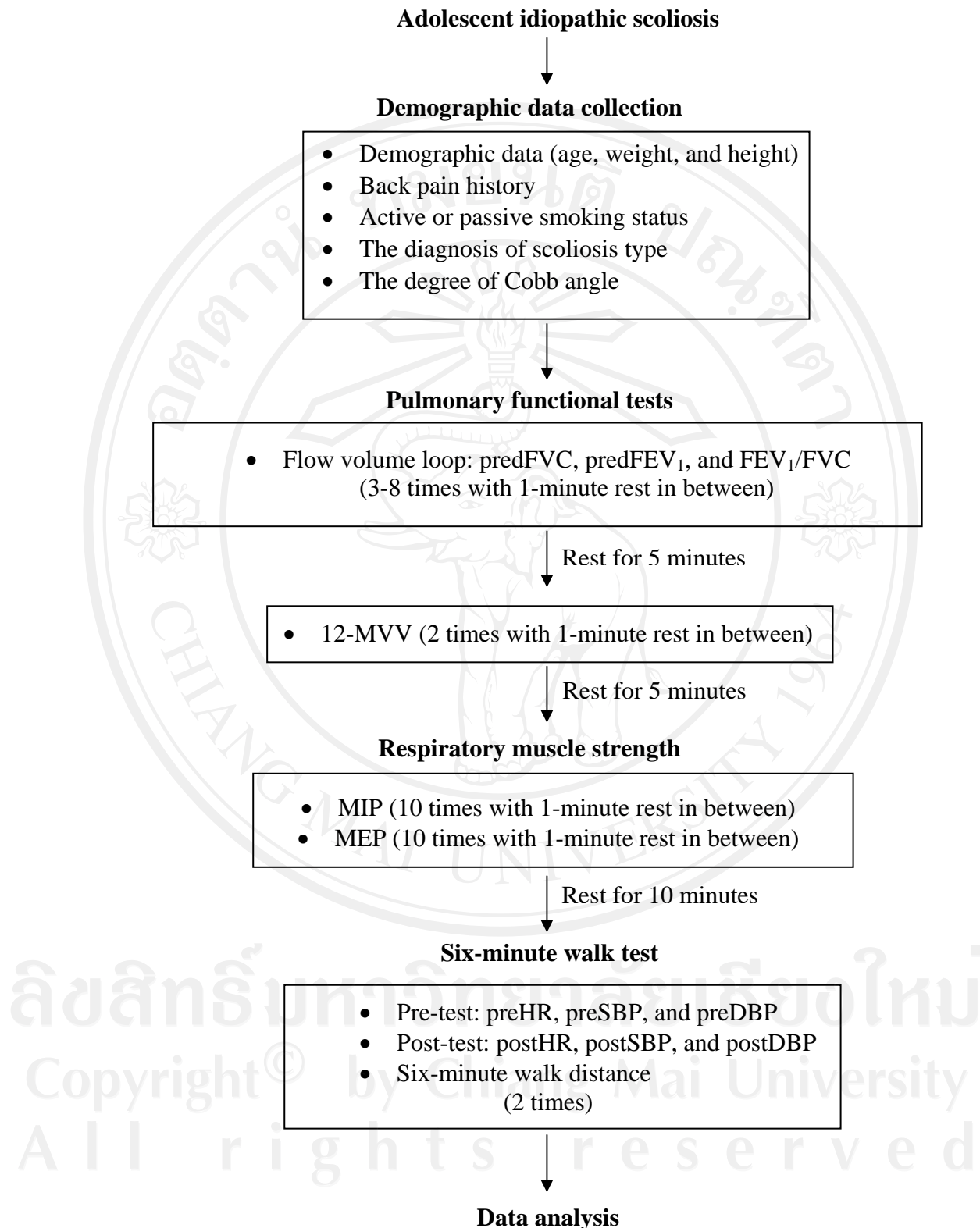
- Diastolic blood pressure $\geq$ 115 mmHg

- Decrease in systolic blood pressure > 20 mmHg

- Significant ventricular or atrial dysrhythmias

- Second or third degree heart block

- Signs/symptoms of exercise intolerance, including angina, marked

  dyspnea and electrocardiogram changes suggestive of ischemia.

Adolescent idiopathic scoliosis

Demographic data collection

- Demographic data (age, weight, and height)
- Back pain history
- Active or passive smoking status
- The diagnosis of scoliosis type
- The degree of Cobb angle

Pulmonary functional tests

- Flow volume loop: predFVC, predFEV$_1$, and FEV$_1$/FVC
  (3-8 times with 1-minute rest in between)

Rest for 5 minutes

- 12-MVV (2 times with 1-minute rest in between)

Rest for 5 minutes

Respiratory muscle strength

- MIP (10 times with 1-minute rest in between)
- MEP (10 times with 1-minute rest in between)

Rest for 10 minutes

Six-minute walk test

- Pre-test: preHR, preSBP, and preDBP
- Post-test: postHR, postSBP, and postDBP
- Six-minute walk distance
  (2 times)

Data analysis

Figure 2. Experimental protocol

Statistical analysis

1. Descriptive statistics were used for demographic data, the diagnosis of scoliosis type, and the degree of the Cobb angle, the cardiopulmonary variables, and 6 MWD.

2. One-way ANOVA was used to compare age, weight, height, the cardiopulmonary variables, and 6 MWD among mild, moderate, and severe group.

3. Pearson correlation was used to determine the correlation between age, weight, height, the Cobb angle, the cardiopulmonary variables, and 6 MWD.

4. Multiple linear regression analysis was used to predict 6 MWD by using age, weight, height, the Cobb angle, the pulmonary variables, and the cardiovascular variables at rest.

All data were presented as mean ± standard deviation (SD). Statistically significant level was set at $p < 0.05$.