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Original article

# Responsiveness of the Victorian Institute for Sport Assessment for Gluteal Tendinopathy (VISA-G), modified Harris hip and Oxford hip scores in patients undergoing hip abductor tendon repair

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ABSTRACT

*Background:* A lack of consensus exists on which patient-reported outcome measures (PROMs) best evaluate change following hip abductor tendon (HAT) repair.
*Objectives:* To compare the responsiveness of the Victorian Institute for Sport Assessment for Gluteal Tendinopathy (VISA-G), Oxford Hip (OHS) and modified Harris Hip (mHHS) scores in patients undergoing HAT repair.
*Study design:* Prospective case series.
*Methods:* 56 patients underwent HAT repair and were evaluated pre-surgery and 3, 6 and 12 months post-operatively using the VISA-G, OHS, mHHS and a Global Rating of Change (GRC) scale. Internal and external responsiveness, the minimal clinically important change (MIC) and the presence of ceiling effects were evaluated. The extent to which VISA-G change was associated with mHHS and OHS change was investigated, as was the extent to which PROM changes were discriminatory for GRC improvement.
*Results:* All PROMs demonstrated large standardized effect sizes (> 1), with the VISA-G demonstrating responsiveness similar to the mHHS and OHS. At 12 months, the GRC correlated similarly with VISA-G (0.42, 95% CI: 0.17–0.61), mHHS (0.44, 95% CI: 0.17–0.61) and OHS (0.53, 95% CI: 0.31–0.70) changes. Using a GRC anchor of ≥ 4, an MIC of 29/100, 29/91 (32/100) and 16/48 (33/100) was observed for the VISA-G, mHHS and OHS, respectively. At 12 months ceiling effects existed for the mHHS (18/56, 32.1%) and OHS (13/56, 23.2%), but not VISA-G (1/56, 1.8%).
*Conclusion:* The VISA-G demonstrated acceptable responsiveness and was more resistant to ceiling effects, though demonstrated similar change scores and correlations with perceived improvement to the mHHS and OHS.
*Clinical trial registration:* This research trial is registered in the Australian New Zealand Clinical Trials Registry (ACTRN12616001655437).

## 1. Introduction

Greater Trochanteric Pain Syndrome (GTPS) is a well documented and common cause of hip pain (Lievense et al., 2005; Segal et al., 2007); bestowing significant pain and functional limitations on the patient (Ebert et al., 2016; Fearon et al., 2014). Gluteal tendinopathy, with or without tears, is now recognised as being the primary pathology and underlying cause of GTPS (previously referred to as trochanteric bursitis) (Bird et al., 2001; Cvitanic et al., 2004; Grimaldi and Fearon, 2015; Kingzett-Taylor et al., 1999). Kagan (1999) published one of the earliest series of surgical reattachment of the torn hip abductor tendons (HAT), reporting that 100% of patients (n = 7) were pain free at a mean 45 months post-surgery, though no other outcome measures were reported. In the presence of HAT tears, a number of surgical procedures evaluated via a variety of patient-reported outcome measures (PROMs) have since been published, generally with satisfactory outcomes (Ebert

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et al., 2015).

In addition to a pain score (visual analogue or numeric rating), the Harris Hip Score (HHS) (Harris, 1969) and modified HHS (mHHS) (Byrd and Jones, 2003), as well as the Oxford Hip Score (OHS) (Dawson et al., 1996; Murray et al., 2007), have been most commonly employed to evaluate the outcomes of HAT repair (Ebert et al., 2015). The OHS and the HHS were both originally designed for use in osteoarthritis (OA) and Total Hip Arthroplasty (THA) patients (Dawson et al., 1996; Harris, 1969). Both the HHS and mHHS have been widely used in studies involving people with hip arthritis and/or following proximal femur fracture (Nilsdotter and Bremander, 2011). While these PROMs appear to have face validity for use in people undergoing HAT repair, and have frequently been used in prospective HAT repair studies (Ebert et al., 2015), neither have been validated in this population, nor has their responsiveness been evaluated.

Therefore, while a number PROMs have been employed to assess clinical outcome after HAT repair, a gluteal tendon tear specific tool has not been located (Ebert et al., 2015, 2018). The Victorian Institute for Sport Assessment for Gluteal Tendinopathy (VISA-G) is the first condition specific PROM for GTPS, and has been demonstrated to be reliable and valid in people with GTPS (Fearon et al., 2015). However, its responsiveness has not been reported nor compared with more commonly employed PROMS (i.e. OHS and mHHS) designed for a different purpose (i.e. OA and/or THA). While evaluating many of the same domains as the HHS and mHHS, the VISA-G measures a different construct (Fearon et al., 2015). While the HHS measures disablity associated with bone and joint destruction, the VISA-G measures disablity associated with soft tissue impairments around the lateral hip (Fearon et al., 2015). The VISA-G has not been employed to evaluate patients before and after HAT repair; however, given it's condition specific nature it may be more responsive than non-GTPS PROMs. Therefore, the primary aim of this study was to compare the responsiveness of the mHHS, OHS and VISA-G in patients undergoing surgical HAT repair. Secondary aims sought to investigate the presence of ceiling effects and estimate minimal clinically important changes (MICs) for each PROM at 12 months post-surgery in this HAT cohort.

