CHAPTER 5

DISCUSSION

This study evaluated the effects of knee educational program on knowledge of knee care, average knee pain, pain-free knee extension and leg strengths, knee functional ability, and quality of lifting in Thai national weightlifters with knee pain. All outcome measures except quality of lifting were significantly improved over the 12-week study period (p<0.0167). A developed knee educational program was specifically designed for Thai national weightlifters with knee pain. This program used a holistic approach. Thus, the contents of the program included both lecture and practical classes, which covered various important aspects of knee care. The program was mainly delivered by the physiotherapist. In addition, the sport medicine physician and the sport psychologist also participated to deliver the educational program to the participants. The effects of knee educational program on each outcome measure were discussed below.

1. Improvement in knowledge of knee care

The results of this study support the hypothesis that knee educational program significantly increased knowledge of knee care. The knowledge of knee care as determined by the knowledge questionnaire at the end of the intervention period (week 8th) and 12-week follow-up were significantly increased from the baseline (p=0.003). However, the knowledge of knee care did not significantly alter during the time interval of week 8th and week 12th (p=0.157). This finding demonstrated that the knee educational program led to an improvement in knowledge of knee care among

Thai national weightlifters with knee pain over the 8-week intervention period. Such improvement could even be maintained 4 weeks after the intervention ended (follow-up at week 12th). However, these results should be interpreted with caution, because only 7 participants (out of 11) could maintain the knowledge scores throughout the follow-up period. The knowledge scores of 4 remaining participants slightly decreased from week 8th to week 12th. This indicates that at 4 weeks after the completion of the knee educational program, some participants could not maintain their knowledge scores.

The improvement in knowledge of knee care indicated that the participants appropriately understood the contents included in the educational program for both of lecture and practical classes. It was possible that during the 8-week intervention period, the participants often applied the knowledge for self-management. Thus, they had more understanding of knowledge of knee care practically. During the follow-up period, the participants usually reviewed the contents of knee educational program contained in a booklet, which could be a reason for maintaining the improvement in knowledge of knee care throughout this period. In addition, the knowledge was not forgotten because the participants continued to use the knowledge for self-management and practise the exercise on their own even after the end of an intervention.

High level of exercise compliance (87.01%) in the present study implies that the participants performed the exercises continuously during 8-week intervention period. Although the exercise compliance during follow-up period was not monitored, most participants verbally reported that they performed the exercises continuously throughout the follow-up period. Many researchers (15, 18, 56)

suggested that experiencing the benefits attainable from exercise program allowed the participants to be self-motivated to change behavior and therefore be more compliant long-term. The finding of the present study seems consistent with this notion. For example, as participants progressed their exercise level over the 8-week intervention period, most had a reduction of pain, improved well-being and feeling of accomplishment that motivated them to continue.

2. Improvement in average knee pain

Average knee pain as determined by 100 mm VAS showed a trend toward significant decrease after 8 weeks of the intervention program (p=0.027). However, the VAS scores significantly decreased by 31.39 mm from the baseline comparing to the data at the 12-week follow up (p=0.005). Bird and Dickson (57) reported three ranges of pain intensity that the patients with initial pain VAS scores of less than 34 mm, between 34–66 mm, and equal to or greater than 67 mm, the minimal clinically significant change in pain severity were 13 mm, 17 mm, and 28 mm, respectively. Therefore, the change of knee pain intensity in this study was considerably to be both clinical and statistical significances. However, when considering the pain intensity of individual data from baseline to week 8th, the decrease in VAS scores seemed to be small. Therefore, the clinically significant decrease in average knee pain during the baseline to week 8th should be interpreted with care.

The clinically significant improvement in average knee pain was also supported by the significant improvement in functional outcome measures such as knee functional ability VISA scores over the 12-week study period. This suggests

that the improvement in average knee pain in the present study was able to improve the knee function of the participants.

