CASE STUDIES OF ASYMMETRIES IN SWIMMING

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An interrelated influence of strength, flexibility, anthropometric and technique asymmetries affects performance in swimming. Underpinning aetiologies include both acquired and inherited factors. The combination of factors varies among swimmers and therefore demands a multi-disciplinary case study approach to identify and correct asymmetries to improve performance and reduce incidence of injuries. The purpose of this presentation is to provide examples of analyses informing individualised interventions to correct asymmetries. Interventions comprise programmes of strength, flexibility, posture, and technique refinement. Analyses included measures of strength on the Biodex, measures of strength, posture, flexibility and anthropometry based on the International Society for the Advancement of Kinesiology (ISAK) conventions, and video-based qualitative and quantitative three-dimensional analysis of technique. Sample data of a breaststroke swimmer and a backstroke swimmer are presented to illustrate the interrelationships among strength, flexibility, posture, technique and performance.

KEY WORDS: swimming, asymmetries, technique, strength, flexibility, posture, performance

INTRODUCTION: Bilateral and antero-posterior asymmetries can arise from many different influences (see Sanders et al, 2011, for a review). Figure 1 provides a summary of the main categories of influences.

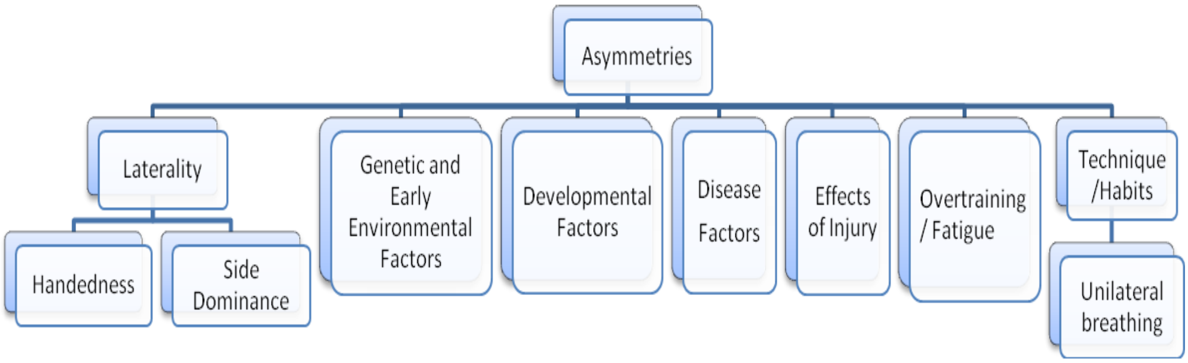

Figure 1: A Model of Factors Associated with Asymmetry in Swimmers

Swimming performance depends on optimsiation of propulsion within the physiological constraints of the swimmer and minimisation of resistive forces. Asymmetries can affect the swimming technique and performance via their effects on both propulsion and resistance as well as physiological economy (see Sanders, 2013 for a review).

While there are many infuencing factors it must be recognised that cause and effect are interlinked and that the asymmetry profile of a swimmer is changing dynamically. Indeed, a 'viscious cycle' among postural deficits, muscular deficits, and asymmetries (figure 2) demands regular monitoring of swimmers and adjustment of training regimens to ensure that asymmetries that affect performance are minimised. Therefore, diagnosis and remediation of asymmetries requires a multi-disciplinary approach involving biomechanics, anthropometry, strength and conditioning, and physiotherapy. Also, it is critial that the coach is involved in all of the data collection, diagnosis, and intervention processes.

