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Clinical Perspective

The potential for haptic touch technology to supplement human empathetic touch during radiotherapy

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ABSTRACT

Radiotherapy for cancer is an effective treatment but requires precise delivery. Patients are required to remain still in the same position during procedure which may be uncomfortable. This combined with high anxiety experienced by patients, and feelings of isolation, have indicated a need for comfort interventions. Care conveyed through empathetic touch promotes comfort, individual attention and presence and provides both psychological and physical comfort at the same time. Evidence in nursing and care literature showed that empathetic touch interventions have a significant role in promoting comfort, facilitating communication between care recipients and caregivers. However, the application of empathetic touch interventions may be challenging to administer due to the safety concern in the radiotherapy environment. The emergence of haptic technologies that enable the communication of touch remotely may have a potential to fill this gap. We take inspiration from both clinical empathetic touch in radiotherapy practice, as well as affective haptic technologies to envision the opportunities for haptic technologies as a complimentary comfort intervention to supplement human empathetic touch during radiotherapy.

RÉSUMÉ

Pour le cancer, la radiothérapie est un traitement efficace, mais qui exige une grande précision. Les patients doivent demeurer immobiles dans la même position durant toute la procédure, ce qui peut devenir inconfortable. Combinée avec le niveau d'anxiété élevé et le sentiment d'isolement ressentis par les patients, cette situation indique que des interventions de réconfort sont nécessaires. Les soins transmis par le toucher empathique favorisent le confort, l'attention individuelle et la présence et fournissent un réconfort physique et psychologique en même temps. Les données probantes provenant de la documentation scientifique en soins infirmiers et soins médicaux montrent que les interventions de toucher empathique jouent un rôle important pour favoriser le confort et faciliter la communication entre les soignants et les patients. L'application des interventions de toucher empathique peut être difficile à gérer en raison des contraintes de sécurité dans l'environnement de radiothérapie. L'émergence des technologies haptiques qui permettent la communication du toucher à distance pourrait combler cette lacune. Nous nous inspirons à la fois du toucher empathique dans la pratique de la radiothérapie et des technologies haptiques affectives pour imaginer les façons d'utiliser les technologies haptiques comme interventions complémentaires de réconfort pour compléter le toucher empathique humain durant les traitements de radiothérapie.

Keywords: Comfort interventions; Radiotherapy; Haptics; Tactile touch; Empathetic touch

Introduction

Radiotherapy for cancer is an effective treatment requiring precise delivery. Outcomes are dependent on stable, reproducible

body positioning over many treatment sessions.^{1,2} The current clinical solutions require patients to remain absolutely still in the same position over a period of 10–30 min, which can be uncomfortable.^{3,4} This, combined with the reported high anxiety experienced by patients,^{5,6} has indicated a need for interventions to support patients receiving radiotherapy. Interventions that may have potential in increasing comfort in the radiotherapy setting include audio-visual, psychological, physical, education/information and aromatherapy.⁷ There is

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Fig. 1. Comforting effect of Human Empathetic Touch, courtesy of the COMFORT study.

suggestion that multiple interventions used concurrently could enhance effectiveness.⁷ Human empathetic touch converge both physical and psychological categories and could have potential to improve patient comfort (Fig. 1).

Care conveyed through human empathetic touch promotes comfort, individual attention and presence. The unique characteristics of empathetic touch is that it provides both psychological and physical comfort at the same time.⁸ Evidence in nursing and care literature showed that empathetic touch interventions have a significant role in promoting comfort, and facilitating communication between care recipients and caregivers.⁹ Empathetic human touch has the potential to offer comfort during radiotherapy treatment,⁷ however, it is not currently accessible due to the safety and efficiency requirement during the procedure.

During radiotherapy, once patients have been accurately positioned everyone except the patient must leave the room due to the principles of radiotherapy. They receive radiotherapy alone which can lead to feelings of isolation or loneliness.⁵ These sessions can take upwards of 20 min and patients are separated from the clinical team, their carers' and family during the treatment, and as such any reassurance from them in the form of touch during treatment is impossible. Not surprisingly up to 49% of patients experience stress and anxiety during the radiotherapy treatment.^{5,6} Clearly we need to consider novel approaches to reducing stress and anxiety in this in patients receiving radiotherapy to support them through their treatments. One novel approach is to use haptic technology; derived from the Greek verb *haptesthai*, the word haptics means to sense touch.¹⁰ Remotely delivering human empathetic touch via technology may also limit the risk of interpersonal touch (removing the stress from patients on interpreting the intention of the touch).

To contemplate novel approaches, we take inspiration from both human empathetic clinical practice in radiotherapy and affective haptic tactile touch technologies to envision the opportunities for haptic touch technology to supplement human empathetic touch during radiotherapy.

