CHAPTER V

DISCUSSION

5.1 Introduction

This study investigated the EMG activity of RA, EO, and TrA/IO during AH in crook lying, prone lying, four-point kneeling, and wall support standing positions. This aimed to determine whether there was any significant difference in the EMG activity among the three abdominal muscles in each starting position; and to determine whether there was any statistically significant difference in the EMG activity of each muscle among four different starting positions.

5.2 Comparison of EMG activity recorded from three abdominal muscles in each starting position

This study showed significant differences in EMG activity of three abdominal muscles in all four starting positions. The highest EMG activity was always found in TrA/IO with minimal EMG activity in EO and RA. Approximately 20 to 30 percent of MVC was demonstrated in TrA/IO while the associated EMG activity of EO and RA was less than 6.5 percent of MVC (Table 4.3). The muscle activity of TrA/IO is within the range of low load activity that approximately 25 percent are benefit for the specific stabilization exercises (Richardson and Jull, 1995). These results suggest that these four starting positions are appropriate for performing AH. They encourage contraction of local muscles with minimal contribution from global muscles. This supports previous studies that recommended the use of these four positions in the early stage for practicing AH (Norris, 1999; O'Sullivan, 2000; Richardson et al., 2004).

5.3 Comparison of EMG activity of each muscle among four different starting positions

Only the TrA/IO showed significant differences in mean EMG activity among four different starting positions. The EMG activity of RA and EO was not significantly different among the four starting positions. These results imply that the EMG activity of TrA/IO varies with starting position while the starting position has no effect on RA and EO.

The highest mean EMG activity of TrA/IO was shown in prone lying position. This was followed by the mean produced in crook lying, wall support standing, and four-point kneeling positions, respectively. The higher TrA/IO EMG activity in prone lying position than in four-point kneeling position is consistent with previous study that used a similar testing protocol (Beith et al., 2001). The differences in TrA/IO EMG activity among these four positions might be explained by the differences in the amount of support provided in each position. In prone lying position, whole body of the participants was fully supported on the plinth so that their postural muscles could be relaxed. More concentration can be placed on the contraction of TrA/IO. Although, in crook lying position, a similar support was also provided, the participants needed to control their hips and knees in flexed position which might decrease their ability to concentrate on the contraction of TrA/IO. However, the difference in the EMG activity of TrA/IO between prone lying and crook lying positions was not significant. In wall support standing position, the trunk of the participants were partially supported by the wall. The TrA/IO muscle fibers were arranged horizontally in which the gravity and the weight from abdominal contents had negligible effects of the muscle function. In four-point kneeling position, the spine was not supported. The neck, shoulder, hip, and trunk muscles were activated to control this posture. This would cause the TrA/IO to contract with some difficulties. However, the difference in the EMG activity of TrA/IO between wall support standing and four-point kneeling positions was not significant. This supports the recommendation by Norris (1999) that these two positions could be used interchangeably for early training of AH.

There are no significant differences in TrA/IO EMG activity between prone lying and crook lying; between crook lying and wall support standing; and between wall support standing and four-point kneeling positions. Since there has been no study that investigated the EMG activity of abdominal muscles during AH in wall support standing position, no comparison could be made between the findings of this study with previous studies. The non-significant difference in TrA/IO EMG activity between prone lying and crook lying is inconsistent with the study by Urquhart et al (2005). The researchers reported a significantly higher EMG activity of TrA/IO in crook lying position than in prone lying position. This conflicting result may relate to the set up of the prone lying position used in the previous study. The participants were asked to lie prone with two boxes supported at xiphisternum and pubic symphysis in order that their abdomens would not contact with the plinth. The prone lying position in the previous study would therefore be considered closed to a four-point kneeling position. In such condition, the result of the greater EMG activity of TrA/IO in crook lying position than in four-point kneeling position in this study supports the previous study.

Mean EMG activity of RA ranged from 1.35 to 2.09 percent of MVC was always presented during AH (Table 4.3). This is in line with previous study that reported nearly zero activity of RA during AH in prone lying and four-point kneeling positions (Beith et al., 2001). However, it was revealed that the starting position had no significant effect on RA ($p = 0.746$). The reason for the relatively low RA EMG activity in these starting positions might be due to the fact that these positions were not in full weight-bearing positions. In crook lying and prone lying positions, the spine and pelvis were fully supported on the plinth. In four-point kneeling position, the spine and pelvis were aligned horizontally and not against the gravity. The TrA/IO was sagged by the gravity, consequently this might activate muscle stretch receptors which would increase the excitability of the motorneurone pool of the TrA/IO (Beith et al., 2001). Therefore, this decreases need to recruit RA in this position. In wall support standing position, the spine and pelvis were partially supported against the wall. Thus, the RA is not required to function in these positions.

Likewise, the mean EMG activity of EO ranged from 4.52 to 6.28 percent of MVC was found in all four starting positions during AH (Table 4.3). The EO EMG activity in this study was less than 30 percent of TrA EMG activity. The relatively low EO EMG activity in these starting positions might be explained by the results of RA that function as a global muscle.

