Thesis of Master of Science

Strength and Balance Training for Preventing Falls in Prostate Cancer Patients Receiving Androgen Deprivation Therapy: Case Report

안드로겐 박탈치료를 받는 전립선암 환자를 대상으로 저항성 및 평형성 낙상 예방 운동: 사례연구

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ABSTRACT

Prostate cancer (PCa) survivors are at risk of falls because of the accelerated physiological changes following receiving androgen deprivation therapy (ADT). Thus, follow-up care of PCa survivors after treatment is vital; not only to prevent high healthcare costs of fall-induced injuries, but also to maintain quality of life and help them to live longer. Many studies focused on investigating the benefits of exercise interventions on risk of falls, balance and physical performance of older adults. But yet, we do not know what type of exercise can be beneficial to decrease falls risk factors in prostate cancer patients.

Here we report for the first time the possible benefits of strength and balance training (SBT) program to explore the effects on key components of falls predictors such as balance confidence, physical functioning performance and musculoskeletal health. For this purpose, center-based SBT exercise program conducted twice a week for 8 weeks and we compared outcomes of musculoskeletal health, physical function performance, dynamic balance, balance confidence, fatigue and quality of life of four prostate cancer patients with one control subject at the baseline and after intervention period. Following the exercise intervention, improvements were observed in bone mineral density,

functional movement screen score, times for performing backward walk and timed up and go tests as well as outcomes of self-reported falls efficacy and functional assessment of chronic illness therapy – fatigue; however lower body muscle mass and strength did not change. Therefore, strength and balance training might be an efficient and practical approach to minimizing falls risk factors in PCa men with ADT and reducing the future health-care costs.

Keywords: Geriatric oncology, Cancer treatment, survivorship, Falls, Risk factors

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

I. INTRODUCTION

1. Significance of the Study

Prostate cancer (PCa) is the 2nd most frequent cancer diagnosed in men and the fifth leading cause of death (Rawla, 2019). In 2018, 1,276,106 new cases of PCa were registered worldwide which represented 7.1% of all cancers in men. Thus, it carries a progressive economic burden on both developed and developing countries (Bray et al., 2018; Kang et al., 2019; The International Agency for Research on Cancer, 2018). In favor of advanced treatments as well as early detection, the 5-year survival rate of men with local or original PCa is estimated more than 99%; whereas the adverse effects after treatment remains a major concern for the cancer patients (American Cancer Society).

Androgen deprivation therapy (ADT) is commonly used as a basic systematic treatment for men with PCa that in one hand, it improves disease-free and overall survivor rate, however patients must weigh the benefits of ADT against physiological and psychological adverse effects that decrease overall quality of life (QOL) of survivors (Alberga et al., 2012; Moe et al., 2017). The incidence of PCa is getting higher by aging, and most survivors of PCa are men aged 65 or older (Bray et al., 2018). With advancing age, unintentional falls become a serious public health problem for elderly that impose a significant economic burden on the healthcare system (Bergen, 2016). A recent study determined PCa survivors who received ADT had experienced recurrent falls more than unexposed men (Winters-Stone et al., 2017). In order to prevent high

costs of healthcare following fall-induced injuries in older men with PCa, follow-up after treatment is vital to help survivors live longer and maintain their quality of life (Elit & Reade, 2015). Although very limited studies reported the falling issue in men with PCa, it is considerable that accelerated physical and psychological changes such as decreased lower body muscle mass and strength, cognitive decline, worsen fatigue, progressive loss of bone mineral density (BMD) following initiating ADT might put PCa survivors at higher risk of impaired physical functioning performance and subsequently developing falls (Winters-Stone et al., 2017; Yunfeng, Weiyang, Xueyang, Yilong, & Xin, 2017).

Exercise is well-known as an economic and key adjuvant treatment in clinical oncology that improves health related fitness and QOL of cancer survivors (Rock et al., 2012). A growing body of literature provides strong evidence that exercise is safe, feasible and can mitigate adverse effects of treatments (Liam Bourke et al., 2016); However little is known about either optimal type or effects of exercise on major components of falls in PCa survivors with ADT. Therefore, to satisfy the knowledge gap in this area, our study demonstrated effects of SBT exercise program on falls risk components in PCa survivors with ADT.

2. Purpose of Research

To our knowledge the present study is the first clinical trial that verified the effects of 8-week strength and balance training on risk factors of falls such as balance confidence, physical functioning performance and musculoskeletal health in purpose of reducing the future health-care costs associated with falls. In this study we tried to explore the effects of exercise intervention from participates' perspective and look deeper than quantitative analysis alone.

3. Research Hypothesis

To clarify the purpose of this study, the following research hypotheses were set up;

1) Combination of strength and balance exercise with resistance band could increase lower limb muscle strength and prevent negative changes in body composition and bone mineral density of older men with PCa receiving ADT.
2) An 8-week of SBT program would enhance balance in men with PCa through improving physical functioning performance and asymmetries as well as balance confidence.
3) There would be a difference on self-reported QOL and level of fatigue after the SBT program intervention.

II. LITERATURE REVIEW

1. Overview of Prostate Cancer

PCa which carries a progressive economic burden on society, is the second most prevalence diagnosed malignancy (13.5%) among men followed by lung cancer (14.5%) worldwide (Bray et al., 2018; Kang et al., 2019; The International Agency for Research on Cancer, 2018). Yet there is no evidence how to prevent incidence of PCa but it is recommended that healthy diet and regular exercise may decrease the risk. Subsequently, there is strong evidence that being overweight or obese is highly correlated with increased risk of advanced PCa (World Cancer Research Fund, 2018).

Since the risk factors of PCa is getting increased by aging, the prevalence of PCa incidence is higher in men aged 65 or older. In early stage of PCa there is not specific symptoms; but it can be detected by screening practices (i.e., screening the prostate-specific antigen). With the progression of disease, urinary incontinence, blood or pain in urine may be experienced as symptoms. In favor of advanced treatments as well as early detection, the 5-year survival rate of men with PCa is estimated more than 99% (American Cancer Society). Depending on each case, man with PCa might be treated with surgery, radiation therapy, cryotherapy, chemotherapy, immunotherapy and hormone therapy which successfully increase the survivor rates, whereas the adverse effects after treatment remains a major concern for the cancer patients.

2. Androgen Deprivation Therapy for Prostate Cancer Patients

The PCa cell proliferation is stimulated by androgens hormones (i.e. dihydrotestosterone and testosterone). ADT also known as hormone therapy is used as a basic systematic treatment for men with early stage, locally advanced, recurrent, or metastasis disease. It results in lowering levels of androgens or stopping them from affecting PCa cells which prolongs survival rate (Moe et al., 2017). ADT comes in form of either surgical or medical castration with using gonadotropin-releasing hormone (GnRH) which reduces pain, improves disease-free and overall survivor rate up to 90% (Saylor & Smith, 2010). Thus, the use of ADT as a primary treatment has been increased consistently among men with all ages, stages and grades of PCa (Shahinian, Kuo, Freeman, Orihuela, & Goodwin, 2005).

Despite proved efficacy of ADT, this medication often accompanied with some adverse effects such as anemia, lipid changes, fatigue, osteoporosis, gaining fat mass, loss of metabolically active muscles, falls and fractures (Bylow, Mohile, Stadler, & Dale, 2007; Moyad, 2005). Although the exact mechanisms by which ADT increases risk of falls are not fully understood, hypogonadism might be one of the possible explanations that describe this event. Androgens play significant roles in musculoskeletal development and metabolism whereas suppression of androgens in process of ADT causes hypogonadism and disturbs the hormonal equilibrium in men with PCa. Many studies emphasized that administration of ADT has negative impact on bone

health with progressive loss of BMD in varies skeletal sites up 1.0% annually which may lead to osteoporosis (Kim et al., 2019; Owen, Daly, Livingston, & Fraser, 2017). Likewise, average annual gain of 11% of whole body fat mass and decline of 2-3.6% of skeletal muscle mass reported following initiating of ADT (Owen et al., 2017). Men receiving ADT indicated 40% and 27% less strength of muscles in upper and lower body respectively compared to non-ADT PCa group (Storer, Miciek, & Travison, 2012). A growing body of evidence supports the hypothesis that ADT can induce cognitive impairment with 47-69% decline in men on ADT over 9-12 months (Mundell, Daly, Macpherson, & Fraser, 2017). Furthermore, it is confirmed that prostate cancer patients receiving ADT experience worsening fatigue over time compared to either prostate cancer patients not receiving ADT or men with no history of cancer (Nelson et al., 2016).