## 2. Materials and methods

### 2.1. Patients

Between May 2015 and May 2017, a prospective series of 61 consecutive patients underwent HAT repair, all performed in private practice by a single surgeon (GJ). All patients had symptomatic (minimum 6 months) partial or full thickness tears of gluteus minimus, along with the anterior portion of gluteus medius, diagnosed via magentic resonance imaging (MRI). All patients had failed non-operative treatment including corticosteroid injections and physical therapy. The current analysis excluded patients with existing (or concomitant) THA (n = 2), patients that underwent HAT repair bilaterally (n = 1), patients that had either withdrawn from the study after surgery due to reported time and travel restraints or could not be located for all pre- and post-operative (3, 6 and 12 month) clinical reviews (n = 1), or patients that had suffered an MRI-diagnosed tendon re-tear within the 12 month post-operative review period (n = 1). Therefore, this analysis was undertaken on 56 patients (Table 1). Although this was a sample of convenience, a sample size of n = 56 allowed 95% confidence intervals of change scores for each PROM within ± 4 points on a 100 point scale (based on a change score SD of 15 points), ensuring the sample was adequately powered to observe meaningful differences in responsiveness between the three PROMs, by way of non-overlapping confidence intervals of a width of 8 points. Patients provided written informed consent prior to study enrollment and subsequent pre-operative clinical evaluation, the study had ethics approval from the relevant hospital ethics committee and was registered in a clinical trial registry.

**Table 1**
Patient demographics and injury/surgery history for the 56 patients who were included in the study. Shown are means (SD, range) where relevant.

| Variable | Mean (SD, range) |
|---|---|
| Gender (female/male) | 52/4 |
| Prior Hip Surgical Procedures | 4 |
| Age (years) | 65.8 (7.8, 51–84) |
| Body Mass Index (BMI) | 28.6 (4.4, 20.9–39.5) |
| Duration of Symptoms (years) | 3.9 (3.7, 0.5–20.0) |
| Prior Cortisone Injections | 3.5 (2.5, 1–12) |

Prior Hip Surgical Procedures = failed Hip Abductor Tendon (HAT) repair (n = 1), iliotibial band (ITB) release and/or bursectomy (n = 2), arthroscopic labral debridement (n = 1).

### 2.2. Surgical procedure

The augmented HAT surgical repair technique and post-operative rehabilitation process has been previously described (Ebert et al., 2018). Briefly, the gluteus minimus and the anterior fibres of gluteus medius (in all cases) were elevated from the anterior greater trochanter. Any intact, generally posterior, fibres of the gluteus medius were not dissected from bone. The bony insertional footprint of the tendon was decorticated and tendinopathic tissue was excised from the distal tendon end. Gluteal tendons were formally repaired with interosseous suture and bone anchors, augmented with a LARS (ACTOR 10, Corin Group, Cirencester, UK) ligament. Patients underwent a coordinated rehabilitation program of graduated weight bearing and progressive exercise over 3–4 months, with ongoing advice and exercise prescription provided as required.

### 2.3. Clinical assessment

Firstly, all patients in this study completed the OHS, mHHS and VISA-G pre-operatively and at 3, 6 and 12 months post-operatively. The OHS is scored from 0 to 48 (a higher score being desirable), with this PROM primarily evaluating percieved hip pain and function. The mHHS is scored out of 91, also including pain (0–44) and function (0–47) components. To facilitate the comparison of responsiveness across the PROMS, the OHS and mHHS were The VISA-G is a condition specific PROM for GTPS, for which gluteal tendinopathy is now considered to be the primary cause (Blankenbaker et al., 2008; Connell et al., 2003; Fearon et al., 2017). The VISA-G is scored from 0 to 100 (a higher score being desirable), and consists of eight items, covering three primary domains: pain, function and current activity level (Fearon et al., 2015). It includes a visual analogue score for pain (0–10), the effect of pain on weight bearing activities (0–30) and six further questions that relate to difficulty and/or function, including lying on the symptomatic side (0–10), using stairs (0–10), using a ramp (0–10), transitioning to standing from sitting (0–10), work about the house or garden (0–10) and participation in regular exercise, physical activity and sport (0–10). It has demonstrated good reliability and validity in people with GTPS (Fearon et al., 2015), though its responsiveness has not been reported. Finally, patients also completed an 11-point Global Rating of Change (GRC) scale (Kamper, 2009), employed to evaluate the patient's perceived status compared to before their surgery, ranging from −5 (very much worse) to 0 (about the same) to 5 (completely recovered). converted to a 0–100 scale.