Empathetic touch in radiotherapy

A large number of cancer patients are accessing complementary therapies for comfort and relaxation during radiotherapy.¹¹ In some services, patients can access aromatherapy massage or reflexology to support them. There are often restrictions to the application of empathetic touch interventions due to the radiotherapy environment, ensuring the safety of patients, professionals and the carers. Other than the individual patient receiving radiotherapy treatment, staff, friends and family cannot remain in the treatment room due to the dose of radiation they would unnecessarily receive. Face-to-face empathetic touch interventions usually cannot be administered during a radiotherapy session. According to Bolderston,¹² radiation therapists value a humanistic and compassionate interaction with patients yet they have to work within the confines of the environment which prevents human touch. CCTV, intercom and audio systems are used when required to reassure patients, but this may not ameliorate feelings of isolation or reduce levels of patient anxiety. There are novel approaches such as the use of string for children to maintain empathetic contact with their parents during a radiotherapy session.¹³ A child and parent can pull the string to let each other know they are at the end of the string as a form of empathetic touch to comfort the child.

Although there is limited evidence of empathetic touch interventions in radiotherapy, there are interventions from other healthcare settings which maybe applicable.^{14,15} Some empathetic touch interventions come naturally to a health professional, for instance stroking someone's arm. There are potentially novel approaches to delivering empathetic touch using technology during a radiotherapy session that could make a positive change to patient experience. Careful design is needed to ensure these technologies do not disrupt or impact the treatment delivered. Furthermore, such interventions need to consider patient choice and preference (e.g. some patients may like music while others may prefer empathetic touch) requires the involvement of patients in the design and tailoring of the interventions¹² and to individually tailor interventions to the individuals.⁷

Understanding the attributes of empathetic touch

The foundations of touch extend beyond the physiological sensations transmitted by neural pathways to the brain; moreover, the sensations are felt both psychologically and sociologically.¹⁶ Social and psychological touch ranges from unpleasant to pleasant, depending on the individual. This can include striking the skin, being pinched, shaking hands, kissing, and pleasant strokes in erogenous zones.¹⁶ Touch, in many ways, is subjective and open to interpretation by the individual. Social touch interactions can, depending on the type and strength of the dyadic social relationship, elicit a plethora of physiological, emotional, and behavioural responses.^{17–19}

Historically, scientific research has viewed touch as serving only a discriminative role, which helps to differentiate the location of a stimulus on the skin, identify, haptically explore, and manipulate objects.²⁰ This discriminative touch system is mediated by a group of nerve fibres called A β afferents, which is characterised as being fast-conducting and myelinated.²⁰ However, this does not explain why some forms of touch can feel pleasant. Recent studies have identified that the human body has a specialised neurophysiological system that mediate the affective properties of touch,^{21,22} which may help to explain the mechanisms underpinning the beneficial qualities of empathetic touch. Affective touch refers to tactile processing with a hedonic or emotional component.²³ Affective touch system is mediated by a different group of nerve fibres called CT-afferents, which are characterised as being slow conducting and unmyelinated. Such affective touch system projects via brain regions that are correlated with reward, emotion-related processing and social connection,^{21,22} which is a different neuropathway than discriminative touch system.

CT-afferents selectively respond to slow, gentle touch which is perceived as pleasant and socially supportive. On the contrary, faster, discriminative touch which allows a person to sense and localise touch shows no relationship with perceived pleasantness.^{21–23} Gentle touch at a velocity of 1–10 cm/s²⁴ is often called CT-optimal touch, as it most optimally excites the CT-afferents. CT-optimal touch has shown positive potential in alleviating stress,²⁵ reducing feelings of social exclusion²⁶ and enhancing emotional bonding between children and caregivers.²⁷

Current trend in affective haptic technologies

Haptic technologies create mechanical stimulation of force, vibration or motion to a patient, through a haptic device, which is usually a mechanical apparatus, to generate touch sensations for the purpose of feedback on environmental information, remote communication, and control.²⁸ The field of haptics is the most recent technology in computer interface devices and this new human computer interaction paradigm has brought together a variety of disciplines including biomechanics, psychology, neurophysiology, engineering and computer science.^{28,29} Within this field, what is most relevant to our topic on envisioning empathetic touch in the radiotherapy environment is an emerging new research interest called affective haptics, which integrates ideas from

affective computing, haptic technology and user experience and focuses on the design of devices and systems that can detect, process, or display the emotional state of the human by means of the sense of touch.²⁹ This led us to envision that empathetic touch be digitally transmitted via a haptic device promoting comfort and providing an alternative communication channel between care givers and patients.

There are existing works in the affective haptics field that create affective tactile stimulation devices for the application of psychological health and emotion communication via remote touch. Affective haptic technologies can apply to both wearable devices and robots that exchange physical contact with humans. We focus our discussion on wearable devices as we see it more relevant to the radiotherapy setting (see Table 1).

