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TMA 02

**Compare and contrast the effectiveness of two recovery strategies.**

The two recovery strategies that will be compared and contrasted in this work are compression garments and massage. A range of academic and other materials will be considered to firstly assess the ways in which the respective strategies have been shown to influence recovery. Having examined each strategy any similarities or differences will be identified and discussed.

Before considering the two strategies it is necessary to consider what is meant by effectiveness in this context. Physical performance tends to improve with training (Lambert and Mujika, 2013) and programmes will generally include an element of overload. The result of overload can be physiological stress which will disturb homeostasis of the body. Some adjustments the body makes to maintain homeostasis will last only minutes after exercise; for example the heart rate or body temperature (Lambert and Mujika, 2013). Others may take much longer, for example muscle function may take weeks to return to pre-exercise levels.

One possible outcome of a training session or competition is exercise-induced muscle damage (EIMD) (Hill et al., 2014). EIMD includes a number of symptoms, increased feelings of soreness (Delayed onset muscle soreness DOMS), the appearance of intracellular proteins in the blood, reduced range of movement, reductions in muscle strength and decreased rate of force development. Since EIMD may last for several days and consequently prevent an athlete from training at the required intensity which can in turn negatively influence longer term training and performance it is important to minimise both the effect and length of EIMD symptoms (Hill et al., 2014). Recovery may then be judged against these various markers and so the effectiveness of a recovery strategy can be seen as the degree to which the strategy lessens the time taken to return to pre-exercise levels (Lambert and Mujika, 2013). The specific markers that will be considered in respect of compression garment and massage are Creatine Kinase (CK) levels, muscle strength, range of motion and perception of DOMS.

The first recovery strategy to be examined will be compression garments. There seems to be limited information regarding their start, the Skins© website (n.d.) cites a skier as coming up with the idea however Time magazine (2015) suggests the starting point was 2001. This is contradicted by Hill et al., (2014) who cite an early study by Carling, Francis and Lorish "The effects of continuous external compression on delay onset muscle soreness (DOMS)" dating from 1995. The wearing of compression garments is gaining popularity amongst athletes (Beliard et al., 2015) and there are over 100 different types of compression stocking commercially available.

In one study on the impact of compression garments (Jakeman et al., in 2010[a]) 17 physically active females were allocated to either a control group with passive recovery or a treatment group given Skins© compression tights to wear for 12 hours following an exercise protocol designed to elicit EIMD. The compression garment group experienced fewer effects of EIDM across all markers except CK, suggesting that compression garments are an effective recovery strategy (Jakeman et al., 2010[a]). Although Jakeman et al., (2010[a]) state they use Skins© other studies do not specify brand or the pressures exerted (see for example Erten et al., 2016). Some studies (Hamlin et al., 2012) give the composition of the fabric but not the pressure exerted. In this study (Hamlin et al., 2012) well-trained male rugby players completed circuits then compression/placebo garments were worn for 24 hours. Post intervention tests found less fatigue and increased sprint times in the intervention group suggesting that wearing compression garments may benefit well trained rugby union players.

There are however a number of other research articles (Hill et al., 2014) both refuting and supporting the use of compression garments. Some of the issues seem to be; standardisation of the garments used with respect to pressure exerted, time worn, lack of a control and the placebo effect. One review (Beliard et al., 2015) attempted to retrospectively analyse the pressure exerted by garments tested in previous studies. They concluded that although there seemed to be some evidence compression garments can be effective much research design failed to take account of the number of important factors. These included the pressure exerted, time worn, and participating athletes' levels of fitness, age and gender. In addition the exercise protocol should be reproducible; there should be more objective and quantifiable data and finally the inclusion of a placebo.

Some issues have been addressed by Hill et al. (n.d.) whose study randomly but equally assigned participants to one of three groups: high pressure, low pressure or sham therapy. The results showed that the higher pressure garment seemed to be more effective in improving muscle function but that there were no significant differences in blood markers such as CK in any group.

Massage can be defined as "mechanical manipulation of body tissue with rhythmical pressure and stroking" (Resnick, 2016, p4) and the effects of massage can be physiological, neurological and psychological (Chua et al., 2016 and Massage Magazine, n.d.). Massage seems to feature extensively in the training of elite athletes (Barnett, 2006) and may assist with recovery (Resnick, 2016). Although similarly to compression garments there seems to be mixed evidence regarding its efficacy (Jakeman et al., 2010[b]).