Duration for significant changes in primary outcome measures was one of interesting issues. The results of the present study differed from those of previous studies (15, 18), which examined the effects of knee educational program in patients with knee osteoarthritis. The most recent study by Coleman et al (15) found that participants who attended 6 educational sessions (one 2.5-hour session per week) showed a significant improvement in pain from baseline to week 8^{th}. It seemed to indicate that the significant improvement in pain in this thesis study appeared to be later than that of the previous study by Coleman et al (15). Such differences in the findings may be due to differences in participant populations and their daily activities. Participants in the present study were weightlifters, whereas participants in Coleman et al study were non-athletic population. Athletic lifestyle is quite different from the sedentary participants in that the athletes have to train strenuously everyday with more load bearing on the knee joints. This contributing factor causes long lasting effect of pro-inflammatory markers in plasma and surrounding soft tissues (58). In contrast to the sedentary participants, they do not have much aggravating activities and take more time of rest.

When compared with the previous studies, which examined the effects of eccentric exercise program, the finding of the present study differed from that of the recent study by Boling et al (43), which showed that using lunges, step downs, and squats as part of weight bearing exercises during 6 weeks of rehabilitation program for patients with patellofemoral syndrome could significantly decrease VAS scores after 4 weeks of rehabilitation. Difference in participant populations between these

two studies might account for this recovery. For example, the participants in the present study were athletic population, whereas the participants in the study by Boling et al were non-athletic population. However, the finding of the present study was consistent with that of many previous studies (48, 59, 60) which showed a significant reduction in pain in athletes with patellar tendinopathy who completed a 12-week eccentric exercise program. Conversely, the study by Visnes et al (61) found that a 12-week eccentric training program did not show any effect in athletes with patellar tendinopathy. This discrepancy was likely explained by differences in exercise program. In this thesis study, the eccentric exercise program included squats, lunges, and step downs, whereas the eccentric exercise program in Visnes et al study (61) only consisted of squats.

Because knee educational program in the present study included 2 main components (i.e., exercise, and participant education/self-management interventions), the significant improvements in pain may be due to the effects of applying the knowledge to use for self-management and also a cumulative effect from the exercise program. Because the knee educational program in this study used the holistic approach, the participants received knowledge, which covered all aspects of knee care (both physical and psychological dimensions). Thus, they could self-manage their condition effectively. For the physical dimension, participants were taught methods for basic self-care or treatments of knee injuries such as hot and cold therapy, taping and bandaging, ADL adjustments (avoiding positions or activities that aggravated their symptoms), stretching, and eccentric exercise program. For the psychological dimension, participants were taught strategies for cognitive symptom management such as distraction, guided imagery, and relaxation techniques. The use of these

methods and strategies for self-management may contribute to the reduced pain levels reported by the participants in the present study.

The effects of eccentric exercise program in this study could also contribute to the improvement in knee pain. This program consisted of stretching and eccentric exercises. Thus, this exercise program could lead to the improvements in strength and flexibility of various structures around the knee (11, 33, 37). Such improvements helped to restore normal muscle balance and biomechanics of the knee, resulting in good clinical results such as reduction in pain and prevention of recurrent injury (11, 14, 43). Previous studies (37, 43) showed that eccentric knee exercises, particularly squats could improve strength of VMO, leading to the improvement in vastus lateralis and VMO onset timing differences. This improvement had a meaningful effect on knee kinematics by improving patellar tracking on the femur and thus reducing pain caused by abnormal tracking. Based on previous studies (11, 14, 33, 37, 43), improvement in strength of hip abductors and adductors, and hip external rotators, which are normally dysfunction in anterior knee pain, and also improvement of muscles surrounding the knee by the effects of eccentric exercises such as squats, forward lungs, and step downs could also contribute to the improvement in pain and functions. In the present study, self-stretching that was performed before and after each training session could result in the improvement in flexibility of quadriceps, hamstrings, calfs, hip flexors, piriformis, ITB, and lateral retinaculum that normally inflexibility and/or tightness in anterior knee pain (11, 37). For the tendinosis, eccentric exercises may enhance the mechanical properties of the degenerative tendon. The findings from a recent study (62) suggested that eccentric exercises may increase the mass of the tendon because of the enhanced deposition of Type I