Working with mental health professionals, Vaucelle et al.²⁹ were among the first researchers who provided proof-of-concept that a haptic stimulation prototype provided relief to patients with mental illness. Inspired by sensory grounding therapies (e.g. breathe deeply, savour food, take a short walk, put your hands in water) in comforting the body and alleviating pain through tactile stimulation, the authors created haptic stimulation prototypes including a soft wearable piece Touch Me that could be worn on the chosen position of the body and the vibrotactile stimulation could be actuated by care-givers remotely²⁹ and a further device Squeeze me which is a vest with pneumatic compression to create a holding sensation meant to be helpful during panic attacks.²⁹ GoodVibe is a soft sleeve generating dynamic vibration patterns around the arm alleviating stress (e.g., decreased heart rate).³⁰ Huggy Pajamas enables remotely communicating emotional support in the form of “hug” between parent and child.³¹ Some devices are already commercially available. Squease,³² a lightweight, inflatable vest applies pressure to the upper body when needed, to calm people with sensory difficulties. Doppel, a device that creates a silent, heartbeat vibration on the inside of wrist has shown to have calming effect during socially stressful situation.³³ Haptic stimulation could provide an alternative intervention for anxious or distressed patients such as those receiving radiotherapy for head and neck cancer who may suffer claustrophobia.^{4,6} Despite the interesting potential of many haptic technologies^{29–33}, we need to consider the acceptance to patients and the applicability to the radiotherapy environment due to the size and position of the wearable devices.

Table 1
Existing experimental devices using affective haptic stimulation for psychological benefit.

Author	Prototype	Intended area of application
Vaucelle C et al. ²⁹	Touch Me Squeeze me	To enable caregivers to provide relief for mental health patients To provide a holding sensation to help during panic attacks
Kelling C et al. ³⁰	GoodVibe	To alleviate stress
Teh JKS et al. ³¹	Huggy Pajamas	To enable parent send remote “hug” to children
Squasewear Ltd ³²	Squease	To calm people with sensory difficulties.
Azevedo T et al. ³³	Doppel	To calm people during socially stressful situations

The sensory qualities of different types of touch stimulation generated by haptic devices (actuators) have also been brought to the emergent research agenda. Although the majority of touch stimulation is realised by employing a vibrotactile motor, it has been found that this may not be the best actuator for affective touch sensation. Instead of pleasant feelings in some situations, high frequency vibrations can induce negative sensations.³⁴ Researchers have been experimenting with alternative actuators which may generate more pleasant touch sensations, such as air,³⁵ friction,³⁶ heat,³⁷ textured surface,³⁸ pneumatic and soft robotics.^{38–41} A soft brush attached to a robotic hand has been widely used to apply CT-optimal affective touch in psychological studies and has the potential to be made into affective touch haptic device, as mentioned above. Zheng⁴⁰ and Wang et al.⁴¹ postulate that soft robotic actuators using pliable and skin-like surface textures and controllable pressure have great potential for generating affective tactile touch. This technology could provide an opportunity for empathetic touch to have a more realistic human like sensation.

We see benefits from affective haptic devices on several fronts. First the felt sensation of the physical stimulation may merit positive psychological effect.^{8,24–26} Secondly, the digital system enables devices to be remotely controlled and administered. Thirdly the remote administration enables families and carers to connect and communicate support via such remote touch. Regardless of the actual sensory quality of the physical stimuli, the remote physical presence of family and caregivers itself is a source of psychological positivity to an isolated patient.

Opportunities & challenges

Opportunities

There is an opportunity to provide a non – invasive intervention that can be remotely administered from the linear accelerator control area, and at the same time provide the remote physical presence of quasi human contact. This means that there is limited risk of interpersonal touch - (remove the stress from patients on interpreting the intention of the touch) and concurrently enable a non-contact intervention that could be beneficial during pandemics such as COVID-19.

Challenge

The promising potential is not without challenge. On one hand, much of the haptic technology is still in the proof-of-concept stage without sufficient evidence to determine effectiveness. Moreover, the restrictions of the radiotherapy environment make the implementation of haptic technology a challenge. The acceptability of new interventions has to be explored in patients, radiation therapists and service providers.

Conclusion

This commentary was inspired from the doctoral research to develop comfort interventions in radiotherapy and the

development of affective haptic touch technologies. We envision the opportunities and challenges for tactile touch technology to supplement human empathetic touch during radiotherapy. In clinical practice radiation therapists greet their patients with empathy; there is a dearth of literature targeting empathetic touch in radiotherapy. However the effective use of string for children to maintain empathic contact with parents had shown promising findings,¹² therefore the above envisioned haptic technologies for adults could also benefit children receiving radiotherapy. Empathetic touch generated by haptic technologies may equally suit procedures like magnetic resonance imaging, with relatively long scanning times in isolation, providing similar patient benefits. We would like to motivate radiation therapists to develop human empathic touch interventions in clinical practice, and to seek available technology that deploys empathetic tactile touch when available to improve patient comfort.

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