Is Enough Being Done For Safe Patient Positioning?

Improving patient outcomes with implementation of an intra-operative monitoring device for pressure injuries and patient positioning

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INTRODUCTION

Safe patient positioning is a common problem in many high risk surgeries, the choice of position and positioning devices allow for the optimal expose to the site whilst minimising risk of injury. [1]. In the prone position, mispositioning of the patient can cause serious complications such as peri-operative vision loss, peripheral nerve damage and pressure injuries (PIs) [2]. Mispositioning can increase the risk of Pi development when the body weight is not evenly distributed on support surfaces [3].

Currently, multiple strategies, risk assessment and predictive models are available that act as guidelines for clinicians to help initial positioning to prevent the onset of PIs. However, these methods are paper and digital based tool that are used pre and post operatively and do not allow for intra-operative measurements of pressure during surgery. In current literature it is highlighted that there needs to be more research evidenced based upon pressure reducing surfaces [4] as there is a distinct lack of PI visual positioning aids developed specifically for surgery.

METHODS

In this study, healthy participants between the ages of 18 - 65 (n = 24) were asked to position themselves on a surgical spinal frame provided by Baxter Healthcare. Participants would be placed in the prone position for a maximum of 5 minutes, this was to limit the risk of PI development to the participant. Each participant was required to answer demographics questions where the Body Mass Index (BMI) could be calculated. The study included qualitative data where a visual analog scale and a written comments section were provided which allowed participants to document their perceived comfort levels. Quantitative data was also collected in the form of sensor intersection point outputs that form a sensor matrix. In the study, four, custom 16 x 16 sensor matrices were used to collect pressure readings from where the participant and the surgical frame made contact (hip and chest pads). The data was collected using a microprocessor and data processing software, this was then visualised using Matlab where heatmaps were constructed highlighting the differences in the analog signal readings, red signifying areas of high readings and blue lowest readings. Observations were also made on the top view of the participant and the side view with photographic evidence.