3. Fall Risk Following Androgen Deprivation Therapy

Unintentional Falls are considered as a serious public health problem that cause to morbidity and mortality in elderly and impose a significant economic burden on the healthcare system (Bergen, 2016). It is estimated that more than thirty percent of people over age 65 may experience fall each year and the frequency of falling tend to increase with advancing age (Hussain, Breunis, Timilshina, & Alibhai, 2010). Fall-induced injuries are very costly associated with expensive medical expenses (Burns, Stevens, & Lee, 2016). Thus, development of a cost-effective fall prediction system is necessary to reduce the financial and health burdens followed with the consequences of a fall (Rajagopalan, Litvan, & Jung, 2017).

Ageing is strongly correlated with increasing incidence of falls and cancer (i.e. PCa) (M. H. Huang, Blackwood, Godoshian, & Pfalzer, 2019; "SEER Cancer Stat Facts: Prostate cancer.," 2017). Particularly, people living with the beyond cancer are at greater risk of falls due to the inactivity, treatment and disease (Williams et al., 2018). Huang et al. in a recent study demonstrated the age at diagnosis of PCa was associated with increasing odds of falls (M. H. Huang et al., 2019). Indeed, previous studies pointed out that ADT may accelerate physical changes (e.g., loss of muscle mass, decrease strength, impaired muscle function and worsen fatigue) which increases frailty (Bylow et al., 2007) but very limited studies have examined falls as an

outcome (Bylow et al., 2008; Hussain et al., 2010; Winters-Stone et al., 2017; Wu, Sheu, Lin, & Chung, 2016). A recent cross-sectional study determined that ADT users in overall experienced falls twice as many recurrent falls than non-users (Winters-Stone et al., 2017). ADT administration also lead to accelerated osteoporosis (Kim et al., 2019); subsequently a higher prevalence of fracture following ADT in PCa patients has been reported in studies (Shahinian, Kuo, Freeman, & Goodwin, 2005; Wu et al., 2016).

Although the exact mechanisms by which ADT increases risk of falls are not fully understood, a possible explanation may describe this event. As pictured in Figure 1, consequences of lowered androgens level whether because of hypogonadism or administration of ADT might negatively affect quality of life of men with PCa which might cascade falls and in overall lead to progression of frailty. Thus, enhancing physical function and maintaining body composition might be a practical strategy to reduce risks of falls, fracture, and subsequent complications in this population.

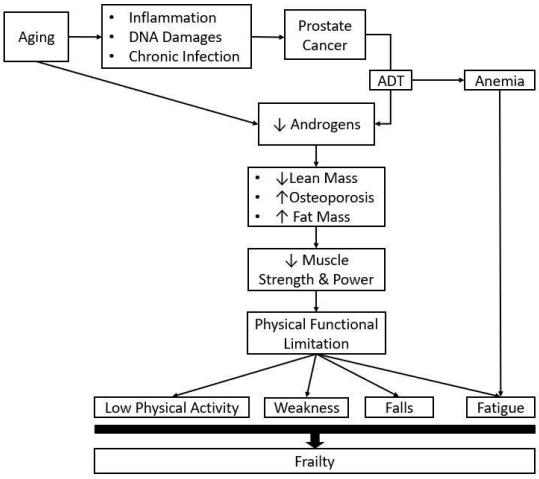

Figure 1. The possible contribution of androgen deprivation therapy to the falls in men with prostate cancer

4. Exercise Medicine for Preventing Falls

Exercise has been well-known as a safe method to turnover side effects of treatment for people living with and beyond cancer (R. Segal et al., 2017). A recent systematic review demonstrated the efficacy of exercise for the management of ADT-induced adverse effects through improving physical and mental health in men with PCa (Fig. 2) (Prue Cormie & Zopf, 2018).

Outcomes	Exercise Modality[a]	Level of Evidence[b]				
		MA	SR	RCT	OB	QUAL
Aerobic Fitness						
Muscular Strength						
Body Composition		MA[c]				
Fatigue/Energy						
Quality of Life						
Physical Function						
Social Functioning						
Psychological Distress						
Bone Health				RCT[d]		
Co-Morbid Disease Risk Factors				RCT[e]	OB[e]	
Sexual Wellbeing						
Bone Pain				RCT[f]		
Urinary Problems				RCT[g]		
Cognitive Decline				RCT[g]		

- Aerobic exercise (e.g. walking, running, cycling, swimming, rowing)
- Resistance exercise (e.g. repetitively lifting weights using free weights, weight machines or resistance bands)
- Impact exercise (e.g. jumping, skipping, hopping, bounding)
- Meta-analyses
- Systematic reviews
- Randomised controlled trials
- Observational studies (incl. controlled trials, non-controlled trials, cross-sectional studies, case reports)
- Qualitative studies

[a] Exercise modality involved in the interventions; presented in the order of importance for eliciting therapeutic effect
[b] Evidence is based on studies with significant results
[c] Effect observed for body mass index and total body mass
[d] Effect observed for selected bones sites only; no significant effect observed for other bone sites examined
[e] Risk factors examined include cholesterol, c-reactive protein, flow-mediated dilatation, Sex hormone-binding globulin, triglycerides, glucose, blood pressure, insulin sensitivity
[f] Evidence from only one trial reporting no significant exacerbation of bone pain (i.e. not alleviation of pain)
[g] Evidence from only one trial reporting beneficial effect during and after radiation

Figure 2. Summary of the current evidence regarding effects of exercise on common androgen deprivation therapy-related side effects (Prue Cormie & Zopf, 2018)

Many Studies focused on investigating the benefits of exercise interventions on preventing falls and improving and physical performance of older adults (Cadore, Rodríguez-Mañas, Sinclair, & Izquierdo, 2013). Previews studies determined that strength training could enhance neuromuscular activity, muscle mass, strength in older adults and it has been systematically highlighted as a necessary component of successful fall reduction multicomponent exercise program (Lopez et al., 2018). Balance training broadly prescribe along with other types of exercise as a multi-component fall prevention exercise program (Williams et al., 2018). Recent physical activity guideline recommended that the strength and balance training is two necessary components in exercise program for older adult to prevent of falls and disability (Piercy et al., 2018). Combination of at least two types of exercise in a program appears to be more beneficial for improving the overall health status of frail elderly individuals (Cadore et al., 2013). Combination of strength and functional balance exercise has been demonstrated as an effective method to improve balance performance, rather than strength training alone (de Bruin & Murer, 2007; Rhonda Orr, Raymond, & Singh, 2008). According to studies, fall prevention exercise programs not only reduce the rates of falls but also prevent injuries resulting from falls in older community dwelling people. Notably, all exercise programs that have proved to be effective for fall prevention emphasize balance training, and there is now ample evidence that this type of exercise improves balance ability (El-Khoury, Cassou, Charles, & Dargent-Molina, 2013).

In fact, several studies have shown improvements of walking speed, sit to stand, TUG test, lower body strength and muscle mass following exercise in

PCa patients which generally are common-used with elderly to predict physical function and fall risk (Keogh & MacLeod, 2012), but yet no study reports the effect of fall-prevention exercise as the primary outcome for PCa patients receiving ADT. To our knowledge, no study compared exercise with no treatment or non-exercise intervention (Williams et al., 2018). Furthermore, we do not know whether and what type of exercise can be effective to reduce risk of fall in PCa patients while optimally managing their disease with ADT.

III. METHODOLOGY

1. Recruitment Process

Recruitment of outpatients proceed from July 2018 to April 2019 through medical screening examination in Boramae Medical Center in Seoul, South Korea. We were referred a list of 14 PCa patients who were registered as volunteer to participate in our clinical trial. Subjects were excluded if they were suspected to have any difficulty in participation due to age, metastasis disease, serious musculoskeletal, neurological and cardiovascular disorders.

Ethical approval was granted from Institutional Review Board (IRB) of Seoul National University Boramae Medical Center (SNUIRB No. 26-2014-126).