collagen. Therefore, eccentric exercises may serve to strengthen the tendon and protect it from subsequent overuse. Some researchers (63) proposed that eccentric exercise may be possibly associated with changes in metabolism of certain substances in the tendon causing alteration in pain perception from the tendon. For the neovascularization that also associated with tendinosis pain, eccentric exercises may halt the growth of new blood vessels in tendinosis and subsequently minimize the pain (44, 64). Recent evidence (65) reported that intermittent hydrostatic pressure evaluation in healthy tendon may increase the production of anti-angiogenic factors, therefore help to limit the growth of new vessels. Limiting the growth of neo-vessels may eliminate the increased blood flow that could reduce tendon degeneration and ultimately strengthen the structure. In addition, eccentric exercise immediately increases water contents and/or hyperemia in tendon with tendinosis (66), which may also activate the expression of anti-angiogenic factors (65).

3. Improvements in pain-free strength outcome measures

The pain-free strength outcome measures in the present study included pain-free knee extension strength, and pain-free double legs and single leg strengths. The results of the reliability study showed that the values of the $ICC_{(3,3)}$ for the measurement of the outcome measures used in this present study were acceptable ($ICC_{(3,3)} \geq 0.89$) which was considerably acceptable reliability of the measurement under the test-retest conditions (67). The SEMs values for these measurements were also minimal indicating (SEMs were less than 5%) that the errors of the measurements were considerably low.

All of the pain-free strength outcome measures showed trend toward a significant increase over the 8-week intervention period ($p \leq 0.026$). At 12-week follow-up, these outcome measures significantly increased from the baseline measure ($p \leq 0.014$). Such improvements were consistent with those of VAS and VISA scores. This result confirmed the findings by Frohm et al (68) who reported a significant increase in knee extension strength over the 12-week eccentric training program in athletes with knee pain. However, the results of the present study differed from those of Bahr et al study (47), which showed that at 6 and 12-month follow up, leg extension strength in patients with patellar tendinopathy who participated in the eccentric exercise program for a minimum of 12 weeks was significantly increased from baseline data. One reason for such differences in findings might be due to the difference in frequency of assessments. In the present study, leg extension strength was tested at baseline (week 0) and again after 8 and 12 weeks, whereas the study by Bahr et al did not reassess this outcome measure until 3 and 6 months after starting the program.

In the present study, the strength values were obtained from the pain-free knee extension, and leg strength tests. Therefore, a decrease in pain may be one of possible mechanisms for the improvements in the pain-free strength outcome measures. If participants experienced less pain during the follow up assessment, they were able to generate greater muscle force during the pain-free strength tests. Strength gain from the eccentric and plyometric exercises might be another explanation for the improvements in these outcome measures (11, 51, 52, 54, 68).

4. Improvements in functional outcome measures

The functional outcome measures in the present study consisted of knee functional ability and quality of lifting.

4.1 Knee functional ability

Knee functional ability as determined by VISA questionnaire showed trend toward significant improvements immediately after completion of the intervention (week 8th) in comparing to baseline values (week 0) (p=0.038). At 12-week follow-up, the VISA scores significantly improved from baseline (p=0.001). Such improvements were consistent with those of average knee pain VAS scores, and pain-free strength outcome measures.

In the present study, changes in VISA scores were observed in all individual questions, excepted the question numbers 1, 3, and 8. In each of these questions, participants had maximal scores (10 points) at any assessments of study. It was likely that these questions had the ceiling effect and did not affect knee functional ability in this athlete population. For the remaining questions, greater changes in VISA scores from baseline to week 12th were found in the question numbers 2, 4, 5, and 6. This demonstrated that these questions were highly sensitive to detect changes in knee functional ability in the participants of the present study. In contrast, in the question numbers, change in VISA scores from baseline to week 12th was minimal indicating the less sensitive of this question in detecting the changes of knee functional ability in weightlifters with knee pain.

