



USING FREQUENCY IN THE ODFS® PACE

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The ODFS®III had a fixed frequency of 40 Hz (40 pulses per second). This was chosen because it gave a nice rapid response to the stimulation and was effective at producing a withdrawal reflex. The ODFS®Pace has the option of choosing different stimulation frequencies and this can be useful in modifying the effect of the stimulation.

What is the effect of Frequency?

Electrical stimulation produces a muscle contraction by repeatedly stimulating the nerve that supplies the paralysed muscle. Each pulse of stimulation, lasting typically 200µs (200 millionths of a second) causes an action potential to travel down the nerve and cause a twitch contraction. Repeat the twitch soon enough after the first twitch and the force produced by the first twitch joins with the force of the second twitch. Keep repeating and a continuous contraction, also known as a tetanic contraction, is produced.

The faster the twitches are repeated, the more force is produced by the muscle because it is being made to do more work. The inevitable result of this is that the harder the muscle works, the faster it will fatigue. Hence higher frequencies of stimulation will fatigue muscles faster. Using a lower stimulation frequency will therefore cause slower muscle fatigue but because the twitches are further apart, the contraction produced may feel less smooth than the higher frequency and may require a higher level of intensity (pulse width or current) to produce the same contraction strength.

When stimulating the motor nerves the sensory nerves are also stimulated. These sensory nerves can be used to cause reflexes, the most common of which is the withdrawal reflex. This reflex consists of knee flexion, hip flexion and hip external rotation. When combined with the direct stimulation of dorsiflexors and everters, a better step may be taken, particularly by patients with raised knee extensor tone. Stimulation of sensory nerves can also have effects on the antagonistic muscles. For example, stimulation of the 1a nerve fibres from the muscle spindles may inhibit activity in antagonist muscle (reciprocal inhibition). However, stimulation of the 1b fibres from the Golgi tendon organs may cause a reflex in the antagonist muscle, opposing the desired movement.

Like the direct effect on muscles, changing the frequency will modify the effect of stimulation on sensory nerve fibres. For instance a high frequency may produce a better withdrawal reflex or cause the reflex slightly sooner. This is because a reflex may be caused by a cumulative effect from several nerve impulses (temporal summation). Higher frequencies may also promote greater reciprocal inhibition. However, we have had several reports that the movement of the ankle has been improved by using a slightly lower frequency and it can be speculated that this may be due to the effects on the 1b nerve fibres.

How should frequency be used?

In most cases the default setting of 40Hz is fine for most people. However, don't be afraid to experiment by making small variations to the frequency. Remember though, when increasing the frequency it is common for the overall contraction strength to increase. For this reason lower the current slightly and then set a new current level for each new frequency setting:

- If the patient may benefit from more knee flexion and a popliteal electrode position is being used, try taking the frequency up to 45 or 50 Hz

- If the amount of dorsiflexion reduced over a few minutes, try lowering the frequency. This may reduce muscle fatigue.
- If the ROM of ankle or knee is limited in walking by apparent high tone, try lowering the frequency. Some patients have reported this has produced a looser movement of the knee and ankle.
- For patients who have limited mobility and a generally poor response to FES, increasing the frequency may improve the response. This may be at the expense of muscle fatigue but enable sufficient mobility for short transfers.
- If a patient has consistent problems with skin irritation to the electrodes, minimizing the amount of stimulation may be beneficial. Try a lower stimulation frequency.