2. Case Selection Strategy

We contacted all the 14 patients that we were referred by Boramae Medical Center and explained them about our ongoing study. All subjects were asked whether they could participate in our clinical; however, only seven patients agreed to participate in. The major reason of patients who refused to participate was being busy with another schedule or lack of time. Also, in some cases one-year time gap between hospital recruitment and beginning of our research might negatively affect patients to change their minds.

Among 7 patients that we recruited for our study, 5 subjects confirmed as being able to participate in our 8-week supervised exercise program (SBT; n=5); while 2 patients were clustered as exercise placebo subjects (CON; n=2) who refused to attend in scheduled exercise program. The overall flow of study is presented in Figure 3. In period of intervention one case from each group dropped out so in overall, we used data of 5 patients in this study.

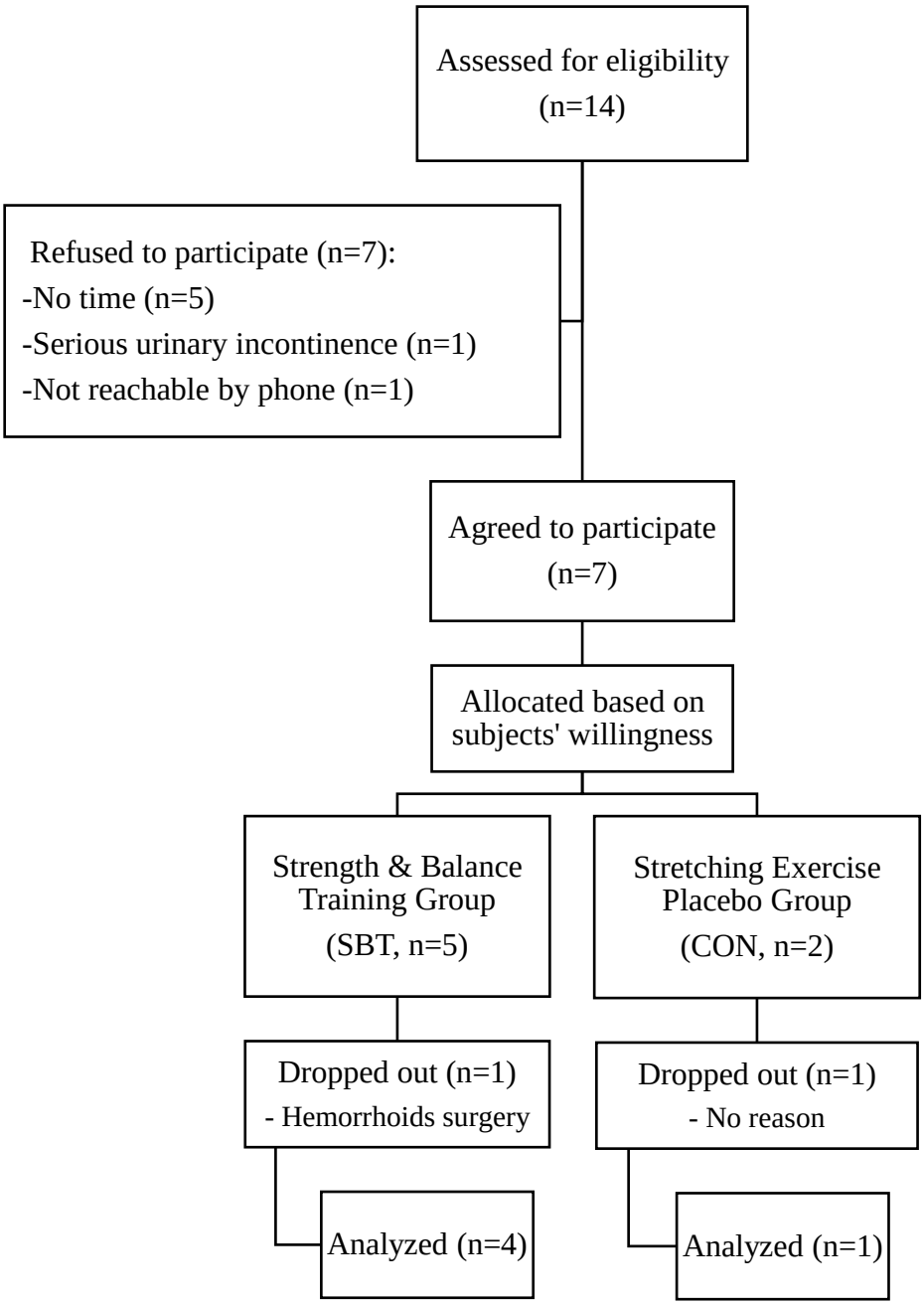

Figure 3. Study flow chart for 8-week intervention

3. Intervention Program

Participants of both groups received physical activity diary as well as written educational materials about PCa and importance of exercise in cancer survivorship. Then we conducted an 8-week exercise program which supervised by an exercise science specialist at multi-purpose gym in Seoul National University, South Korea.

For duration of 8 weeks intervention, the SBT group participated in 16-session supervised exercise training (Fig. 4) while CON group advised to follow the provided stretching training program at home. All subjects were assessed for clinical and anthropometric assessments within one week before and after exercise intervention. Also, a structured interview conducted for all subjects at the end of the intervention.

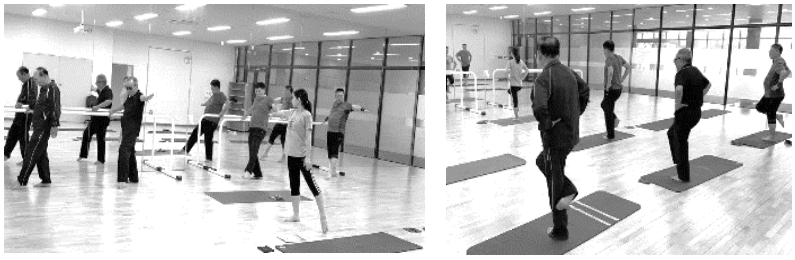

Figure 4. Intervention program for strength and balance training group

4. Exercise Protocol

The SBT group participated in supervised center-based strength and balance training program with using Thera-Band® for duration of 8 weeks. The major exercise protocol of each session is presented in Table 1. The whole exercise program lasted for 60 minutes and conducted by the same exercise science specialist at multi-purpose gym in Seoul National University.

The balance exercises performed in 2 sets of 8-10 repetitions (e.g. line walking, standing on one leg, side and front leg raise, hip airplane, knee cross, single leg squat, heel raise, single leg balance and clock exercise) and for safety of patients we conducted balance exercises with support of barre. Subsequently, patients instructed to follow 2 sets of strength training work-out which mostly focused on major muscles of lower body (e.g. squat, lateral walk, good morning, leg press, bent knee planter flexion, calf raise, kickback, calf press, straight leg hip extension, one leg circle) (Fig. 5). Rating of Perceived Exertion (RPE) was asked 2 times, in the middle and after of exercise to monitor subject physical condition while they are doing exercise and getting constant feedback of intensity of exercise. The average RPE for all session was 13 (somewhat hard) which equivalents to moderate intensity (Riebe, Ehrman, Liguori, & Magal, 2018). We began exercise program with the green colored resistance band and modified intensity of the training by progression of every movements as well as upgrading the level of Thera-band to blue color. At the end of intervention participants of SBT group were awarded resistance band.

Figure 5. Strength & balance exercise program for prostate cancer patients receiving androgen deprivation therapy

Table 1. Protocol of strength & balance training

Type	The progressive strength and balance training program with Thera-band
Time	60minutes; - Warm-up 10 minutes - Balance training 15 minutes - Strength training 25 minutes - Cool-down 10 minutes
Duration	8 weeks
Frequency	2 days per week
Intensity	8-10 rep, 2sets
Pattern	Interval rest of 2-3min between each set

Subjects of CON group provided a full body stretching program structure and recommended to follow it at home for 8 weeks. In purpose of monitoring overall level of physical activity during intervention period, we asked all subjects including SBT group to record their daily physical activity in the exercise diary.

5. Clinical Measurements

Objective assessments were done to all participants before and after intervention program on week 0, week 8 as following (Table 2).

