Institution: University of Northampton		
Unit of Assessment: 5 - Biological Sciences		
Title of case study: Improving rehabilitation and advances in international practice in relation to ankle ligament surgical repair		
Period when the underpinning research was undertaken: 2005 - 2019		
Details of staff conducting the underpinning research from the submitting unit:		
Name(s): William Ribbans	**Role(s) (e.g. job title):** Professor	**Period(s) employed by submitting HEI:** 2005 - Present
Period when the claimed impact occurred: 2015 - 2020		
Is this case study continued from a case study submitted in 2014? No		

1. Summary of the impact

Ribbans' innovative clinical practice and research have confirmed the efficacy of, and led to new applications for, the *Internal*Brace, a product initially developed and employed in the treatment of ankle soft tissue injuries amongst sports players. His research demonstrated minimal complications and accelerated return to activities such as running, and has widened the product's reach to a range of joints in the body and in the non-sporting population with enhanced recovery, stability and return to physical activity and general activities of daily living. For many surgeons around the world, it has now become their primary method of ankle ligament stabilisation for all patients.

2. Underpinning research

The most commonly used and accepted orthopaedic approach to re-establishing lateral ankle ligament stability has been anatomic reconstruction using the Broström approach in both the acute and chronic situations since 1966. Despite the efficacy of this approach, research has found that there are concerns related to the initial strength of the repairs, their impact on mobility, continuing pain, return to sport, and the potential for re-injury after return to normal activities, be these activities in sport, work, or general activities of daily living. In response to these challenges, **Ribbans**, a clinical practitioner (orthopaedic surgeon) and Professor of Sports Medicine at the University of Northampton, has collaborated with Professor Gordon Mackay in developing the *Internal*Brace in 2012, on clinical applications of the *Internal*Brace to refocus on the restoration of normal anatomy and function and early mobilisation.

Ribbans has a long history of research into the foot and ankle. He has published on many aspects such as injuries (e.g. fractures, tendons and ligaments **[3.1]**), underlying pathologies (e.g. haemophilia and arthritis of various joints), basic science contribution to disease (e.g. genetics of tendon and ligament ruptures), surgical techniques **[3.2]**, optimising outcomes (e.g. bone health status **[3.3]**) and minimising complications (e.g. infection risks). The extensive research undertaken and published by **Ribbans** over the last 20 years on ankle and foot injuries, their underlying pathologies and basic science, led to the conclusion that the next clear area for his research attention was investigating better means of securing optimal outcomes for ankle ligament surgery. This conclusion was reached as patient outcomes were often not optimal and a considerable amount of his clinical time was devoted to this ongoing problem. Once the *Internal*Brace was launched in 2012, it seemed a promising avenue for clinical utilisation and objective analysis of patient outcomes.

The *Internal*Brace is a FibreTape augmentation of the Broström technique secured with Biocomposite SwiveLocks, and its use has produced improved results in ankle repair biomechanics and recovery. **Ribbans** has worked closely with Mackay, who originally developed the product, on producing data around its use and confirming efficacy in clinical situations **[3.4]**. Working with Mackay, **Ribbans** has expanded the indications of the product's efficacy from the initial augmentation of Broström repair in chronic cases to the support of more acutely injured soft tissues in high performance sport **[3.4]**.

Ribbans research has contributed to the successful application to other foot and ankle ligaments including the deltoid, spring and syndesmosis complexes as well as other locations including the knee, shoulder, elbow and hand **[3.5]**. This confirmed that the surgical technique works, and that it produces an improved outcome compared to other techniques, or when used in conjunction with them **[3.4, 3.5]**. Following these findings, Mackay and **Ribbans** published a chapter that provides important points in performing the operation for surgeons embarking upon this technique **[3.6]**. The chapter provides independent biomechanical research on the enhanced strength of this augmented construct. It provides surgical principles and 'tips and pearls', for instance regarding anatomical landmarks, to guide surgeons in ensuring optimal surgical and patient outcomes.

3. References to the research

[3.1] Ribbans W.J. & Garde, A. (2013). Tibialis posterior tendon and deltoid and spring ligament injuries in the elite athlete. *Foot and Ankle Clinics*, *18*(2), 255-291. https://doi.org/10.1016/j.fcl.2013.02.006

[3.2] Aslam, N., & **Ribbans W.J.** (2005). First metatarsophalangeal joint arthrodesis using a vitallium plate with a mean two year follow up. *Foot and Ankle Surgery*, *11*, 197-201. https://doi.org/10.1016/j.fas.2005.07.002

[3.3] Aujla, R., Allen, P., & **Ribbans W.J.** (2017). Vitamin D levels in 577 consecutive elective foot and ankle surgery patients. *Foot and Ankle Surgery*, *25*(3), 310-315. https://doi.org/10.1016/j.fas.2017.12.007

[3.4] MacKay, G., & **Ribbans W.J.** (2016). The Addition of an "Internal Brace" to Augment the Broström Technique for Lateral Ankle Ligament Instability. *Techniques in Foot and Ankle Surgery*, *15*(1), 47-56. https://doi.org/10.1097/BTF.0000000000000111

[3.5] MacKay, G., Blyth, MJG., Anthony, I., Hopper, GP., & **Ribbans W.J.** (2015). A Review of Ligament Augmentation with the *Internal*BraceTM: The Surgical Principle Is Described for the Lateral Ankle Ligament and ACL Repair in Particular, and a Comprehensive Review of Other Surgical Applications and Techniques Is Presented. *Surgical Technology International*, *26*, 239-255. https://europepmc.org/abstract/med/26055016