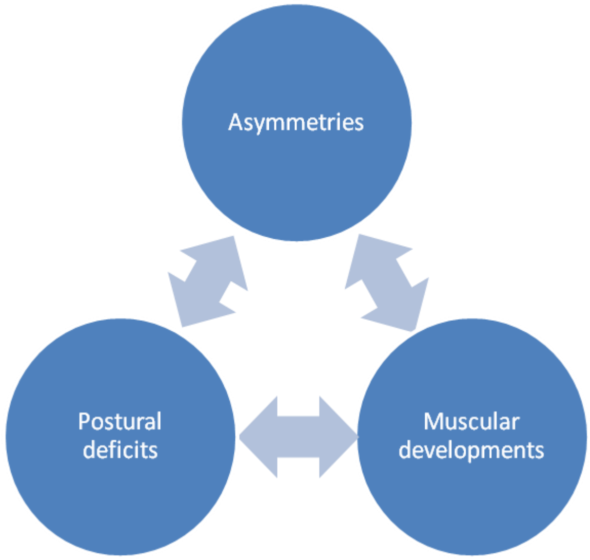

Figure 2: A ‘vicious cycle‘ cause and effect among postural deficits, muscular developments and asymmetry of swimmers.

METHODS:
Ten elite Scottish swimmers participated in a longitudinal study funded by sportscotland. The model in Figure 1 was applied to ensure that all relevant information about individual swimmers was collected. Consequently, a questionnaire was used to obtain information regarding laterality, side dominance and handedness, history of injuries, breathing side preference and percentage of breathing on each side during training. Anthropometric variables including limb lengths and girths and joint ranges of motion were measured in accordance with International Society for the Advancement of Kinesiology (ISAK) guidelines. Posture was assessed in terms of thoracic and lumbar angles in the sagittal plane, indicating kyphosis and lordosis respectively, applying the protocol established by Fairweather and Sidaway (1993).
Strength data for right and left shoulder flexion and extension, shoulder internal and external rotation and knee flexion and extension were obtained on a Biodex isokinetic dynamometer for 12 repetitions at 60 degrees and 180 degrees per second. Speeds, sides, and exercise order were randomised.
Video data were collected from front and side views above and below the water surface for qualitative analysis of a swimmer in a non-fatigued state. Data were also collected for subsequent three-dimensional analysis by four video underwater video cameras and two above water video cameras with their axes oblique to the axes of the three-dimensional calibration frame (Psycharakis, Sanders, and Mill, 2005) while the swimmers performed a fatigue set comprising four maximal effort 100m swims in their main competitive stroke.
The three-dimensional kinematic and kinetic analysis was based on a full body model of manually digitised landmarks using a bespoke MATLAB analysis program (Sanders, 2005). Body segment parameter data were obtained by PC software (Deffeyes and Sanders, 2005) applying the elliptical zone method (Jensen, 1978).
The longitudinal study comprises a pre-test, analysis, concurrent strength/conditioning, physiotherapy, and technique interventions, post-test, and second analysis with comparison to assess the effect of the interventions. Currently the pre-test and first analysis have been completed.

RESULTS AND DISCUSSION:

Given that every individual has a unique profile of asymmetries two case studies, a female breaststroke swimmer, and a male backstroke swimmer, are presented to illustrate the interactive nature of causes and effects.

Case Study 1

Descriptive data for Case Study 1 are provided in Table 1.

Table 1: Descriptive Data for Case Study 1.

Gender	Female
Age	21 yrs 11 months
Specialist events	50/100m Brst
Personal best	1.10.85 100m (LC)
Level	International – 3yrs
Injuries	L Intercostal, R ankle, L3 disk
Breathing (front crawl)	Right unilateral
Laterality	Right hand and foot

Strength, Flexibility, and Posture

The Biodex results revealed that this swimmer was stronger in the right shoulder than the left in flexion and extension. This could be linked to her right side dominance and also to the effects of left intercostal injury. The left knee was stronger than the right in flexion despite the right side dominance. This may be linked to the history of right ankle injury.

This swimmer had poor scores for lumbar extension strength and flexibility. She also had a large lumbar curve, which may result from the pelvis tilting forwards as a result of decreased hip flexibility.

Technique

This breaststroke swimmer had a slight lean to the right side and the left shoulder, hip, and lower limbs tended to be higher throughout the stroke than the right. The hand on the right side completed its pull prior to the left and led the left hand in recovery.