Table 2. Objective measurements

Variables	Analysis Method	Model
Body Composition -BMI -Fat Mass -Lean Mass -Bone Mineral Density	DXA	Hologic Discovery W
Safety of exercise	Blood test	
Lower Extremity Functioning	-Balance -Chair Stand -Gait Speed	Short Physical Performance Battery (SPPB)
Functional Limitations & Asymmetries	-Overhead Squat -Hurdle Step -In-line Lung -Straight Leg Raise -Shoulder Mobility -Push-up -Rotatory Stability	Functional Movement Screen (FMS)
Lower Body Strength & Power	Cybex	HUMAC NORM System, CSMI
Dynamic Balance	-Timed Up & Go -Walk backward	
Balance Confidence	Self-reported questionnaire	Falls Self-Efficacy Scale – International (FES-I)
Fatigue	Self-reported questionnaire	FACIT-Fatigue
Quality of Life	Self-reported questionnaire	The Functional Assessment of Cancer Therapy-Prostate (FACT-P)
Physical Activity	Self-reported questionnaire	International Physical Activity Questionnaires (IPAQ)

5.1. Body Composition & Bone Mineral Density

Whole body composition and bone mineral density (BMD) of subjects were evaluated by using dual energy x-ray absorptiometry (DXA, Hologic Discovery W, Waltham, MA, USA) machine (Fig. 6). We asked patients to remove any metal objects and change to no-zipper clothes. The whole-body scan lasted for 6-minutes in a fixed position. Measures of body composition included body mass index (BMI), lean mass (LM), fat percentage, total and legs specifics BMD as well as T-score which represents the level of osteoporosis. Prior to DXA assessment, weight and height were measured by InBody 720 (Biospace Co. Ltd, Seoul, Korea) and stadiometer respectively.

Figure 6. Dual-energy X-ray absorptiometry for body composition assessment

5.2. Blood Chemistry Measures

To examine safety of exercise we asked Boramae Medical center to share us data of prostate specific antigen (PSA), testosterone, uric acid (UA), hemoglobin (Hb), cholesterol, high-density lipoprotein (HDL) and low-density lipoprotein (LDL), triglycerides (TG), aspartate aminotransferase (AST) and alanine aminotransferase (ALT) before and after period of intervention. Blood data of each subject analyzed in clinical laboratory of Boramae Medical Center, Seoul, Korea.

5.3. Physical Function

5.3.1. Short Physical Performance Battery Test

The short physical performance battery (SPPB) test is an objective assessment tool which combines the results of balance, gait speed and chair stand tests to evaluate lower extremity functioning in elderly (Guralnik et al., 1994). Performance score and time of tests collected after balance test (4 points) in three different standing positions (i.e. feet side by side, semi tandem, and tandem), 3-meter gait test (4 points), and 5 reputations of stand up and sit down the chair without use of the hands for support (4 points). The last two tests were asked to perform in subjects' preferred speed.

5.3.2. Functional Movement Screen Test

The functional movement screen (FMS™) test is a non-invasive and inexpressive tool that assesses the quality of fundamental whole-body movement patterns and identifies functional limitations and asymmetries in elderly population (Mitchell, Johnson, Vehrs, Feland, & Hilton, 2016). Test includes a total of seven fundamental movements that requires a balance of mobility and stability (Fig. 7). The tests place the individual in extreme positions where weaknesses and imbalances become noticeable if appropriate stability and mobility is not utilized (Cook, Burton, & Hoogenboom, 2006). Each movement gives a score from 0 to 3 based on quality of performance. The score of 3 represents a normal performance while 1 and 2 consider as level of functional limitations. The score of 0 was given to a subject who feels pain while doing the movement. In total the scores from each test were summed to generate the FMS score (range 0-21).

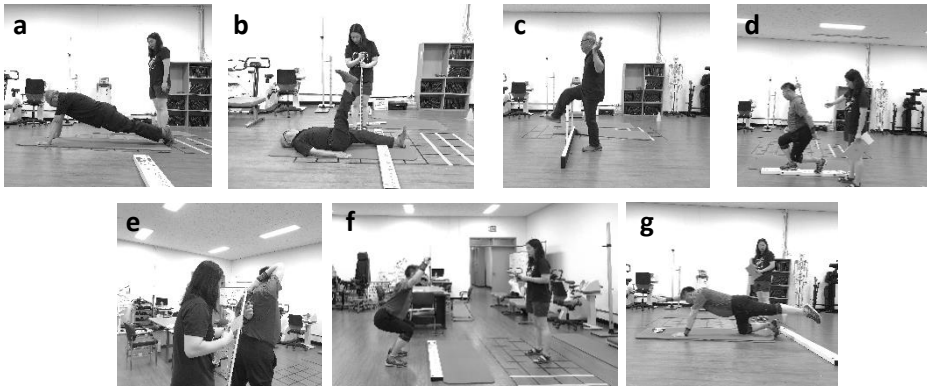

Figure 7. Functional movement screening test; (a) trunk stability push-up, (b) active straight leg raises, (c) hurdle step, (d) in-line lunge, (e) shoulder mobility, (f) deep squat, and (g) rotary stability.

5.3.3. Isokinetic Muscle Strength & Power

A Cybex Norm® isokinetic dynamometer (Cybex International Inc., New York, NY, USA) was used to assess lower extremity strength through measuring peak torque and average power (Fig. 8). The test was applied for subject's preferred leg. Muscle strength and average power were measured by performing 3 repetitions of knee extension and flexion at angular velocity of 60°/sec. To perform test, chair back and chair rotation angle were set to 85° and 40° respectively. And the dynamometer height and rotation angle were fixed to 8 and 40° each. All setting value was re-modified according to subject's physical characteristics. Range of motion of knee flexion and extension were set to 95° and -5° respectively. In order to reach to best performance, assessment kept encouraging patients while doing the test.

Figure 8. Isokinetic dynamometer test for lower muscle strength

5.4. Dynamic Balance

5.4.1. 6-meter Backward Test

The backward test is designed to assess dynamic balance through measuring the time that a subject performs a backward tandem walk for 6 meters, placing one foot exactly behind the other heel (Fritz et al., 2013). The test was performed in triplicate with recovery times between trails and the average time was used in the analysis.

5.4.2. Timed-Up and Go Test

The timed-up and go (TUG) test is aimed to evaluate functional balance and eligibility which is strongly correlated to level of functional mobility in elderly (Podsiadlo & Richardson, 1991). It has been suggested that a change of even 3.5 to 4 seconds may represent a clinical significant change (S.-L. Huang et al., 2011). The test measures the time that a subject requires to arise and walk 3 meters, then turn back and sit down in comfortable speed. Subjects were asked to perform the test for three times with sufficient interval rest and the average time of three attempts was selected for further analysis.

5.5. Psychological Assessments

5.5.1. FES-I Questionnaire

Measurement of fear of falling, followed by appropriate intervention is important to promote independence, function, wellness and safety of older adults (Greenberg, 2011).The falls efficacy scale-international (FES-I) is a questionnaire using the activities-specific balance confidence scale. It is confirmed that FES-I is validated and has a good internal and test-retest reliability (Cronbach's α=0.96) for measuring of concerning about falling (Yardley et al., 2005). The level of concern was assessed on a four-point Likert scale (1=not at all concerned to 4=very concerned) and we simply summed up the scores for each item which resulted a total score range from minimum 16 (no concern about falling) to maximum 64 (severe concern about falling).

5.5.2. FACIT-Fatigue Questionnaire

The functional assessment of chronic illness therapy (FACIT) -fatigue scale is a validated and reliable (Cronbach's $\alpha = 0.96$) questionnaire which measures an individual's level of fatigue during their usual daily activities over past week [28]. It contains of 13 items which scored (0-52) based on a four-point Likert scale (4=not at all fatigued to 0=very much fatigued). The total score of less than 30 indicates severe fatigue while the higher score represents the better quality of life.

5.5.3. FACT-P Questionnaire

Patient's health related quality of life was evaluated by using functional assessment of cancer therapy-prostate (FACT-P) which is a validated and reliable (Cronbach's $\alpha = 0.60$) questionnaire with 27 core items in four domains of wellbeing, subscale as follows (Chu et al., 2014; Esper et al., 1997). Physical well-being (PWB, score range 0-28), social/family well-being (SWB, score range 0-28), emotional well-being (EWB, score range 0-24), functional well-being (FWB, score range 0-28), prostate cancer subscale (PCS, score range 0-48), and FACT-P as a total score (0-156). Notably, the higher score indicates the higher quality of life.

