Reliability and validity of skin blot examination for adenosine triphosphate to detect pressure induced minor tissue damage

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Background

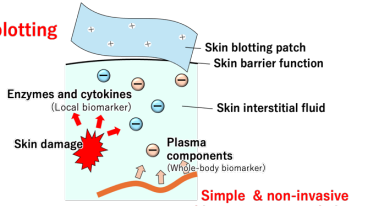
- Early detection of subtle tissue damage caused by external force is a promising approach for personalized pressure injury prediction.
- We previously reported that adenosine triphosphate (ATP) collected from compressed skin through skin blotting can identify tissue damage.

Aim

To study the reliability and validity of ATP detection through skin blotting for identifying minor tissue damage induced by pressure.

What is skin blotting?

- Developed as an objective and non-invasive skin assessment technique[3)].
- By simply applying a skin blotting membrane hydrated with saline on skin surface for 10 mins, physiological molecules (e.g. ATP) localized within the tissues can be collected.
- Skin blotting has been applied to various human-based studies including vulnerable populations such as older adults and neonates for assessing risk of skin tear[4,5)], pressure ulcer healing[6)] and neonatal dermatitis[7)].



References

1) Minematsu et al. The Japanese Society for Wound Healing Abstracts, 52:78, 2022.
2) Anders et al. J Am Soc Nephrol, 25(7):1387-1400, 2014.
3) Minematsu T, et al. Adv Skin Wound Care. 2014;27(6):272-279.
4) Rayner et al. Int Wound J. 2019;16(1):52-63. 5) Koyano et al. Int Wound J. 2016;13(2):189-197.
6) Nakai et al. J Tissue Viability. 2019;28(2):87-93.
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Methods

1. **The intra-rater reliability**
   - Design: cross-sectional study
   - Participants: examiners: three nursing researchers
     subjects: seven healthy adults
   - Procedures: three examiners conducted an **ATP test using skin blotting** twice on each subject.
   - Analysis: the intra-class correlation coefficient (ICC 1,1)
   - This study was approved by the ethical committee of Ishikawa Prefectural Nursing University (#2023−152).

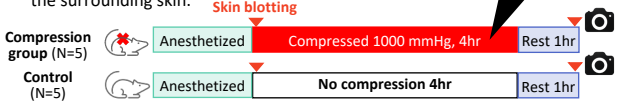
< ATP test using skin blotting >

① Wiping the targeted skin area five times in one direction with a non-woven cloth moistened with distilled water.
② Applying a skin blotting patch for 10 mins.
③ The nylon membrane was placed into an inspection kit, and the amount of collected ATP was measured using a portable ATP analyzer.

Portable ATP analyzer (Kikkoman, Co. Ltd)

2. **Validity**
   - Design: animal study
   - Animal: 6-wk-old male BALB/cCreSlc mice
   - Procedures:

① Acclimatized and housed for 1 wk, and then randomly assigned to the compression group and the control group.
② The compression group: the dorsal skin was compressed.
③ The ATP test using skin blotting was conducted on the skin surface of the compressed area and the surrounding skin.



   - Analysis: The ratio of ATP in the compressed area to the surrounding skin (compressed/surrounding skin) was compared between the compression and control groups(independent t-tests).
   - This study was approved by the ethical committee of the Animal Experimentation Committee of Kanazawa University (AP-234455).

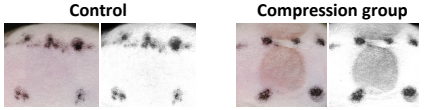
Results

1. **The intra-rater reliability**

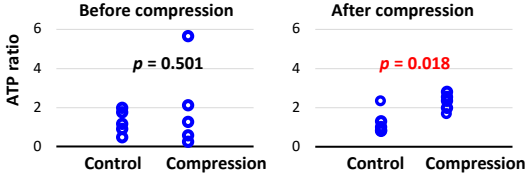
Examiner	ICC	95% CI			p value
A	0.409	-0.431	-	0.887	0.160
B	0.620	-0.268	-	0.951	0.072
C	0.912	0.491	-	0.990	0.002
Average	**0.615**	**0.201**	**-**	**0.845**	**0.004**

2. **Validity**
   - The compression group exhibited Grade I pressure injuries after compression.

Photos at 1hr after compression



   - The ATP ratio (compressed/surrounding skin) was significantly higher after compression in the compression group (2.3 ± 0.4 vs 1.3 ± 0.6, p = 0.018)



Conclusion

The ATP test using skin blotting is a reliable and valid point-of-care method for detecting minor tissue damage in a mice model of pressure injuries.

Disclosure of COI: Hasegawa Y and Ogai K belong to the department sponsored by Saraya Co., Ltd (Osaka, Japan).

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