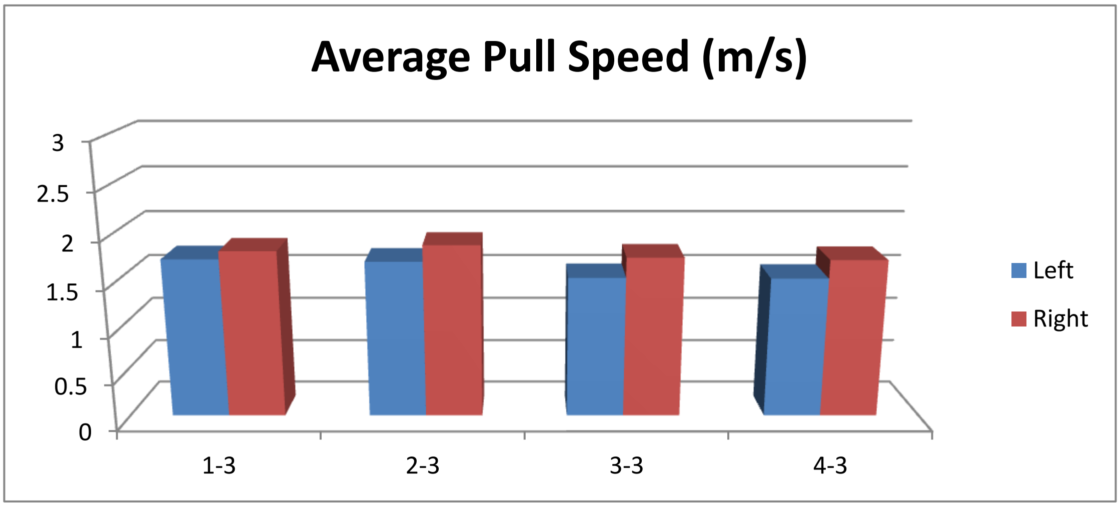

Figure 3. Average hand speed during the pull phase for the 3rd 25m of each the four hundred metre swims of the fatigue set.

This could be linked to greater strength on the right side and the left side intercostal injury. This possibility was reinforced by the results for average pull speed of the hand (figure 3) indicating that the right hand moved faster than the left. The imbalance of forces created yaw rotation (rotation about the vertical axis) of the trunk as shown in figure 4.

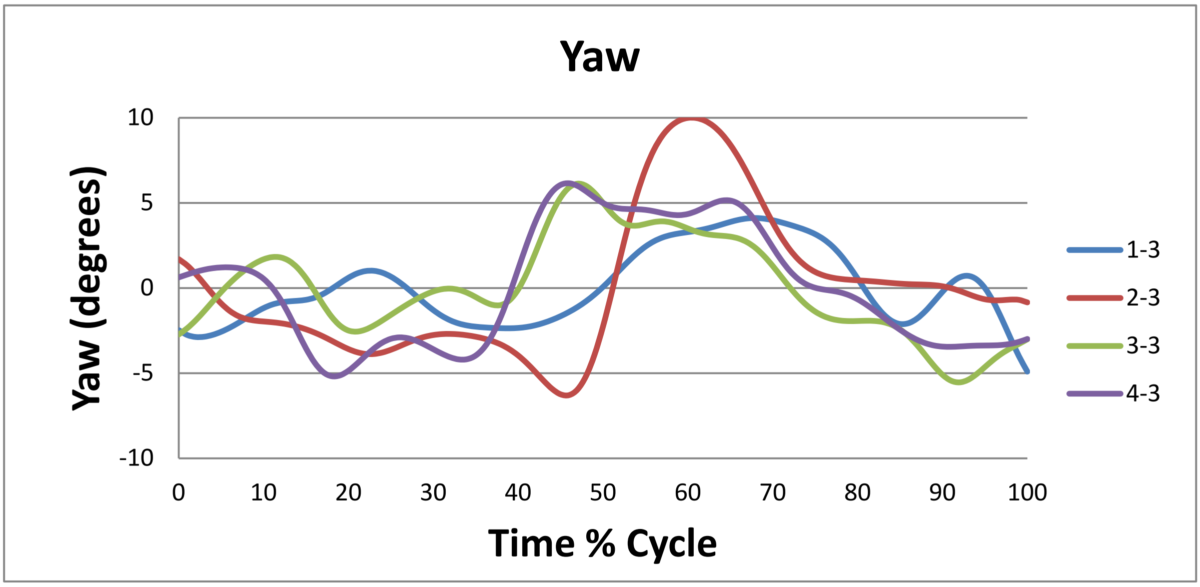

Figure 4. Yaw angle of the trunk for the 3rd 25m of each of the four hundred metre swims of the fatigue set.