5.6. Level of Physical Activity

The International Physical Activity Questionnaires (IPAQ) comprises a set of four well-developed questions which measures health-related physical activity by self-report over the previous 7 days. Data from the questionnaire were summarized according to the physical activities recorded (walking, moderate, and vigorous activities); Then transformed into energy expenditure estimates as metabolic equivalent task (MET) to calculate the weekly physical activity (MET-minute per week).

6. Structured Interview

At the end of intervention, a ten-minutes structured interview conducted with all subjects who completed the study. We considered a private room for interview and interviewer was a researcher who had not any interaction with subjects before. Interview with all subjects was recorded separately and then transcribed. the interview focused on three main area related to intervention; (a) beliefs about adherence to exercise, (b) beliefs about group training, and (c) outcome experienced through this program.

7. Data Analysis

Descriptive statistical analysis was performed in regard to the subjects' background characteristics and outcome result. Results of each subject were expressed as difference between data of pre-test and post-test.

IV. RESULTS

1. Case Presentation

1.1. Case Study A (YBS)

YBS was a 74-year-old man who diagnosed with T3b N1 M0 non-small prostate cancer cell with a grade 4 gland according to Gleason grading system (Gleason score 4+4) six years prior to our study. He underwent a radical retropubic prostatectomy on 2013 and he has begun hormone therapy with 10.8 mg of Goserelin, since April 2015 so he had a history of 50-month ADT before starting the intervention. He mentioned he was a taxi driver but it had been 5 months since he quitted his job. He also diagnosed with diabetes mellitus (DM). He was neither smoker nor regular alcohol drinker. He implied he does regular exercise by his own, and according to IPAQ his level of physical activity in one week before starting the intervention categorized as "moderate" or 1173 MET-minutes per week. He was the only case who stated that had a fall experience while he was riding bicycle which resulted a surgery followed by limited range of motion on his left shoulder. He asserted that doctor recommendation was the only reason of participating on this study;

"I joined the program because the doctor in Boramae hospital suggested me to try exercise."

1.2. Case Study B (KKS)

KKS was an 81-year-old retired man who was diagnosed with a tumor grown into both side of prostate on 2011 which medically defined as T2c N0 M0 and grade 1 gland (Gleason score 3+3) according to Gleason grading system. He never received surgery, and he began receiving treatment with injection of 14.58 mg Triptorelin Pamoate since January 2018 which was a 17-month history of ADT prior to our study. He noted he was neither smoker nor regular alcohol drinker. He also diagnosed with hypertension (HT). He stated he does regular exercise habit once a week; however, his level of physical activity in leisure time on one week before starting the intervention categorized as "high" by IPAQ which was equal to 3252 MET-minutes per week. He implied that he followed doctor's recommendation for participating in this program;

"…That doctor asked me what is my opinion to attend in exercise program once, so that's why I did it once…"

1.3. Case Study C (BIK)

BIK was the youngest participant with 60 years old who was diagnosed with T2 N0 M0 tumor cell in the prostate; however, he was found with a high-grade cancer (Gleason score 4+5, grade 5) on 2017. After the diagnosis he underwent a radical retropubic prostatectomy surgery at the same year and one year later on May 2018 he began hormone therapy with 3.6 mg of Goserelin which increased to 10.8 mg over a year. Thus, he had a history of 9-month history of ADT prior to our study. He also diagnosed with DM as a comorbidity. BIK was the only case who still was following his career. He pointed out that he was neither a smoker nor alcohol drinker. BIK asserted that he does exercise regularly more than once a week. However, his level of physical activity during one week before starting our study was categorized as "low" according to IPAQ which turned out as 1188 MET-minutes per week. He agreed that doctor's recommendation motivated him to participate in our study but he also added that he had some sort of curiosity about this exercise program;

"mm… doctor recommended me to join this program but, after that I asked again about it, because I was curious to know how it is. That's why I'm here."

1.4. Case Study D (YJH)

YJH was a retired man with 77 years old who diagnosed with the prostate cancer T3c N0 M0 which described the tumor has invaded one or both of the seminal vesicles 8 years ago. His gland graded as 4 according to Gleason grading system (Gleason score 4+4), however he did not receive any surgical operation. He started the hormone therapy (ADT) with 3.6 mg of Goserelin since June 2018, thus he had history of 12-month ADT prior to our study. Beside that DM was noted in his medical history. Although YJH was not a smoker but he stated he was a regular alcohol drinker. He reported us that he had habit of doing exercise regularly once a week and according to IPAQ his level of physical activity during one week before beginning our study was categorized as "moderate" which was 2448 MET-minutes per week. When we asked him about motivation to participate in this study he also mentioned doctor was the one who recommended him;

"About motivation… after I underwent prostate surgery, I go often to hospital for hormone therapy. They told me the injections are very likely to cause osteoporosis. So, I was recommended to try this exercise program once. That's why I was registered for this program through hospital. And I received call from you."

1.5. Case Study E (KST)

KST was an 81-year-old man who was diagnosed with prostate tumor on 2018 which was a grade-3 gland (Gleason score 4+3) according to Gleason grading system then he underwent a transurethral resection of bladder tumor surgery. Following that he began the hormone therapy (ADT) with 3.6 mg of Goserelin since March 2018 which increased to 10.8 mg over a year. Thus, he had a history of 15month ADT prior to our study. He also diagnosed with HTN as a comorbidity. HE noted he is not a smoker but he drinks alcohol often. KST stated he still does his carrier and do regular exercise habit more than once a week; but his level of physical activity on one week before starting the intervention categorized as "low" by IPAQ which was equal to 796 MET-minutes per week. He asserted he does exercise by his own so that was the reason he did not attend our exercise program;

"Oh, the exercise that I do is very similar to training that I do by my own. Work-out I do every day is about the same. So, I do more exercise"

2. Baseline Characteristics

The baseline demographic characteristics of all cases are presented in Table 3. Participants were all in range of 60-81 age with at least 9 months receiving ADT as adjuvant treatment after diagnosis of PCa prior to our study.

Table 3. Baseline clinical characteristics of participants

	SBT				CON
Variable	**A**	**B**	**C**	**D**	**E**
Age, yr	74	81	60	77	81
BMI, kg/m^2	28.5	26.9	29.4	25.1	24.0
Fat, %	37.3	36.6	38.5	32.4	34.1
Education, yr	<12	≥12	≥12	<12	≥12
IPAQ, MET-minutes/week	1173	3252	1188	2448	796
Surgery	Yes	No	Yes	No	No
Comorbidities	DM	HTN	DM	DM	HTN
ADT duration, mo	50	17	9	12	15
Gleason score	8	6	9	8	7
PSA, ng/m	0.85	0.17	<0.02	0.16	0.07
Testosterone, ng/m	<0.1	0.13	0.13	0.22	<0.1

SBT: strength and balance training; CON: control; yr: year; BMI: body mass index; DM: diabetes mellitus; HTN: hypertension; mo: month; IPAQ: international physical activity questionnaires; MET: metabolic equivalent of task; ADT: androgen deprivation therapy; PSA: prostate-specific antigen.

3. Safety of Exercise

Blood variables before and after exercise intervention were all in range of safe and normal (Table 4).

Table 4. Blood biochemistry before and after intervention

		SBT				CON
Variable	**Test**	**A**	**B**	**C**	**D**	**E**
PSA (ng/ml)	Pre	0.85	0.17	<0.02	0.16	0.07
	Post	1.1	0.13	0.07	0.35	0.08
Testosterone (ng/ml)	Pre	<0.1	0.13	0.13	0.22	<0.1
	Post	0.12	<0.1	0.11	0.21	<0.1
UA (ng/ml)	Pre	4.4	6.5	5.5	4.7	5.4
	Post	3.5	6.3	5.3	5.6	5.2
Hb (g/dL)	Pre	14.5	12.9	13.4	13.3	11.2
	Post	13.8	12.6	13.8	12.7	11
Cholesterol (mg/dL)	Pre	108	218	214	133	162
	Post	99	216	198	134	176
LDL (mg/dL)	Pre	45	131	120	40	67
	Post	43	140	110	41	83
HDL (mg/dL)	Pre	48	43	75	59	75
	Post	47	50	78	57	74
TG (mg/dL)	Pre	76	222	97	171	104
	Post	43	132	51	180	97
AST (IU/L)	Pre	28	24	22	23	31
	Post	33	28	31	25	42
ALT (IU/L)	Pre	20	13	27	27	20
	Post	17	16	34	27	35

SBT: strength and balance training; CON: control; PSA: prostate-specific antigen; UA: uric acid; Hb: hemoglobin, HDL: high-density lipoprotein; LDL: low-density lipoprotein; TG: triglycerides; AST: aspartate aminotransferase; ALT: alanine aminotransferase; ng: nanogram; ml: milliliter; g: gram; dL: deciliter; mg: milligram; IU: international unit

4. Change of Body Composition and Bone Mineral Density

The body composition and bone mineral density was analyzed via DXA scan and the result of test of both SBT group and CON subject presented in Figure 9. Except one case, the rest of cases of SBT group had a slight increase of BMI, decline of total lean mass and modest rise of leg fat percentage after 8 weeks intervention. However, level of bone density of 3 cases in SBT group which remarked as T-score improved in favor of strength and balance training.