5.4 Inhibition and isolation of abdominal muscles in four starting positions

Apart from the high activity of local muscles, one essential criterion that determines the effectiveness of AH is the isolation of local muscles (Richardson and Jull, 1995). In other words, the inhibition of global muscles (RA and EO) is also need to be considered. In all four starting positions, more participants could inhibit RA EMG activity better than EO EMG activity (Figures 4.4A and 4.4B). More than 60 percent of participants could at least one of the three trials perform AH with no contribution from RA. More than 75 percent of participants could never perform AH without contribution from EO. This difference in the inhibition of RA and EO might relate to the differences in the anatomical attachment between these two muscles. Both EO and TrA/IO share the same fibro-osseous attachments in that they attach to the costal cartilages, the thoracolumbar fascia, the iliac crest, and the pubis (Moore and Dalley, 1999). As a result, these two muscles can function to flatten the abdomen during AH. Independent activation of TrA/IO from EO may therefore be difficult. This supports previous finding that the eliminating of activity in EO is more difficult to achieve (Beith et al., 2001). In contrary, RA shares much less the same fibro-osseous attachments with TrA/IO (Moore and Dalley, 1999). The independent activation of TrA/IO from RA may therefore be easier.

This study found no differences in the proportion of participants who could always inhibit RA while performing AH in all four starting positions. Nevertheless, different results were found for those who could sometimes and never inhibit RA. More participants could sometimes inhibit RA in prone lying and four-point kneeling positions than in crook lying and wall support standing positions. Much less participants could never inhibit RA in prone lying and four-point kneeling positions (Figure 4.4A). This supports previous study which rarely found EMG activity of RA during AH (Beith et al., 2001). Relatively greater proportion of participants who could never perform AH without contribution from RA was found in crook lying and wall support standing positions. In regard to the inhibition of RA, these results suggest that prone lying and four-point kneeling positions are superior to crook lying and wall support standing positions.

Similar proportion of participants could 'always', 'sometimes', and 'never' inhibit EO EMG activity during AH were found in all four starting positions (Figure 4.4B). More than 75 percent of participants could never perform AH without contribution from EO. These results suggest that none of these starting positions are superior to the others in inhibition of EO during AH. The position that almost 100 percent of participants found difficult to inhibit EO was the wall support standing position.

In regard to the isolation of TrA/IO during AH, almost no participants could always activate TrA/IO without contribution from both RA and EO. This finding is inconsistent with previous study that reported approximately 20 and 50 percent of participants could always activate IO in isolation from RA and EO in prone lying and four-point kneeling positions, respectively (Beith et al., 2001). Although the participants in this study could not keep their RA and EO silence during AH, the EMG activity of these muscles were kept at very low levels. For EMG activity of RA, it ranged from 0 to 5.07 and from 0 to 6.67 percent of MVC in the prone lying and the four-point kneeling positions, respectively. For EMG activity of EO, it ranged from 0 to 35.65 and from 0 to 29.17 percent of MVC in the prone lying and the four-point kneeling positions, respectively. On the other hand, in the previous study, the EMG activity of RA ranged from 0 to 0.9 percent of MVC in both positions. The EMG activity of EO ranged from 0 to 68.2 and from 0 to 46.7 percent of MVC in the prone lying and the four-point kneeling positions, respectively. The number of participants who could sometimes or never activate TrA/IO in isolation was similar across the four starting positions. The least effective starting position for isolation of TrA/IO was the wall support standing position.

However, it is recommended that the appropriate starting position for AH should facilitate the isolated activation of TrA/IO (O'Sullivan, 2000; Richardson and Jull, 1995). With this consideration, the results of this study suggest that the prone lying position is the most appropriate starting position for AH in the early stage. It allowed for more isolated activation of TrA/IO from RA and EO with the highest EMG activity and was the best position for inhibiting activity of RA. The next recommended starting position would be the four-point kneeling position. This is because it could facilitate isolated activation of TrA/IO from RA and EO with reasonably high EMG activity. The proportion of participants who could inhibit RA during AH was also high in this position. The crook lying position would be recommended next as relatively lower proportion of participants could inhibit RA during AH in this position. The wall support standing position would be recommended last. Most participants could never perform isolated activation of TrA/IO from RA and EO during AH in this position. This results support the suggestion from Richardson and Jull (1995) that proposed prone lying and four-point kneeling positions were suitable to train AH in early stage.

5.5 Limitations and further study

The present findings should be considered in light of a few limitations. First, this study used surface EMG electrodes to record EMG activity from deep abdominal muscles. Although the TrA/IO electrodes were aligned with TrA muscle fibers in this region (Marshall and Murphy, 2003), the recorded EMG activity represents EMG signals from both TrA and IO. However, this should not affect the results of this study which aimed to investigate the EMG activity of three abdominal muscles during AH in four starting positions. This is because both TrA and IO (lower fibers) are proved to function as local muscles that should be facilitated during AH (Marshall and Murphy, 2003).

Second, the crosstalk phenomenon in which the electrodes pick up activity from adjacent muscles might occur in this study. Anatomically, it is known that EO, IO, and TrA form layers in front of the trunk. Any surface electrodes that are attached on the anterolateral aspect of the abdomen would be able to pick up activity from these three muscles. However, the careful electrode placement in this study seemed to reduce this crosstalk phenomenon satisfactorily. This was shown as significant differences in the EMG activity recorded from EO and TrA/IO.

Last, all participants in this study were asymptomatic LBP. The presence of pain might alter the ability of participants to contract abdominal muscles. Consequently, the differences in the starting positions may cause the differences in the activation of the abdominal muscles. Further study in symptomatic LBP is therefore needed.