It is likely that the yaw rotation affects streamlining and increases resistance thereby reducing performance. There was also a lack of hip extension to adopt a streamlined position during the glide phase.
Thus, the planned intervention includes strength and conditoning to correct the imbalances in shoulder and knee strength, strength and conditioning of hip and lumbar flexion and extension combined with flexibility exercises to correct muscle balance and pelvic orientation, and technique intervention to attain symmetry of hand path and speed during the pull.

Case Study 2
Descriptive data for Case Study 2 are provided in Table 1.

Table 1: Descriptive Data for Case Study 1.

Gender	Male
Age	21yrs 7 months
Specialist events	100/200 Backstroke
Personal best	54.88; 1.59.12
Relevant Injuries	Right shoulder impingement
Level	International - 8 years
Breathing side (front crawl)	Left; 50/50
Laterality	Left hand and foot

<u>Strength, Flexibility, and Posture</u>
The Biodex data indicated left side strength dominance in shoulder flexion and extension, shoulder internatl and external rotation, and knee flexion and extension. This swimmer had large thoracic curve and a large lumbar curve.

<u>Technique</u>
The technique was predominantly symmetrical enabling good maintenance of streamlined alignment. However, there was strong evidence that the left hand produced more force than the right. This corresponded to the left shoulder being stronger in flexion/extension and internal/external rotation measured on the Biodex.

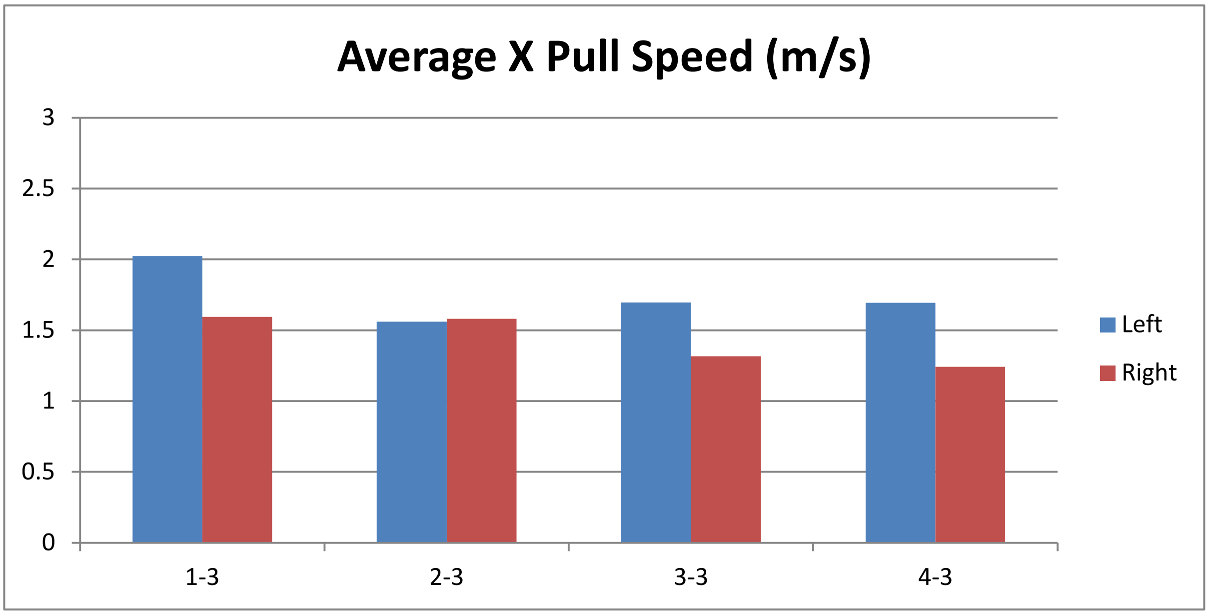

Figure 5. Average hand speed in the X direction during the pull phase for the 3rd 25m of each the four hundred metre swims of the fatigue set.