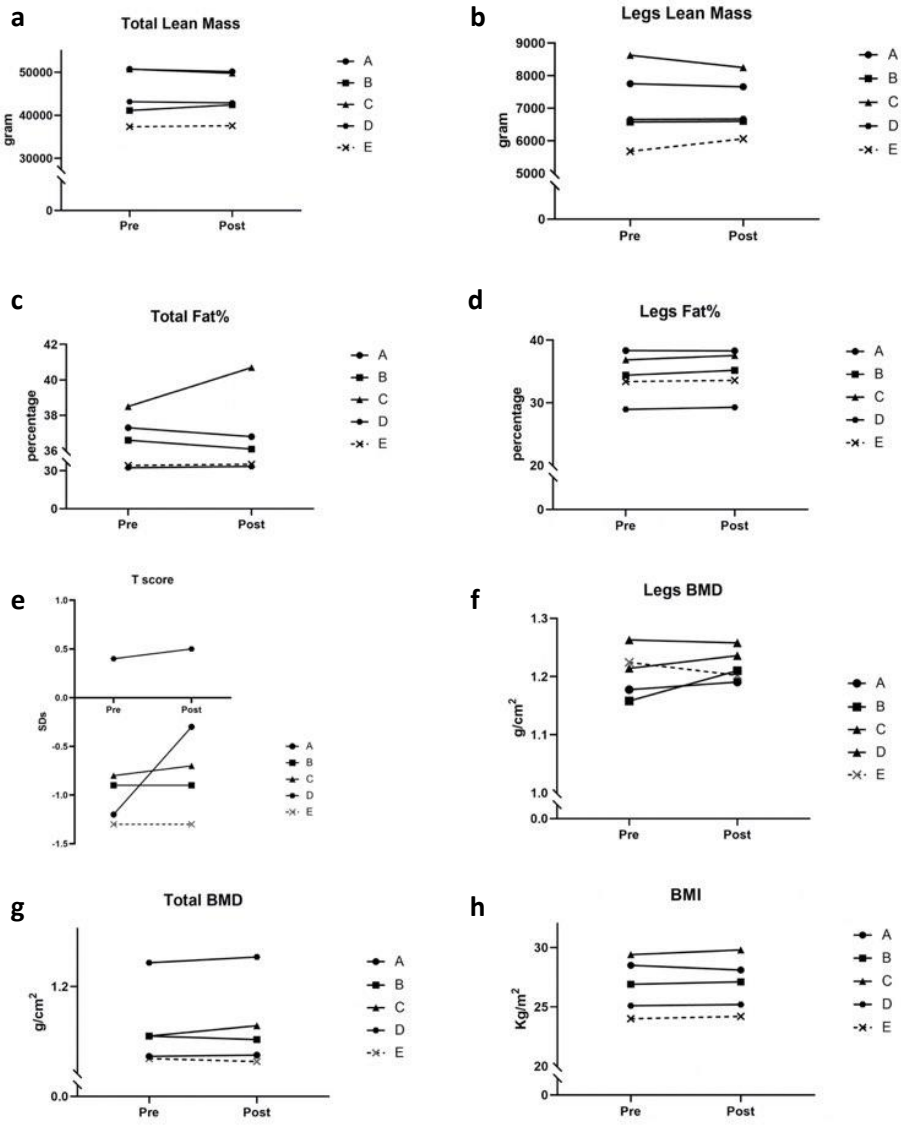

Figure 7. The effects of 8-week strength and balance training on body composition and bone mineral density; (a&b) Changes of total lean mass & legs lean mass between pre-test and post-test; (c&d) total & legs fat percentage alternation between pre-test and post-test; (e) changes in level of osteoporosis between pre-test and post-test; (f&g) alternation in legs and total bone mineral density between pre-test and post-test; (h) differences in body mass index between pre-test and post-test. Strength and balance training group (n=4): A, B, C, D; Control subject (n=1): E.

5. Changes in Physical Performances

5.1. Functional Limitation & Asymmetries

Functional limitation & asymmetries of all cases were measured by FMS test. All SBT group cases had improvements in functional performances in favor of our supervised exercise intervention; however, control subject's total score didn't change. The scores of all seven tests of FMS were presented in Table 5.

Table 5. Changes in the outcomes of functional movement screen test

		SBT				CON
Variable	**Test**	**A**	**B**	**C**	**D**	**E**
Deep Squat	Pre	1	2	2	3	2
	Post	2	3	3	3	2
	Dif	1	1	1	0	0
Hurdle Step	Pre	1	2	2	2	2
	Post	1	2	2	2	2
	Dif	0	0	0	0	0
In-line Lunge	Pre	1	3	2	2	2
	Post	1	3	2	2	2
	Dif	0	0	0	0	0
Shoulder Mobility	Pre	1	1	3	1	1
	Post	1	2	3	2	1
	Dif	0	1	0	1	0
Leg Raises	Pre	3	2	3	1	3
	Post	3	3	2	2	2
	Dif	0	1	-1	1	-1
Trunk stability	Pre	1	1	1	2	1
	Post	1	3	2	3	2
	Dif	0	2	1	1	1
Rotary Stability	Pre	1	1	2	2	1
	Post	1	1	2	2	1
	Dif	0	0	0	0	0
FMS (Total Score)	Pre	9	12	15	13	12
	Post	10	17	16	16	12
	Dif	1	5	1	3	0

SBT: strength and balance training; CON: control; FMS: functional movement screen; Dif: difference between pre-test & post-test.

5.2. Lower Extremity Functioning

The result of physical functional performance which evaluated by balance, chair stand and 3-m gait speed under SPPB test presented in Table 6. There was no difference in outcome of SBT group and control subject in favor of intervention.

Table 6. Changes in Short Physical Performance Battery result

		SBT				CON
Variable	**Test**	**A**	**B**	**C**	**D**	**E**
SPPB (Total Score)	Pre	10	11	12	9	11
	Post	11	11	12	10	12
	Dif	1	0	0	1	1

SBT: strength and balance training; CON: control; FMS: functional movement screen, SPPB: short physical performance battery; Dif: difference between pre-test & post-test.

5.3. Dynamic Balance

Dynamic balance was assessed by time of best performance which subjects finished TUG and 6-m backwards tests. Results of these two tasks presented in Figure 10. In SBT group, three cases in TUG and all four cases in 6-m backwards showed dramatic improvement in favor of supervised exercise program, while control subject's performance got worsen after 8-week intervention.

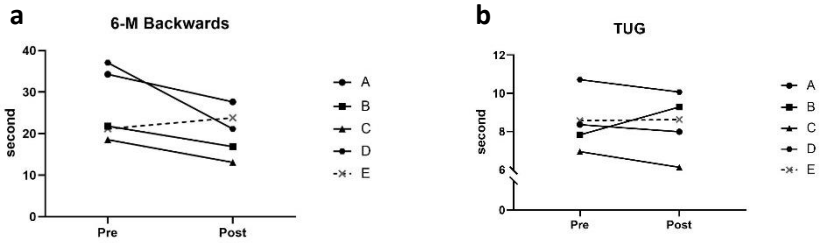

Figure 8. The effects of 8-week strength and balance training on balance domain of physical performances. (a&b) Changes of dynamic balance outcomes measured by 6-m backwards test and timed up & go (TUG) test. Strength and balance training group (n=4): A, B, C, D; Control subject (n=1): E.