Because there has been no research that investigated the effects of knee educational program in athlete populations, the present study was the first study that used the VISA questionnaire to assess the effects of knee educational program on

knee function among weightlifters. The significant improvement in VISA scores demonstrated in the present study agreed with the findings of the previous studies (48, 59, 60, 68) that investigated the effects of eccentric exercise program in athletes with knee pain. Many previous studies (48, 59, 60, 68) reported the significant improvement in VISA scores in athletes with patellar tendinopathy who participated in the 12-week eccentric exercise program. The improvement in knee function might be due to the reduction in pain and improvement in pain-free strength variables that participants reported. In contrast, a recent study by Visnes et al (61) showed there was no effect on knee function as determined by VISA questionnaire from a 12-week eccentric training program in athletes with patellar tendinopathy. Such differences in the findings might be a result of the difference in exercise programs. The eccentric exercise program in the study by Visnes et al (61) only consisted of squats, whereas the eccentric exercise program in the present study consisted of squats, forward lunges, and step downs.

4.2 Quality of lifting

The results of this study showed a trend of improvement in the quality of lifting (i.e., average and worst pain during lifting, and the numbers of painful phase of lifting) over the 12 weeks of study period. These findings seemed to imply that the quality of lifting might be less sensitive than other outcome measures (i.e., knowledge of knee care, VAS scores, pain-free strength outcome measures, and VISA scores) in detecting effects of knee educational program in Thai national weightlifters. It was also likely that the short study period of only 12 weeks might be not enough to detect changes in quality of lifting. Greater improvements in this outcome measure would be possible with a longer study period.

5. Participants' satisfaction with knee educational program

The participants' satisfaction with knee educational program was evaluated using the satisfaction questionnaire. The result showed that after completion of the 8-week intervention period, all participants rated the levels of satisfaction in each item as very high to high levels. It indicated that this knee educational program was highly suitable to provide the beneficial effects such as the trend toward significant improvements in all outcome measures during 8-week intervention period. The contents included in this program were considerably suitable to use as self-management for their conditions. In addition, the time during 8-week intervention period, the follow-up visits from researchers, and the materials and booklets were also helpful. Thereby, participants were highly satisfied with knee educational program.

The high level of satisfaction with knee educational program was consistent with the high exercise compliance. It suggested that this high satisfaction level might be a reason for the participants to keep performing the exercise program continuously throughout the study period. In addition, the improvements in all outcome measures in this study supported the high level of satisfaction with knee educational program.

6. Conclusions

In summary, this thesis study demonstrated that an 8-week knee educational program with 4-week follow up could provide the beneficial effects in Thai national weightlifters with knee pain. All outcome measures (i.e., knowledge of knee care, average knee pain, pain-free knee extension and leg strengths, and knee functional ability) except quality of lifting were significantly improved over the 12-week study period. However, a trend of improvement in quality of lifting over the 12-week study

period was also observed. The satisfaction questionnaire also reflected that the participants highly satisfied with the knee educational program. Therefore, this developed knee educational program can be used as part of management programs for excellence and success of Thai national weightlifters. Moreover, this program may be applied to junior weightlifters and other athletes, who encounter with knee pain.

7. Limitations and suggestions

Although, this is the first study to evaluate the effects of knee educational program in Thai national weightlifters, some points may be considered as limitations in the study.

1. There was no control group, who did not receive knee educational program, for comparison in the present study because there is limited by a number of elite athletes in this kind of sport. To overcome this limitation, we also evaluated the stability of participants' symptoms of knee pain during 4-week interval before starting the knee educational program. The data showed that the participants did not display a sign of natural recovery in their symptoms over this 4-week interval. This finding may suggest that the knee educational program may play an important role for an improvement in outcome measures over the 12-week study period.

2. For long-term evaluation, the follow-up interval should be further applied regularly beyond 4 weeks after program ended (12-week follow up). Whether or not a greater improvement in the outcome measures can be attained if study period is extended remains unknown.

3. Even though, most participants verbally reported that they continued to practice the exercise even after the program ended, the exercise compliance during

follow up period should be systematical examined to confirm the adherence of the studied program.

4. Further studies in the form of multi-centers randomized-controlled-trial (RCT) with a larger number of sample size and longer follow-up periods should be considered to support and further explore the findings of the present study.