The VISA-G is a condition specific PROM for GTPS, for which gluteal tendinopathy is now considered to be the primary cause (Blankenbaker et al., 2008; Connell et al., 2003; Fearon et al., 2017). The VISA-G is scored from 0 to 100 (a higher score being desirable), and consists of eight items, covering three primary domains: pain, function and current activity level (Fearon et al., 2015). It includes a visual analogue score for pain (0–10), the effect of pain on weight bearing activities (0–30) and six further questions that relate to difficulty and/or function, including lying on the symptomatic side (0–10), using stairs (0–10), using a ramp (0–10), transitioning to standing from sitting (0–10), work about the house or garden (0–10) and participation in regular exercise, physical activity and sport (0–10). It has demonstrated good reliability and validity in people with GTPS (Fearon et al., 2015), though its responsiveness has not been reported. Finally, patients also completed an 11-point Global Rating of Change (GRC) scale (Kamper, 2009), employed to evaluate the patient's perceived status compared to before their surgery, ranging from −5 (very much worse) to 0 (about the same) to 5 (completely recovered).

### 2.4. Data and statistical analysis

Statistical analysis was performed using Stata/IC 15.0 for Windows (StataCorp LLC, College Station, TX, USA).

Internal Responsiveness for the mHHS, OHS and VISA-G was evaluated and compared using two standardized measures of change: Cohen's effect size (ES = mean change score/standard deviation [baseline]) and standardized response mean (SRM = mean change score/standard deviation [change score]), at 3, 6 and 12 months post-surgery. Bias-corrected bootstrapped confidence intervals (CIs) were calculated for each measure using 10,000 samples with replacement (Efron, 1987). Additionally, Pearson's correlation coefficient was calculated to examine the extent to which changes in the VISA-G were associated with changes in the mHHS and OHS at 12 months post-surgery.

External responsiveness was assessed by using Spearman's correlation coefficient to estimate the association between the change score for each PROM and GRC from baseline to 12 months post-surgery. A test of equality of the correlation coefficients was performed using *corcor* command in Stata. Additionally, receiver operating characteristic (ROC) curve analyses were performed to estimate and compare the extent to which baseline to 12 month PROM change scores were discriminatory for reports of being 'recovered' using two different cutoffs (≥3 and ≥ 4 on the GRC), using a non-parametric approach to calculate area under the curve (AUC) and corresponding 95% CIs. A test of equality of ROC curve areas was also performed using the *rcomp* command in Stata.

Measures of MIC for each PROM at 12 months post-surgery were estimated in two ways. Firstly, the cut-off point that maximized sensitivity and specificity for identifying those patients who were 'recovered' according to both cut-offs was determined, using the optimal cut-point method; that is, the change score closest to the point (0,1) on the top left-hand corner of the ROC graph. Secondly, using the method of Tubach et al. (2012) the MIC was defined as the 75th percentile of the distribution of change scores for those that reported slight or moderate degree of recovery (i.e. scored 1, 2 or 3 on GRC).

The potential for ceiling effects for each PROM were evaluated at 12 months post-surgery for the mHHS, OHS and VISA-G, and were deemed to be present if > 15% of participants had the maximum possible score (Terwee et al., 2007).

## 3. Results

Fig. 1 displays the trajectory of change of each measure scaled to 100. The ES and SRM for all three PROMs at all time-points were all > 1 (Table 2). The VISA-G demonstrated the same level of responsiveness as the mHHS and OHS at 3, 6 and 12 months post-surgery, with similar 95% CIs for all measures for both ES and SRM at each time-point (Table 2). At 12 months post-surgery, the correlation between the change score for the VISA-G and the change score in the mHHS was 0.52 (95% CI: 0.30–0.69), and the correlation between the change score for the VISA-G and the change score in the OHS was 0.64 (95% CI: 0.45–0.77).

At 12 months post-surgery, the GRC correlated similarly with the change in the VISA-G (0.42, 95% CI: 0.17–0.61), mHHS (0.44, 95% CI: 0.17–0.61) and OHS (0.53, 95% CI: 0.31–0.70). The correlation between the GRC and the VISA-G was not significantly different from the correlation between the GRC and the mHHS (z = −0.21, p = 0.42) or the correlation between the GRC and the OHS (z = −1.12, p = 0.13). The ROC curve analysis showed similar AUCs for the VISA-G, mHHS and OHS, ranging from 0.70 to 0.79 for a GRC of ≥4, and from 0.87 to 0.88 for a GRC of ≥3 (Table 3). The AUCs were not significantly different between the three PROMs for a GRC of ≥4 ($chi^2_{(2)}$ = 2.75, p = 0.25) or a GRC of ≥3 ($chi^2_{(2)}$ = 0.07, p = 0.96).