Recovery can be measured in different ways, for example performance measures (Bishop et al., 2008) such as power output and work performed or through blood markers such as CK (Lanier, 2003, cited in Bishop et al., 2008). However some evidence (Bishop et al, 2008) suggests that CK markers will vary with regard to sex and gender and so maybe less relevant. Some studies for example Chua et al. (2016) have instead considered the effects of massage on post-exercise muscle stiffness. In this study recovery was measured with respect to muscle stiffness in the rectus femoris (RF) and tibialis anteria (TA) on the basis that reduced stiffness would enable the athlete to return to full training more quickly. Although only six males took part massage was found to be effective in reducing stiffness in larger muscles.

A different way of measuring the effects of massage post exercise (Resnick, 2016) is systemic recovery through increased parasympathetic activity. There are few methods for measuring parasympathetic activity (Resnick, 2016) however one way is through heart rate variability (HRV). Resnick (2016) assessed the effect of massage on post-exercise recovery by measuring HRV after massage. The results showed a quicker shift into parasympathetic activity following massage rather than rest alone. Although HRV can indicate the circulating system's return to homeostasis it does not provide evidence about muscle damage. Instead this can be measured via immune cell activation and infiltration; these markers were used in a study (Crane et al, 2016) on the effects of massage after exercise designed to induce EIMD. Following initial muscle biopsy participants completed a cycling exercise to exhaustion. Ten minutes later one leg was massaged for 10 minutes then a muscle biopsy was taken from each leg to compare the markers. Results showed that post massage additional mitochondria were forming (Crane et al, 2012) reducing cellular stress however no significant effect on blood lactate levels was seen.

When considering the effect of compression garments or massage on recovery the number of variables involved causes some difficulties. For example there are over a hundred different types of compression stocking available (Beliard et al., 2015) and a large range of massage techniques (Nedelec et al., 2012). A meta-analysis carried out by Hill et al. (2014) on recovery from EIMD found differences in methodology, timing and duration of intervention and training status. A second review article (Beliard et al., 2015) found a range of garments (tights or socks) and pressures exerted. One of the studies on the effect of massage (Chua et al., 2016) included an eight minute massage of four unnamed techniques. In contrast an additional piece of research (Crane et al, 2012) detailed by the types and duration of each technique used.

Unsurprisingly the results of the research also seem to lack consistency. A recent review suggests that there is evidence both for and against the effectiveness of pressure garments (Hill et al., 2014).

Similarly some studies seem to show benefits of sports massage, however a recent meta-analysis (Poppendieck et al., 2016) found that the effects were generally rather small and the reasons often unclear but massage tended to be more effective for untrained subjects.

From the studies examined it would seem that for both compression garments and massage the measure of recovery on which they have the most significant effect is DOMS (Trademark Therapy, n.d., Men's' Journal, n.d.). DOMS can affect performance negatively so is an important measure of recovery (Hill et al., 2014) but it is inherently difficult to measure as it is based on a perception of pain. Perceived soreness can be measured using a visual analogue scale or Likert scales (Jakeman et al., 2010[a], Hill et al., n.d.) where participants are asked to assess their pain on a point between no pain and worst pain ever. This will vary from person to person and exercise that is unfamiliar or new can affect the experience of DOMS. As a result it can be difficult to have a true understanding of the impact of either the compression garment or the massage intervention. With a self-measure such as this it can be difficult to take account of the placebo effect.

Some studies have attempted to account for the placebo effect by using alternative interventions, for example electrostimulation (Erten et al., 2016) and some introduced "sham" treatments (Hill et al., n.d., Chua et al., 2016) in order to take account of this. One study (Hill et al., n.d.) also attempted to take account of different grades of pressure exerted by the compression garments.

It would seem from a range of evidence that both massage and compression garments have a psychological effect. Cross (You and Yours, cited in Heaney, 2015) talks about how his legs feel less heavy the day after training if he has worn a compression garment. Similarly a review of massage and performance recovery (Poppendieck et al., 2016) found a number of studies had reported positive psychological effects on a number of factors including perceived recovery and pain.

Neither massage or compression garments seem to have significant effect on CK or Lactate levels, however there appears to be increasing evidence (Best and Crawford, 2016) that massage has a positive influence on a number of inflammation markers.