The imbalance of forces created a small yawing effect of the trunk as shown in figure 6.

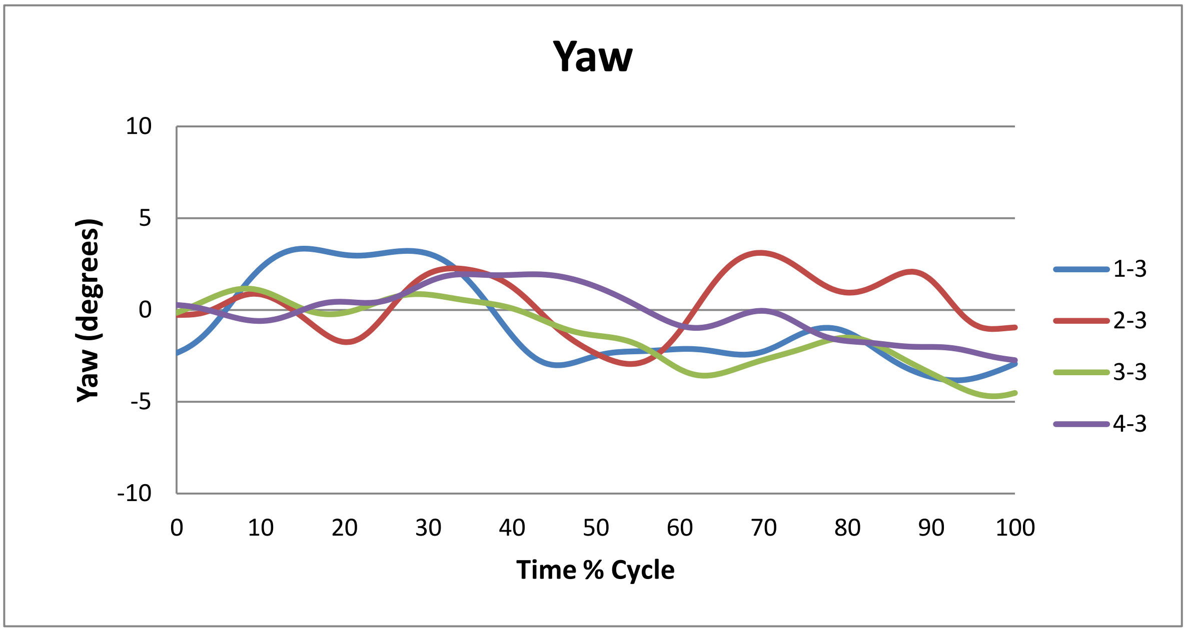

Figure 6. Yaw angle of the trunk for the 3rd 25m of each of the four hundred metre swims of the fatigue set.

The alternating pull of right and left hand produced small yawing effects as shown in figure 6. These effects were largely offset by the leg actions. The slight asymmetries in motion of the legs, required to counterbalance the uneven rotational effects of the left and right pulls, may have an effect on body alignment and resistive drag.

Thus, the internventions planned for thjis swimmer include strength and conditioning to improve bilateral balance of right and left shoulder strength, strengthening of shoulder extensor and external rotator muscles to improve anterio-posterior muscle balance, posture and reduce kyphosis, establishment of hip and lumbar flexor and extensor balance to improve posture and reduce lordosis. Technique will be monitored to ensure that yawing effects are balanced bilaterally to optimise streamlining throughout the stroke cycle.

CONCLUSION:

These two case studies have illustrated the interaction of strength, flexibility, posture, and technique asymmetries and their likely effects on performance in swimming. The results for the other eight swimmers in the study also revealed links between these factors. However, each swimmer had a unique combination of asymmetries.

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