Research Paper Review

Effects of external pelvic compression on form closure, force closure, and neuromotor control of the lumbopelvic spine – A systematic review

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ABSTRACT

Optimal lumbopelvic stability is a function of form closure (joint anatomy), force closure (additional compressive forces acting across the joints) and neuromotor control. Impairment of any of these mechanisms can result in pain, instability, altered lumbopelvic kinematics, and changes in muscle strength and motor control. External pelvic compression (EPC) has been hypothesised to have an effect on force closure and neuromotor control. However, the specific application parameters (type, location and force) and hypothesized effects of EPC are unclear. Thus, a systematic review was conducted to summarize the in vivo and in vitro effects of EPC. Eighteen articles met the eligibility criteria, with quality ranging from 33% to 72% based on a modified Downs and Black index. A modified van Tulder's rating system was used to ascertain the level of evidence synthesised from this review. There is moderate evidence to support the role of EPC in decreasing laxity of the sacroiliac joint, changing lumbopelvic kinematics, altering selective recruitment of stabilizing musculature, and reducing pain. There is limited evidence for effects of EPC on decreasing sacral mobility, and affecting strength of muscles surrounding the SIJ, factors which require further investigation.

ANALYSIS

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Background Information

Anyone in clinical practice can attest to the importance of lumbopelvic stability. However, how we address this problem is a complex issue. For the sake of argument, let's look at it from a layman's perspective: If a patient were to ask a chiropractor what is important for fixing a lumbopelvic problem and developing lumbopelvic stability, they'll likely say that it's all about the adjustment/manipulation. Ask a physiotherapist the same question, and they may say it's all about the exercise prescription. This is a simplification and this may seem like a pretty archaic scenario…most informed clinician (hopefully) don't think this way, right? Unfortunately, those who mainly employ one clinical tool tend to think it is the right tool for everything (If all you have is a hammer, you start looking at everything as a nail!).

The truth of the matter is that the lumbopelvic region is very complex, with optimal function including important contributions from passive, active and neuromotor control systems to effectively transfer loads and bring about stability. To make things even more complex, we all know that each patient is built differently, requiring a personalized and unique rehabilitative approach to addressing their pelvic problems.

Let's get back to 'stability' which, in this case, is defined as "*the effective accommodation of the (pelvic) joints to each specific load demand through an adequately tailored joint compression, as a function of gravity, coordinated muscle and ligament forces, to produce effective joint reaction forces under changing conditions*". That's a long definition that comes to us from Dr. Andry Vleeming (1), a Dutch professor currently working at the University of New England (USA) as well as the University of Ghent (Belgium). EDITOR'S NOTE: *For an in-depth understanding of the pelvis, interested readers should reviews the works done by Andry Vleeming and Chris Snijders.*

Lumbopelvic stability, and more specifically, sacro-iliac joint (SIJ) stability, is maintained with the help of form closure (a function of the SIJ anatomy that resists shear forces), force closure (a dynamic process achieved through the muscular system with the help of ligaments and fascia) and neuromuscular control (involuntary activation of dynamic restraints in feedforward [preparation or anticipation] and feedback responses to joint motion and loading under functional demand). These systems, ideally, work synergistically together to maintain stability. However, sometimes this ideal scenario does not occur.

Clinically addressing the root cause of any problem can once again bring about stability. Lumbopelvic stability could be optimized by manipulative therapy, rehabilitative exercises, and/or orthotic devices, such as external pelvic compression (EPC) belts. Unfortunately, we currently don't know exactly how EPCs work. Therefore, the aim of this systematic review was to analyze the immediate effects of EPC on the passive, active and neuromotor control systems of the lumbopelvic region and thigh, in individuals with and without lumbopelvic dysfunction.

PERTINENT RESULTS

Eighteen articles met the eligibility criteria. Nine of the studies investigated individuals with some sort of pathology in the lumbopelvic region (SIJ, low back, groin, or pelvic girdle pain). The remaining eight in vivo studies and one in vitro study investigated healthy participants/cadavers. Methodological quality ratings varied from 33% to 72%, with a mean of 58%, and sample sizes ranged from 5 to 88. The results from the Modified Downs and Black index found moderate quality for 17 studies while one study was of low quality.

Three types of EPC were reported: pelvic compression belt, manual compression and mechanical device compression. 15 studies (one in vitro and 14 in vivo) used a pelvic compression belt (PCB) as an intervention. The PCB was positioned just caudal to the anterior superior iliac spines (high position) and/or at the level of pubic symphysis/ greater trochanter (low position).

Doppler-imaging found that the application of a PCB in the high position with the participant prone resulted in decreased SIJ laxity by approximately 50% in healthy individuals and by 36% in women with pregnancy-related pelvic girdle pain. The reduction in laxity was less than 17% when the belt was applied at the low position. Wearing a PCB fitted in the low position was found to increase erector spinae muscle activity in standing and slump sitting, with the opposite effects observed in erect sitting. Furthermore, wearing a belt improved lifting strength by approximately 40% and 30% for the near and high lifts (respectively), increased hip adduction force (by 13%) for athletes with groin pain, decreased pain during isometric hip adduction in 33-38% in athletes with longstanding groin pain and decreased pain low back pain in 13% of participants.

