Challenges with Deep Water and Lumbar Stabilization
Beth Scalone, PT, DPT, OCS

Deep water exercise provides distinctive benefits for rehabilitation of spine injuries. The greatest, being decompression of the joints leading to diminished pain and greater range of motion. In addition to the upward thrust of buoyancy responsible for the un-weighting of the joints, when immersed in the water one must control rotational forces. These forces vary the muscle activation required to maintain desired vertical position compared to muscles utilized in maintaining upright alignment against gravity. This alteration challenges the patient's neuromuscular timing and kinesetic awareness. These challenges of deep water exercise can be used to the patient's benefit with correct use of equipment and verbal cuing.

A person's center of gravity (COG) is located just anterior to the second sacral vertebrae and their center of buoyancy (COB) is located mid chest. According to Bougier's Theorem a body in water is subjected to both the force of gravity acting through the COG and the force of buoyancy acting through the COB. The body in the water will seek a stable equilibrium until the COB and COG are aligned. The body gain's this stability by rotating. Rotation can occur around the longitudinal or transverse axes or a combination of both. The length of lever arms will determine the amount of inertia and therefore the speed of rotation. What this means in terms of patient care is placement of equipment and position of the patient will influence the rotational force to either assist the patient or challenge the trunk muscles in sustaining vertical.

As on land you want a neutral alignment during deep water exercise. Following a plumb line in the sagital plane the head should be balanced with the ear over the shoulders, shoulders in line with the hips and knees and ankles directly under the body. The pelvis should be in neutral without excessive lumbar extension or flexion. Flotation equipment, patient strength and awareness all play a role in maintaining this position.

The first step is to choose floatation equipment. Multiple choices of belts, vests and cuffs are available. Depending on the shape of a belt the center of buoyancy can be altered a great deal. For example the original Aqua Jogger® has wide foam area along the persons back and narrower sides, this shifts the COB posteriorly and can leave a patient feeling as if the belt is pushing or rotating them forward. Patients with a larger chest or abdomen may benefit from this shaped belt to even out the buoyancy. Water Gear® sells an aqua trim belt that is tapered on the ends providing a more even distribution of the foam around the body. Hydro-Tone® has a longer rectangular shape often surrounding the waist equally, with small cut outs on the sides allowing for easier hip movement. There are dog bone shaped belts allowing more foam and buoyancy on the side and less at the lower back. The Hydro-Fit Wet Vest II has panels of floatation along the front and back providing equal floatation and minimizing the buoyancy push from the equipment. It is ideal for individuals with significant loss of trunk strength such as those with SCI. In addition you can an additional belt on top of the vest if the patient requires additional floatation support. No one belt does it all for all patients and clinics should have a variety to utilize in order to achieve proper alignment.

Additional equipment that can be used for adding flotation and increasing the difficulty of an exercise is the buoyancy cuff. Buoyancy cuffs come in different sizes and amounts of floatation proving an opportunity for progression. Buoyancy cuffs utilized at the ankles provide a great challenge for trunk stabilization in the deep water. By increasing the buoyancy of the lower limb the trunk and hip muscles are more active to maintain the ideal vertical alignment. As the patient performs exercises in which the limb moves away from center the rotational forces are greater. Care should be used when adding the cuffs, initiating smaller movements and using shorter lever arms when introducing the equipment until the patient demonstrates adequate stabilization with the new challenge. Prone and supine recovery is especially difficult with the cuffs at the ankle. If the feet are at the surface of the water the individual should be instructed to flex the knees towards the chest and reach arms out in front to assist in return to vertical and avoid excessive strain on the spine muscles.

To avoid injury to the shoulder complex adequate floatation is essential. The correct vertical position at rest includes the top of the patient's shoulder should be out of the water. This position allows movement of the arms at the surface of the water without exceeding 90 degrees of shoulder flexion and/ or abduction. Maintaining shoulder abduction greater than 90 degrees can cause compressive forces at the rotator cuff, placing the shoulder at risk for injury. Shoulder abduction with external rotation is recommended with movement greater than 90 degrees.

In addition to shoulder injury inadequate flotation can lead to compensatory patterns as the patient attempts to maintain head out of water position. The most common of these compensations includes increased tension through hand bars and shoulder muscles, breath holding or treading water. The primary problem with poor flotation support is interference with desired movement patterns where the patient is working harder to stay above water and not able to concentrate on the exercise.

Breathing influences the COB, depending on the amount of air held in the lungs. Cueing the patient on a specific breathing pattern can assist their movement. Utilizing the exhale for return to vertical and inhale to assist the body toward the surface allows the patient to move smoothly and gain control of movement through the water without excessive reliance on hand bars or other equipment. For example the pendulum exercise involves the patient to start in a T hang position with arms out abducted 90 degrees legs straight down. The patient swings the feet to the right while reaching left arm to the left without bending at the waist and keeping the body in the frontal plane. Having the patient inhale as they reach to the side and exhale as they return to vertical allows the patient to get the feel of the motion without struggling, twisting or overworking. As strength and coordination improves change the breathing pattern to challenge the patient.

Cuing is essential in deep water exercise. Proper cuing not only improves exercise performance but increases the patient's perceived value of the training. If one is told to jog in the deep water for 10 minutes and does not receive feedback is that patient receiving skilled therapy? Cues should be positive in nature, avoiding the "don't do"

phrase, instead provide direct "do" phrases and corrections. For example if a patient's feet are forward and they are flexed at the hips a poor cue would be "don't bend at your hips" this comment tells them they are performing the activity wrong but does not give them feedback on how to improve. A better cue would be" gently contract your buttocks bringing your feet underneath your body and your shoulders back".

Because of the altered kinesthetic awareness in the water, early in rehabilitation and when new exercises are introduced frequent and varied cues are required to obtain correct position. Common cues include:

- "Relax hands and shoulders"
- "Gently press heels toward bottom of pool"
- "Lengthen the back of your neck/ bring chin in"
- "Gently lift chest to bring shoulders back, keeping stomach muscles engaged."
- "Maintain upright spine with hips under your shoulders"

Although deep water and suspended exercise has many advantages not all patients will benefit. Additional care beyond the standard aquatic therapy precautions should be taken with hydrophobic patients and instability. Individuals with poor trunk control and muscle weakness are at risk for increased shearing forces caused by turbulence; therefore deep water should be delayed for patients who are early in the post operative phase, after a lumbar fusion and those who underwent multiple level fusions. Without weight bearing through the lower extremities joints with ligamentous injury or hypermobility such as individuals with SI joint instability often have a difficult time in deep water with lower extremities in open chain. For these patients shallow water exercise should be utilized until adequate stabilization of the trunk can be maintained.

The best way to combat the challenges of deep water is to experience the exercises yourself, feel how individual belts and other equipment alter your position and the exercise. Not only does this assist you in choosing equipment it will allow you to better cue your patients. Once the challenges of deep water exercise are overcome the possibilities are bottomless.

* Please note I am not endorsing the name brands of equipment mentioned, they are common brands therefore used for discussion on the differences shape makes in the floatation belt. There are many options and each clinic needs to make purchasing decisions based on their patient population and budget.