6. Changes of Lower Body Strength & Power

The normalized value of relative isokinetic muscle strength and power presented in the Table 9. While dramatically decline of muscle strength and power observed in control subject; only case C & D showed improvement after 8-week supervised SBT program. Power also slightly increased in three cases of SBT group. The results of muscle function outcome presented in Table 7.

Table 7. Changes of lower muscle functions

		SBT				CON
Variable	**Test**	**A**	**B**	**C**	**D**	**E**
Muscle strength						
Isokinetic 60°/sec -Peak torque/ %BW (Nm/kg)						
Knee Extensor	Pre	131	155	158	149	182
	Post	122	134	167	164	158
	Dif	-9	-21	9	15	-24
Knee Flexor	Pre	99	75	69	51	95
	Post	95	69	72	72	80
	Dif	-4	-6	3	21	-15
Muscle Power						
Isokinetic 60°/sec -Average power per repetition/% BW (W/kg)						
Knee Extensor	Pre	99	105	103	101	127
	Post	92	95	110	110	105
	Dif	-7	-10	7	9	-22
Knee Flexor	Pre	62	48	57	42	70
	Post	66	46	59	57	62
	Dif	4	-2	2	15	-8

SBT: strength and balance training; CON: control; Dif: difference between pre-test & post-test; BW: body weight.

7. Change of Balance Confidence

Balance confidence evaluated by the FES-I questionnaire and the result presented in Figure 11. Modest improvement observed in three cases of SBT group while control subject did not change after 8 weeks of intervention.

8. Changes of Health-Related Quality of Life

Cancer fatigue was assessed by FACIT-F questionnaire which showed improvement in all SBT cases, while control subject expressed more fatigue symptoms after 8-week intervention. The functional assessment of cancer therapy in men with prostate cancer and health-related quality of life of patients undergoing cancer therapy were assessed by FACT-P survey. Almost all participants of this study had improvement in their functional assessment outcomes as shown is Figure 12.

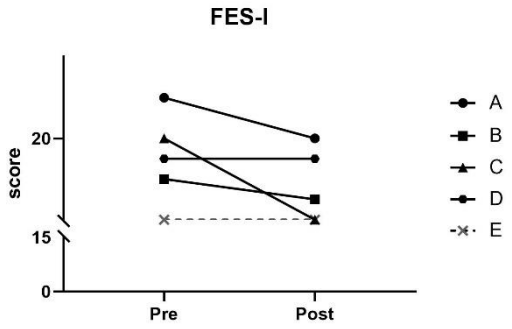

Figure 9. The effects of 8 weeks of strength and balance training on balance confidence. Strength and balance training group (n=4): A, B, C, D; Control subject (n=1): E.

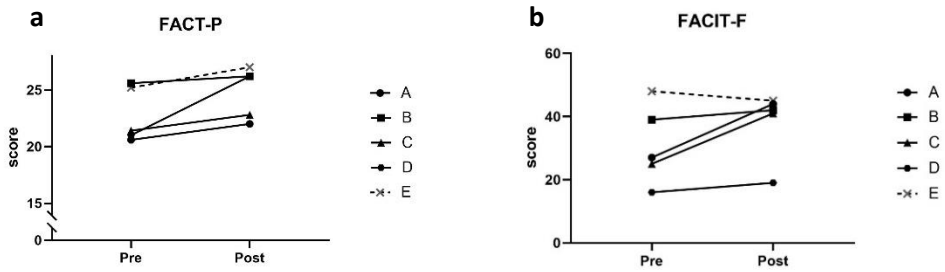

Figure 10. Effects of 8-week strength and balance training of health-related quality of life outcomes of prostate cancer patients receiving Androgen deprivation therapy. (a) changes of prostate cancer patients' quality of life; (b) changes of fatigue symptoms in association with chronic disease. Strength and balance training group (n=4): A, B, C, D; Control subject (n=1): E.

9. Qualitative Interview Outcomes

The interview findings reported across the structured interviews under three headings which reflecting the most outstanding themes.

9.1. Beliefs about Adherence to Exercise

Quite clearly the major reason for signing up to the program was the doctor's prescription, 'I joined the program because the doctor in Boramae hospital suggested me to try' (Case A, 74 years old). Except case D, no other subjects mentioned the importance role of exercise on cancer treatment, 'I go often to hospital for hormone therapy. They told me the injections are very likely to cause osteoporosis. So, I was recommended to try this exercise program once. That's why I was registered for this program through hospital' (Case D, 77 years old).

Case E who became a control subject believed that he does enough physical activity by his own and he does not need more training, '… the exercise that I do by my own is pretty similar to your program' 'I am not a person who doesn't know anything about exercise. I do work-out a lot so I don't think I will attend to these kinds of exercise program later as well' (Case E, 81 years old). Whereas all participants of SBT expressed that they would like to attend other exercise program later on, 'I'm 100% sure I will. If you call me, whenever, I will participate. I really liked it. That's why I kept attending' (Case C, 60 years old).

When we asked them whether after finishing the program they are going to continue doing the same exercise at home, two members of SBT group

explained that it is not easy to follow those work-outs at home, so one of them implied that he ‘registered in fitness class’ (Case C, 60 years old) and the other one suggested if there was a video of exercise program, he would like to follow it even at home, ‘I don’t think it goes well at home. I just keep on doing exercise as I did before. I want to do those exercise at home but I cannot’ ‘If we receive the video, I think it may help. I think the best way is that’ (Case D, 77 years old).

Beside this program, all cases implied that they had already put exercise in their weekly schedule, ‘I go to park, I walk and use fitness equipment. The other day I ride bicycle’ (Case A, 74 years old); ‘I always try to walk more than 10.000 steps… nowadays I go to park where there is public fitness equipment. I do all of them… I go hiking on weekends’ (Case D, 77 years old); ‘From time to time, I go there where there’s lots of fitness equipment, sometimes I do arm work out there, sometimes I do dumbbell at home, recently I play golf 2-3 times a week…’ (Case E, 81 years old).

9.2. Beliefs about Group Training

The subjects were asked to share their opinion about doing exercise in group. Three cases of SBT group stated they prefer group exercising, ‘other people also did the same exercise so it was fine and not boring’ (Case A, 74 years old); ‘It was fine. Maybe because there were not many people… or have similar physical weakness…’ (Case D, 77 years old). While case B asserted he prefer doing exercise alone, Case C remarked about competitive atmosphere in group exercising, ‘It’s no bad to do exercise in group also. It’s because of my competitive personality that I tried my best. maybe I sweated the most among other people’ (Case C, 60 years old). However, no friendship made through this 8-week supervised exercise program.

Case C who was the youngest participants mentioned the ‘age difference of 10 to 20 years’ which he believed his lifestyle was different from other participants and they have nothing in common to talk about. Moreover, Case A explained that interaction between participants made him confused about his medical statement, ‘I just thought everyone who have prostate cancer would be the same condition as me. But when I asked others, they said they didn’t take any medicine after surgery. But I was told if I am not taking medicine, I will get worse… I’m afraid is there something wrong in my surgery … these people all got better after doing surgery. But I’m not all done. When you have cancer cell, you do surgery, and if you don’t take medicine for hormone therapy medicine, you will get worse. I don't know if medically there’s something wrong in my surgery” (Case A, 74 years old).

9.3. Outcome Experienced Through Program

We asked all participants of supervised exercise group to tell us about any physical or psychological feeling they experienced after termination of this program.

Case A expressed that strength in his legs got improved that he felt positive changes in walking and going upstairs, 'I feel my legs getting a little lighter. Before, when I was walking my leg was heavier... that time, I was living in 3rd floor. Always I grabbed the barre for helping me going upstairs. But nowadays, I keep on doing exercise, after doing exercise I now became a person who go upstairs without helping barre. Because I my legs got strengthen. I told you, nowadays, I keep doing exercise for 2 hours every day. So that's why my legs getting better' (Case A, 77 years old).