**Implications for practice**

The evidence suggests that there is no single best way to recover as much will depend on the athlete, their level of training and performance goals. Cross ("You and Yours", cited in Heaney, 2015) suggests that for some people wearing compression garments can be likened to the casual cyclist wanting to be seen in the latest "kit". This attitude is supported by Readle ("You and Yours", cited in Heaney, 2015) who feels compression wear has become a fashion owing to marketing. The Skins© website (n.d.) includes a range of information (including Jakeman et al., 2010[a]) suggesting the average athlete will improve both their performance and recovery by wearing compression garments.

Some research (Beliard et al., 2015 and Hill et al., n.d.) suggest not all compression garments will be effective, the key factors are the fit and pressure exerted. Cross ("You and Yours" cited in Heaney, 2015) also highlights that his compression wear seems to lose elasticity over a number of washes resulting in reduced effectiveness.

A recent review of data (Poppendieck et al., 2016) regarding massage and performance recovery found, in contrast to compression wear, that untrained subjects fared better from massage than trained athletes. Overall they found that the effects on recovery post exercise were small and not fully understood and as a result they (Poppendieck et al., 2016) questioned the widespread use of massage as a recovery method. However all the studies in their analysis looked at strength measurements and as previously discussed there is new research (Best and Crawford, 2016) which looks at specific markers within the body, however this requires a biopsy. In addition much research focussed on single interventions rather than considering the effect of repeated sessions over a period of time.

For those working in sport and fitness it is important to start by assessing the individual to ascertain in what way they may benefit from compression garments or massage to aid recovery. The evidence suggests that there are some benefits to wearing well-fitting garments that offer a suitable level of compression although this may be an expensive option for a recreational athlete. For inexperienced athletes there is a danger that feeling less DOMS may result in an athlete returning to training too quickly or too high an intensity. An additional factor to consider (Poppendieck et al., 2016) is that recovery might be enhanced through a mixed modality approach.

Massage seems to offer slightly more benefits to untrained individuals but there is also a link to the exercise undertaken to trigger fatigue. For example studies using endurance exercise, such as cycling or running showed limited benefit after massage. This may have been in part due to the design of the research however a review (Poppendieck et al., 2016) found that for athletes who had followed a strength-based protocol to induce exhaustion and were assessed post-massage using strength tests there was a small but positive effect.

Websites such as Fitday (n.d.) or Men's Health (n.d.) extol the virtues of massage for both physical and psychological benefits. Unfortunately they seem to rely on increased blood flow and clearance of lactic acid as the principle reasons why and as has been shown previously this is not really the case (Bishop et al., 2008). However psychological benefits are important too, Enoka (cited in Bishop et al., 2008, p1023) suggests that specific recovery is required for specific training.

Although two strategies have been critically analysed with respect to recovery there are a number of additional strategies that might be used. Common strategies include; hydration, diet, cold water, immersion and sleep (Nedelec et al., 2012) although there is some evidence (Broatch et al., 2014, cited in Heaney, 2015) that for cold water it is the result of the placebo effect.

When designing research it is really important to take account of the placebo effect (Heaney, 2015). This can be done in a number of ways for example including a control or placebo group. For example in Crane et al. (2012) study a single leg was massaged but both legs were biopsied and in Chua et al. (2015) study one leg was massaged and the other received a sham ultrasound treatment. In both these studies the leg was chosen at random, presumably to counteract the influence of a dominant leg. Hill et al., (n.d.) took a similar approach using a sham ultrasound on both legs.

A potential weakness which future research should take into account is the training status of the athlete, since this may have an effect on recovery markers (Hill et al., 2014). Non-trained participants are likely to experience greater negative symptoms after intense activity when compared to trained athletes. An additional area to be addressed is a quantification system for compression garments (Beliard et al., 2015) as the lack of standardisation severely limits the ability to draw meaningful conclusions from the results.

There was a wide range of time during which compression garments were worn (Beliard et al., 2015) ranging from 15 minutes to 48 hours. The effect of gender and age on results has not been taken into account and this may influence the outcome of research. It is also important to start developing more empirical measurement methods. Chua et al. (2016) used myotonomy to measure post-exercise muscle stiffness. This is a useful way as it offers a consistent measurement that can then be used to calculate if any differences pre and post intervention are statistically significant.

Unfortunately this research focussed on six well-trained male runners so cannot be applied to a wider population. Invasive measurements (Crane et al., 2012) can provide good data however there are practical and ethical issues involved in the taking of biopsies.

The current research remains ambivalent regarding the extent of benefit from compression garments and massage. There is a need for well-designed longitudinal research that takes account of the placebo effect and includes an appropriate number of suitable participants.

2707 words

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