[3.6] MacKay, G., & **Ribbans W.J.** (2018). Ligament Augmentation with the Internal Brace. In *Foot and Ankle Surgery: Tricks of the Trade* (Vol. 1, pp. 297). Thieme Publishing. https://doi.org/10.1055/b-0038-162069

4. Details of the impact

Ribbans' research led to lecturing and hands-on teaching assignments with surgeons and medical professionals to demonstrate the use of the *Internal*Brace, which has contributed to it becoming an accepted technique for a common surgical problem, and its use has been adopted worldwide, leading to improved patient outcomes. As the Managing Director of Arthrex notes in his testimonial, **Ribbans'** "clinical publications **[3.4, 3.5]** have been pivotal in establishing the role of this innovative implant" and its subsequent adoption worldwide, leading to improved patient outcomes **[5.1].**

Impact on International Practice

Based on his surgical experience with the *Internal*Brace and published research demonstrating its efficacy **[3.4 – 3.6]**, **Ribbans** has been invited to various surgical meetings (lecturing and workshops) to share his experiences with international practitioners **[5.1]**. Additionally, **Ribbans** has presented the technique in hands-on large educational cadaver workshop settings with Arthrex, the manufacturer of the *Internal*Brace. As the Managing Director of Arthrex notes, **Ribbans** has "lectured and provided cadaver workshops to surgical societies from the United Kingdom, Poland, Norway, Sweden, Denmark, and Finland… [and] spoken at international meetings held in Germany, Spain, Portugal, France and the United Kingdom" **[5.1]**. As a result of **Ribbans'** "lecturing and workshop sessions (with hundreds of orthopaedic surgeons), the technique has become an accepted part of the armamentarium of thousands of doctors around the world" **[5.1]**.

Impact on Patients

Ribbans' use of the *Internal*Brace involving lateral ankle ligament reconstruction with athletes, has increased ankle stability and decreased recovery time from surgery to return-to-sport. Professor Gordon Mackay (the inventor of the *Internal*Brace) acknowledges in his testimonial "the significant contribution Professor **Ribbans** has made to the whole process of translational research as we have developed the *Internal*Brace and its application globally over the last 10 years" **[5.3]**. Pre-*Internal*Brace recovery from lateral ankle ligament reconstruction using the Broström technique was typically up to four to five months **[5.2.1]**; with the addition of the *Internal*Brace the return-to-sport was substantially reduced to three months or less **[3.4, 5.3.2]**. This significant reduction in time out from competition has transformed the patient experience. In addition to the reduction in time out of action, further key benefits include reduced surgical morbidity, stronger repairs **[5.3.3, 5.3.4]**, the avoidance of detrimental effects of immobilisation through enhanced rehabilitation, and increased proportion of patients returning to their previous level of sporting activity **[3.4, 5.3.2]**.

Impact on Company

Prior to **Ribbans'** research with Professor Gordon Mackay; Managing Director of Arthrex **[3.4 – 3.6]**, Arthrex (the *Internal*Brace manufacturer) did not have any large data samples regarding the application of the *Internal*Brace, nor was there any published research with which to verify its efficacy. **Ribbans**' research was essential to providing this clinical evidence for the company to enable them to promote the wider use of their technology for clinical populations. Mackay notes that "**Ribbans** not only has collaborated closely and provided significant feedback at the conceptual stage but also has been an early adopter and has helped to develop variations of the surgical technique and clinical applications" **[5.3]**. Overall, **Ribbans'** clinical practice and dissemination of his research has helped Arthrex promote the efficacy and increase the use of the *Internal*Brace since its development and inception in 2012 where it was first used during surgical repair **[5.1]**.

As a result of **Ribbans'** research and clinical workshops, Professor Mackay notes in his testimonial that the *Internal*Brace "has been used in numerous locations throughout the body with similar successful outcomes"; as of 2019, this has resulted in "more than 5,000 implants in Europe and more than 17,000 worldwide used annually" **[5.1]**. Mackay also notes "With the contribution made by Professor Ribbans, surgical practice has not only improved internationally but, more importantly, has also enhanced the patient experience, accelerating recovery and reducing morbidity. Internal bracing for augmentation and repair of injured ligaments is now a recognised technique globally" **[5.3]**.

5. Sources to corroborate the impact

[5.1] Testimonial from Stefan Krupp, the Managing Director of Arthrex, on the impact of **Ribbans'** educational seminars and research on the development and use of the *Internal*Brace.

[5.2] Independent research confirming the efficacy of the *Internal*Brace to improve patient outcomes.

[5.2.1] Lohrer H., Bonsignore G., Dorn-Lange N., Li L., Gollhofer A., Gehring D. (2019). Stabilizing lateral ankle instability by suture tape – a cadaver study. *Journal of Orthopaedic Surgery Research, 14*, 175. https://doi.org/10.1186/s13018-019-1218-6 (cites **[3.4]**)

[5.2.2] Coetzee JC., Ellington JK., Ronan JA., Stone RM. (2018). Functional Results of Open Broström Ankle Ligament Repair Augmented With a Suture Tape. *Foot and Ankle International, 39*(3), pp. 304-310. https://doi.org/10.1177/1071100717742363

[5.2.3] Yoo JS., Yan EA. (2016). Clinical results of an arthroscopic modified Broström operation with and without an internal brace. *Journal of Orthopaedics and Traumatology, 17*, pp. 353–360. https://doi.org/10.1007/s10195-016-0406-y

[5.2.4] Foot and Ankle Institute's recommendations for the efficacy of the *Internal*Brace to improve patient outcomes. - https://www.footankleinstitute.com/treatments/internalbrace-for-chronic-ankle-instability

[5.3] Testimonial from Professor Gordon Mackay, inventor of the *Internal*Brace, on **Ribbans'** contribution to confirming the efficacy of the *Internal*Brace to improve patient outcomes.