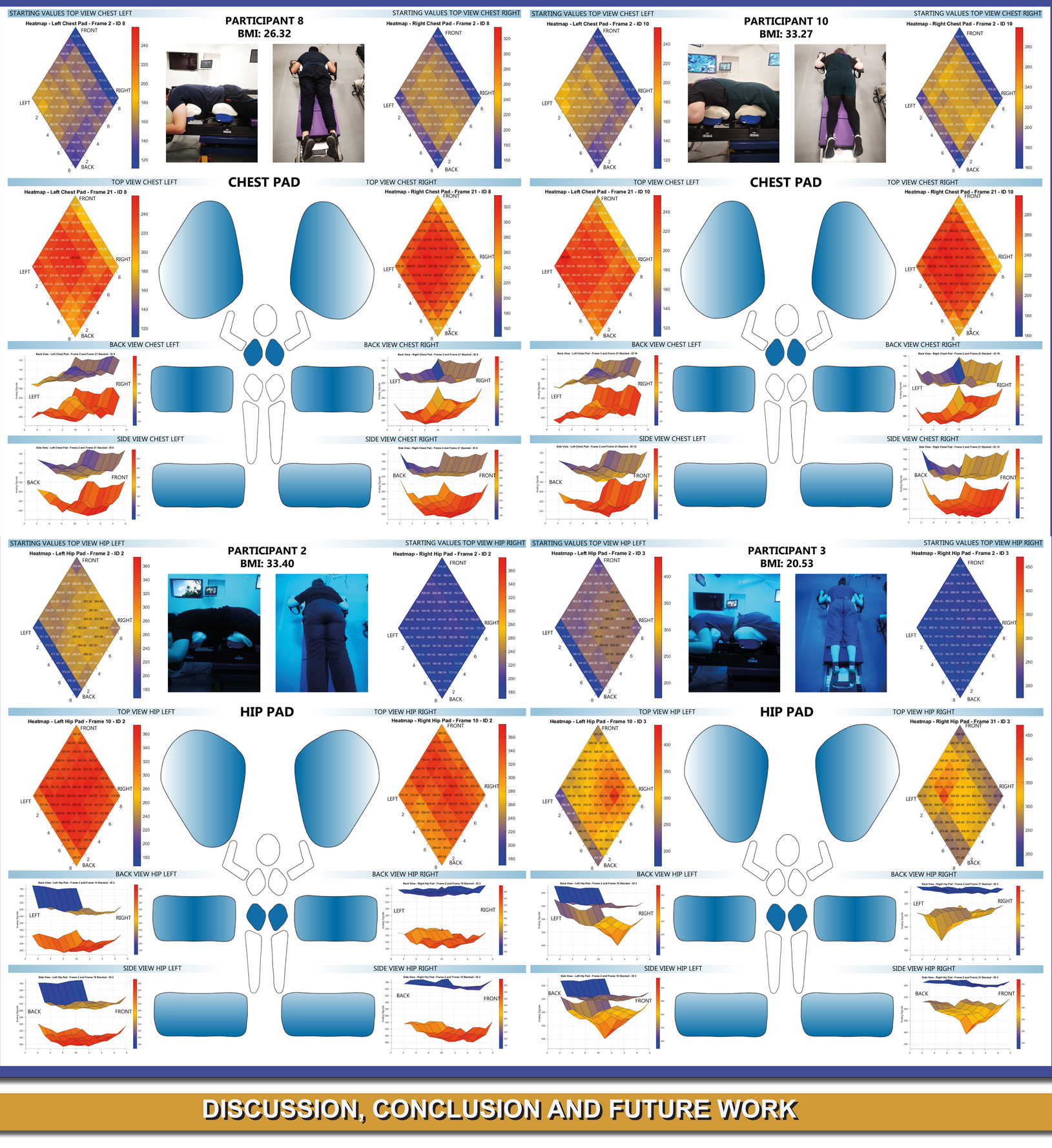
AIM

To design and develop a closed loop system that will monitor and alleviate the development of PIs during surgery. This research specifically focuses on the sensor integration within a spinal surgical frame where data visualisation of patient positioning is collected.

RESULTS

Participants were given the opportunity to describe how uncomfortable they felt in a specific area of their body, each participant was shown a graphic of the human body in the position they were placed in (prone) and then asked to comment if they noticed and pains.

DATA VISUALISATION OF PARTICIPANT TESTING

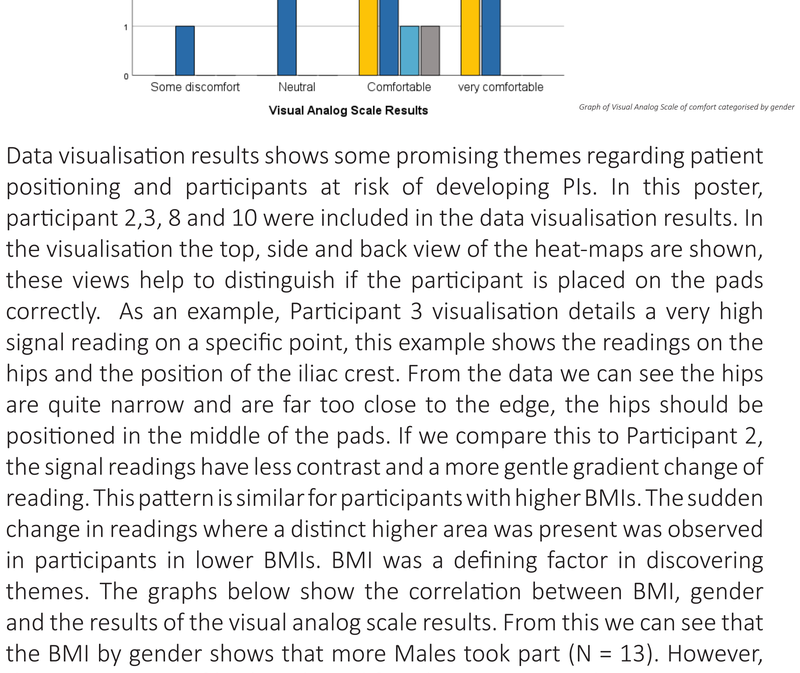


The table below details participants' comments. Participant 2,3,8 and 10 are detailed in the data visualisation to the left.