Looking at muscle activity, there was a reduction in the EMG amplitude for abdominal muscles during standing ASLR and treadmill walking. There was also a reduction in EMG for gluteus maximus and latissimus dorsi during standing and for pelvic floor movement during ASLR. Increased EMG was found for gluteus maximus during walking in healthy women. The PCB modified the recruitment pattern between quadratus lumborum and gluteus medius in healthy individuals during side-lying hip abduction.

There was one study that used a device to achieve 50 N and 100 N of mechanical compression. A significant reduction in the muscle onset latency for gluteus maximus with respect to semitendinosus was found to be directly proportional to the magnitude of applied force.

CLINICAL APPLICATION & CONCLUSIONS

This systematic review found that there is a moderate level of evidence to support the role of EPC in decreasing laxity of the sacroiliac joint, changing lumbopelvic kinematics, altering selective recruitment of stabilizing musculature, and reducing pain. There is limited evidence for effects of EPC on decreasing sacral mobility, and increasing strength of muscles surrounding the SIJ – these factors require further investigation. Generally speaking, the evidence based from this review is favorable for immediate effects of EPC, but not necessarily as supportive for sustained use.

One common scenario that presents in practice is the patient with increased lumbopelvic laxity and pain. The Doppler-imaging from one of the studies examined found a decrease in joint laxity with a PCB worn at the high position (shown to be better than in the low position). However, this study had the participants in a prone-lying position. In vivo effects of a P/ECB on SIJ laxity in weight-bearing positions still remain unexplored. There is moderate evidence that a PCB applied at a high position may decrease laxity and increase stiffness of the SIJ, thereby likely improving form closure. The effects of the PCB may be task-dependent and therefore the effectiveness of the belt may be influenced by whatever the patient is doing while wearing it. Most of the studies investigating EMG outcomes used tasks likely to be included in clinical examinations, such as Active Straight Leg Raise (ASLR). Only one study used a functional movement (walking).

This systematic review found that there is moderate evidence to support strength improvements with EPC in patients with lumbopelvic or groin pain, but not in healthy individuals. This may be due to a decrease in pain and/or increase in stability. Pain and/or hyper-mobility can lead to muscle inhibition or malfunction. If we remove the pain and/or restore the stability, it is hypothesized that the muscles will be able to work better within their normal ranges. Therefore, it would stand to reason that providing your patients with an EPC belt may help with their rehabilitation process.

Finally, high levels of mechanical compression (50/100 N) appears to increase intra-articular friction and counteract nutation by exerting pressure over the postero-inferior sacrum in cadavers. It has been hypothesized that this would decrease the load on the sacrotuberous ligament, while increasing the load on the iliolumbar and sacrospinous ligaments. Theoretically, this would be a good thing for patients with increased sacro-iliac mobility and pain. However, this is simply a hypothesis and further work needs to be done at low level compression, just like that provided by EPC belts.

STUDY METHODS

A systematic review was conducted to summarize the in vivo and in vitro effects of EPC. This systematic review required studies to feature a cross-over design that compared specified outcome variables before and after exposure to EPC. Two researchers independently evaluated abstracts for eligibility.

A modified Downs and Black index was used to determine the quality of the articles. This index consists of 17 items relevant for this review (this index has been shown to have high internal consistency, good inter-rater reliability and high test-retest reliability).

Since there was considerable clinical heterogeneity of participants, intervention and outcome measures, a meta-analysis was not undertaken. A modified van Tulder's rating system was used to ascertain the level of evidence synthesized from this review. This rating system was modified to define the level of evidence as strong (consistent findings from multiple high quality studies), moderate (consistent findings from one high quality study and one or more moderate to low-quality studies, or multiple moderate to low-quality studies), limited or conflicting (findings from one high/moderate/low-quality study or inconsistent findings from multiple studies) or no evidence (no studies).

STUDY WEAKNESSES

The authors should be congratulated on synthesizing the literature on this topic, however there are some limitations that should be considered. First, there were several weaknesses with the studies analyzed. There was inadequate reporting of external validity and power calculation. Fifteen studies did not report mean effect size or confidence intervals across conditions (EPC vs. no EPC), thereby excluding direct inferences about point estimation of population parameters. Further, five studies had a sample size of < 10, which increased the risk of type 2 errors.

The biggest weakness of all EPC studies revolves around the transferability to everyday activities. While the effects of EPC on outcomes has been investigated at impairment level, more research is needed to determine whether it has similar effects during functional tasks such as walking, running, sporting activities and activities of daily living.

A final weakness of this systematic review was that it only included full text articles. It is possible that other findings such as abstracts, editorial/personal communications, or unpublished observations unavailable in the databases may have altered the results. This risk of publication bias is minimal, and it is likely that the authors captured the highest level evidence on this topic.

Additional References

1. Vleeming A, Albert H, Östgaard H, Sturesson B, Stuge B. European guidelines for the diagnosis and treatment of pelvic girdle pain. Eur Spine J 2008; 17(6): 794-819.