Case B and D did not feel a special difference in lower body strength however following statements are mentioned, 'I feel I got better' in going up/down stairs. Nevertheless, he believed exercise with elastic band was helpful for him, 'We did shoulder workout, with elastic band. It seems it helped me somehow' (Case B, 81 years old). 'well, I don't have any special feeling, but I think it helped me with flexibility' (Case D, 77 years old)

Case C emphasized psychological outcome of exercise is in priority for him. 'Sometimes I experience mental breakdown… I think this exercise program might have effect, because I was able to concentrate for an hour… and my heart

rate was originally from 90 to 100. But it reduced to 75~80. I'm so happy. That's means my heart got stronger, right?' (Case C, 60 years old).

V. DISCUSSION

In this control-supported case study, we suggested for the first time that 8-week strength and balance training twice a week improves bone mineral density, physical functioning performance, dynamic balance as well as self-reported balance confidence, fatigue and QOL in PCa men receiving ADT. Although recently increased risk of falls in PCa patients fallowing ADT has been taken into consideration (Bylow et al., 2008; Winters-Stone et al., 2017; Wu et al., 2016), yet there is no tailored fall-prevention exercise program for this population.

Prior studies determined the effects of either short- or long-term SBT program on balance, mobility, falls among cancer patients and healthy older adults (Clemson et al., 2012; Hauer et al., 2001; Tofthagen, Visovsky, & Berry, 2012). The evidence implies that ADT decreased BMD and it is detrimental to bone health (Owen et al., 2017) thus, increased risk of fractures is plausible in this population (Bylow et al., 2008). But little is known about proper exercise program which preserve bone health of ADT patients. Increased BMD following a twelve-week exercise intervention with resistance have been observed in sarcopenic elderly women (S. W. Huang et al., 2017) which also supports use of resistance band in our exercise protocol to have the potential to turn over negative effects of ADT on bone mineral density in PCa patients (Figure 10F). Except examining bone health, clinical assessment of fall risk factors such as functional performance and gait are often quantified in older population (Mion et al., 2012). With regard to intrinsic fall risk factors,

functional ability was the main focus of a number of studies (Rajagopalan et al., 2017). In this study we observed a slight improvement in functional limitation through FMS test of exercise participants (Table 5), while the score of SPPB which is wildly used for evaluating lower extremity function in older adults did not differ with control subject (Table 6). We assume that might be due to physically active lifestyle of our subjects which were greater than physical activity recommendation for older adults, therefore their respond to SPPB test before starting the intervention was quite higher that older age population (Lauretani et al., 2018; Riebe et al., 2018). Regarding to dynamic balance domain of functioning performance we asked subjects to perform TUG and 6-m backwards walk which are commonly-used tasks in older adults and cancer population and we used data of patients' self-reported FES-I questionnaire to assess fear of fall and balance confidence (R Orr, 2010; Williams et al., 2018). Similar to results of our study which indicate improvement of balance (Figure 11), De Bruin, E. D. and K. Murer study also demonstrated the effectiveness of 12 weeks of SBT to improve dynamic posture balance on older adults (Gusi et al., 2012). Notably, fear of falling has been shown to be associated with negative consequences such as avoidance of activities of daily living, falling, depression, and lower QOL which also improved in participants of SBT group of our study (Figure 12) (Rajagopalan et al., 2017).

In this study we could not find similar tendency in subjects of SBT group in variables of lower muscle strength and power after the 8-week exercise program which was relatively a short period of intervention. It seems at least 12-weeks of strength training or combination of aerobic and strength training

is required to impact muscle strength in prostate cancer patients receiving hormone therapy (L. Bourke et al., 2011; P. Cormie et al., 2015; Galvao, Taaffe, Spry, Joseph, & Newton, 2010; R. J. Segal et al., 2003). Although the possible relation of muscle strength and balance performance in elderly have been documented, yet controversial. Several studies indicated no interaction of strength and balance by reporting less or no difference in strength between fallers and non-fallers (Oddsson, Boissy, & Melzer, 2007). So enhancement of functional and balance performance regardless of muscle strength might explained with possible improvement in sensory system such as neuromuscular, visual, somatosensory and vestibular (Oddsson et al., 2007) which gradually decreases with aging and therefore could affect statistic and dynamic performance (Lesinski, Hortobágyi, Muehlbauer, Gollhofer, & Granacher, 2015). Thus, we assume that our exercise program which contained postural control and stability exercise with less support, improved performance via improving postural control by challenging the alignment of the body's center of gravity with regard to base of support.

Our qualitative finding from this study illustrate beliefs of participants about adherence to exercise, social environments and barriers as well as experienced outcome through this intervention. All participants explained how they value being physically active and each one already had own weekly schedule of doing regular exercise. the majority mentioned using public fitness equipment in park and walking exercise as main part of their active lifestyle. However, lack of tailored training program did not allow them to take full advantage of exercise. Although clinical exercise prescription was the major

reason of participant to join this exercise program, it seems they do not have enough knowledge neither about cancer treatment adverse effect and nor possible effects of exercise. however, after participating in 8-weeks strength and balance training with the mean adherence of 95%, they expressed how encouraged they are to continue they program. While the period of exercise was not long, participants described that after they felt improvement in muscle strength, flexibility and fatigue in favor of our exercise program. According to their opinion, it was easier for them to follow workouts accompanied with other patients, while they believed they cannot do the same exercise program alone. Whereas, homogeneity in group exercising seems important for social wellbeing. Age gap and difference in method of cancer treatment were emphasized as a barrier for subjects to make a fair social connection through this program.

In this study we used resistance band which is a comfortable and convenient equipment of training for elderly. However, due to short period of intervention we could not indicate the effects of training method in muscle strength. Further studies with large sample size and longer period of intervention should apply this type of multicomponent training to conclude the effect on muscle health. A follow-up study after the period of exercise also is necessary to see the effects of intervention on reducing rate of falls. In fact, several studies reported that exercise can improve individual frailty components, but we do not yet know what type of exercise can be more beneficial to reduce overall falls status in PCa on ADT. Optimal time and duration of exercise training to prevent falls in PCa is also another issue that still is not confirmed.

VI. CONCLUSION

The results of our study indicated that the 8-weeks SBT with resistance band improved bone mineral density, physical functioning performance, dynamic balance as well as balance confidence and fatigue but not adequate to effect muscle mass and strength of PCa men undergoing ADT. This training program might be an efficient and practical approach to minimizing falls component in prostate cancer men with ADT and reducing the future health-care costs associated with falls.

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ABSTRACT (Korean)

논문 초록

전립선 암 생존자들은 안드로겐 박탈 치료를 받은 후 가속화된 생리적 변화로 인해 낙상의 위험이 있다. 따라서, 치료 후 전립선 암 생존자들은 후속 치료가 필수적이며, 이는 낙상으로 인한 부상의 높은 의료 비용을 예방할뿐만 아니라 삶의 질을 유지하고 더 오래 살 수 있도록 도와줄 수 있다. 현재까지 진행된 연구들은 노인의 낙상 위험, 균형 및 신체기능에 대한 운동 중재의 효과에 중점을 두어 진행되어왔다. 그러나 아직까지는 전립선 암 환자의 낙상 위험 요인을 줄이기 위해서 어떤 유형의 운동이 가장 효과적인지에 관한 연구는 진행된 바가 없다.

본 연구에서는 최초로 균형자신감, 신체수행능력 및 근골격 상태와 같은 낙상 예측지표의 주요 구성 요소에 미치는 영향을 탐색하기 위해 저항성 및 평형성 운동 프로그램의 효과를 보고하고자 한다. 이를 위해 센터에서의 저항성 및 평형성 운동 프로그램을 8 주 동안 일주일에 두 번씩 실시하였고, 전립선 암 환자 4 명의 근골격계 건강, 신체수행능력, 동적균형력, 균형자신감, 피로 및 삶의 질을 비교하였다. 운동 중재 후, 골 밀도,

functional movement screen 점수, 뒤로 걷기와 timed-up and go 검사에서는 수행 시간이 개선 되었을 뿐만 아니라, falls efficacy, functional assessment of chronic illness therapy 와 같은 피로 관련 설문조사의 결과가 향상되었지만; 하체 근육 질량과 기능은 유의한 차이가 없었다.

따라서 저항성 및 평형성 운동은 안드로겐 박탈치료를 받는 전립선암 환자들의 낙상 위험 요소를 최소화할 수 있으며, 장기적으로는 의료 비용을 줄이기에 효율적이고 실용적인 방법일 수 있다.

주요어: 노인환자의 항암치료, 암 치료, 생존자, 낙상, 위험 요소

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