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ORIGINAL ARTICLE

Tensegrity and manual therapy practice: a qualitative study

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Abstract *Background:* Tensegrity has been proposed as a unifying mechanism between structures at cellular, connective tissue and whole body level. Originating in the fields of sculpture and architecture, tensegrity has recently received increasing attention from practitioners and researchers of manual therapy. Notwithstanding this, evidence regarding the role of the tensegrity principle to manual therapy practice is lacking.

Objective: This qualitative study explored the conception of tensegrity amongst manual therapy practitioners and how knowledge of the physical principle of tensegrity may influence manual therapy practitioners' clinical decision-making.

Methods: Eight semi-structured interviews were conducted with participants from manual therapy, fascia research and/or manual therapy education fields, and analysed using grounded theory methods.

Results: Data from this study indicates that tensegrity may inform clinical decision-making in manual therapy. A theory has been constructed that may help to explain aspects of manual therapy practitioners' approaches to tensegrity. Four such approaches to tensegrity were identified and elaborated on.

Conclusion: This study suggests that apart from being of importance as a scientific model in the fields of architecture, engineering and biology, tensegrity may also be useful to the practice of manual therapy. Here, tensegrity may serve as a theoretical underpinning of previously conceived clinical models and subjective clinical experience, and may also inform decision-making processes by providing a biomechanical model of the human body.

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Implications for practice

- Tensegrity may be useful to the practice of manual therapy.
- Tensegrity may serve as a theoretical underpinning of previously conceived clinical models and subjective clinical experience (palpation).
- Tensegrity may also inform decision-making processes by providing a biomechanical model of the human body.

Introduction

The term 'tensegrity' combines the words 'tension' and 'integrity'. First coined by the architect Buckminster Fuller,[1] the term is now used to describe any physical structure that combines the features of tension and stability in a specific manner, best illustrated by sculptor Kenneth Snelson[2] or more recent work by G. Scarr[3](see Fig. 1): Rigid elements, such as struts or beams, are held together by a network of tensioned elements, such as cables, strings or even membranes. A distinguishing property of tensegrity configurations is that those compressive or rigid elements are not connected by compression, as would be the case in a brick wall, for example, where one element is stacked upon the other, but entirely through a global (structure-wide) network of tension. The struts almost seem to float in a continuum of tensile forces. Thus, tensegrity describes a special arrangement of forces within a structure: isolated islands of compression connected by a sea of tension.[4] The artwork shown in Fig. 1 illustrates this principle; and it is useful to imagine how this structure would behave if it was handled manually.

Fig. 1 Tensegrity stick-and-string model 'spine'. With kind permission of G. Scarr.

The internal arrangement of tensegrity configurations determines the behaviour of the structure when external forces are applied. It also results in peculiar properties of the overall structure. For example, forces applied to a tensegrity construction will be transmitted through the entire structure, affecting every single component: if a string is pulled or a strut is broken, the whole arrangement will change to accommodate. Properties emerging from the design principle of tensegrity are, amongst others: a light weight, as very little material is required to build relatively large objects; three-dimensional stability: the shape remains the same no matter how it is oriented in space; 'shape memory', where the structure will return to its original shape once the disturbing force is removed.[1,6] (You squeeze two of the struts together and the entire structure changes its shape; release the grip and the structure will return to its original form.) This study critically considers the putative role of this concept in explaining more complex organisations such as the human body.

Indeed, due to the properties described, the step from architecture, sculpture or toys to living structures is not a large one: energy and material efficiency, a high strength-to-weight ratio, intrinsic pre-stress, mechanical integration of every part into a unified whole, resiliency and dissipation of damaging stresses throughout the entire structure and the ability to automatically balance themselves in equilibrium whilst at the same time allowing movement with minimum effort.[3,7–11] All these properties appear beneficial for biological configurations. Numerous naturally occurring structures have been described in terms of tensegrity principles.[11–15]

Arguably, tensegrity is even a useful model to understand the human musculoskeletal system. Biomechanical models using tensegrity principles have been described as an alternative to traditional lever-based biomechanics[8,10]; however, this is not yet the generally accepted standard (see Refs. 16,17). Evidence endorsing macroscopic tensegrity biomechanics is largely conceptual (e.g., Refs. 11,14), with limited available mathematical models of tensegrity biomechanics (e.g., Ref. 18). Therefore, evidence from expert opinion and conceptual models should be considered with caution and their application to clinical practice robustly appraised.

Apart from the theoretical role in understanding biomechanics, a growing body of theoretical and research literature examines the role of tensegrity in different manual therapies like osteopathy[19–24] and for physiotherapy.[25–28] Tensegrity is regarded