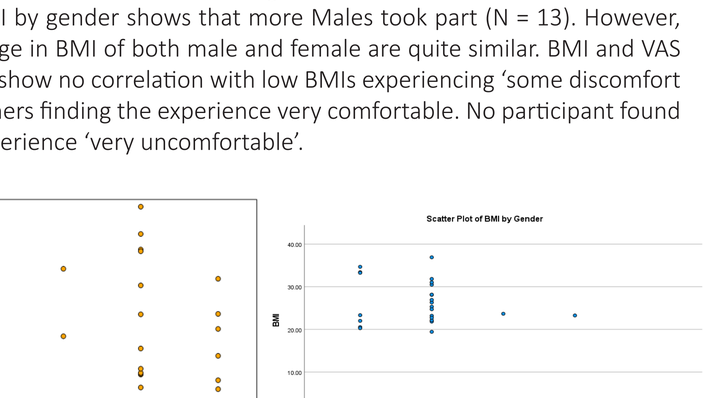
Table 1 Participants' comments

Participant ID	Comments from survey
2	*"Overall comfortable, slight pressure on my right hip, was not uncomfortable just noticeable"*
3	*"I thought the chest pads would be more uncomfortable, but this did not happen. The hip points did get more uncomfortable over time. I did feel like I could not breath fully, my breathing rate was quicker and shallow"*
8	*"Chest pads were okay but my centre chest (sternum) was uncomfortable for a bit"*
10	*"There was some discomfort in the chest area, because I have large breasts. More so on the right side because that breast is larger"*
13	*"Face pad could have been more comfortable than it is right now"*

The graphic below details the accumulation of all the participants' comments specific to a part of the frame where they felt uncomfortable. 54% of all comments included a mention of the head rest being uncomfortable with specific mentions to the chin, cheek and forehead.



Graphic depicting participants' comments and frequency percentage of specific areas of the frame was mentioned in survey.



Graph of Visual Analog Scale of comfort categorised by gender

Data visualisation results shows some promising themes regarding patient positioning and participants at risk of developing PIs. In this poster, participant 2,3, 8 and 10 were included in the data visualisation results. In the visualisation the top, side and back view of the heat-maps are shown, these views help to distinguish if the participant is placed on the pads correctly. As an example, Participant 3 visualisation details a very high signal reading on a specific point, this example shows the readings on the hips and the position of the iliac crest. From the data we can see the hips are quite narrow and are far too close to the edge, the hips should be positioned in the middle of the pads. If we compare this to Participant 2, the signal readings have less contrast and a more gentle gradient change of reading. This pattern is similar for participants with higher BMIs. The sudden change in readings where a distinct higher area was present was observed in participants in lower BMIs. BMI was a defining factor in discovering themes. The graphs below show the correlation between BMI, gender and the results of the visual analog scale results. From this we can see that the BMI by gender shows that more Males took part (N = 13). However, the range in BMI of both male and female are quite similar. BMI and VAS results show no correlation with low BMIs experiencing 'some discomfort and others finding the experience very comfortable. No participant found the experience 'very uncomfortable'.

Scatter plot of BMI vs results from the Visual Analog Scale.

Scatter plot of BMI vs Gender

DISCUSSION, CONCLUSION AND FUTURE WORK

The data visualisation results show promising advancement to being able to monitor PI development during surgery. In the results it is important to note some fluctuations had occurs on some of the columns of the sensor arrays. This is noticeable on the left hip pad column and the right chest pad where it is evidenced that one column signal reading is considerably lower than the rest at the start of testing. This error was due to the manufacture of the electronics and has since been rectified. This issue only occurred on the outermost sensor intersections and localised to that particular column.

This poster explores the themes of safe patient positioning and identifying those at risk of PI development during surgery. The results suggest even if a participant confirms that they are comfortable they still might be at risk of development of a PI due to mispositioning or perceived comfort levels where it might not be possible to see where the patient aligns to support surfaces. Those of lower BMI exhibit a higher point on the heatmaps evidencing bone location or areas of high pressure in a specific location. Low BMI is considered a significant risk factor in identifying possible development of PIs during surgery. The sensor design allows the viewer the ability to see the location of possible areas of high pressure and can be utilised as a useful tool to position patients. The sensor design can also be used to identify those who might be at risk of PI development during surgery, currently it is impossible to monitor the development of PIs during surgery and there is no intra-operative risk assessment or scale used during this time. The develop of these sensors could be adopted to provide intra-operative PI assessment that provide a visual aid at the start of surgery for safe positioning and an ongoing visual tool to assess the risk of PI development.

Future work will include the development of the sensors integration in a closed loop device that will monitor and alleviate PIs. The participant testing is part of a validation and verification process that will lead to a clinical study where these sensors will be integrated in a surgical spinal frame. The data visualisation results require further analysis into pattern recognition of analog signal pattern on the heatmaps which can be used to categorise at risk patients during surgery.

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