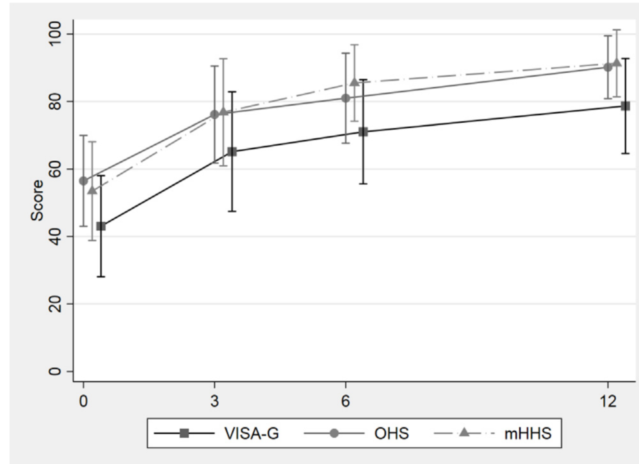


**Fig. 1.** Changes in the Victorian Institute for Sport Assessment for Gluteal Tendinopathy (VISA-G), modified Harris Hip (mHHS) and Oxford Hip (OHS) scores from pre-surgery to 12 months. All scores were scaled to 0–100, showing means (SD).

The MIC for the VISA-G at 12 months post-operatively, calculated using the optimal cut-point method from the ROC curve analysis, was 29 using an anchor of GRC ≥4, and 22 using a GRC ≥3. The MIC for the mHHS at 12 months post-operatively, calculated using the optimal cut-point method from the ROC curve analysis, was 29/91 (32/100) using an anchor of GRC ≥4, and 28/91 (31/100) using a GRC ≥3. The MIC for the OHS at 12 months post-operatively, calculated using the optimal cut-point method from the ROC curve analysis, was 16/48 (33/100) using an anchor of GRC ≥4, and 12/48 (25/100) using a GRC ≥3. Using the method of Tubach et al. (2012) the MIC was calculated as 41/100 for the VISA-G, 41/91 (45/100) for the mHHS and 15/48 (31/100) for the OHS.

Ceiling effects were present at 12 months post-surgery for the mHHS (18/56, 32.1%) and OHS (13/56, 23.2%), but not for the VISA-G (1/56, 1.8%).

## 4. Discussion

The VISA-G demonstrated acceptable internal and external responsiveness in patients undergoing HAT repair. The most important finding of the current study was that despite the condition-specific nature of the VISA-G, albeit developed with input from patients with lateral hip pain though not patients recovering from HAT surgery (Fearon et al., 2015), the VISA-G demonstrated similar post-operative change scores and correlations with perceived improvement to the mHHS and OHS. However, unlike the mHHS and OHS, the VISA-G did not demonstrate a ceiling effect.

Acceptable internal responsiveness was reported for all PROMs in this HAT repair cohort, with large ESs and SRMs observed at all post-operative time-points. Large ESs of 2.8 for pain and 1.72 for function have been reported previously for the mHHS in the first six months following THA (Shi et al., 2009), as well as varying ESs of 2.38–3.1 in the first 12 months post-surgery after THA for the OHS (Nilsdotter and Bremander, 2011). Despite the condition-specific nature of the VISA-G,

**Table 2**
Pre-operative and 3, 6 and 12 post-operative scores, together with change scores, for the three patient-reported outcome measures employed in the 56 patients who underwent hip abductor tendon repair.

| Time-point | Score | Change from Pre-surgery | | Effect Size (ES) | | Standardized Response Mean (SRM) | |
|---|---|---|---|---|---|---|---|
| | Mean (SD) | Mean (SD) | 95% CI | ES | 95% CI | SRM | 95% CI |
| Victorian Institute for Sport Assessment for Gluteal Tendinopathy (VISA-G) | | | | | | | |
| Pre-surgery | 43.0 (15.0) | | | | | | |
| 3 months | 65.2 (17.7) | 22.1 (17.2) | 17.5,26.7 | 1.48 | 1.07,1.99 | 1.28 | 0.88,1.65 |
| 6 months | 71.0 (15.5) | 28.0 (15.6) | 23.8,32.2 | 1.87 | 1.38,2.37 | 1.80 | 1.47,2.16 |
| 12 months | 78.7 (14.1) | 35.6 (16.8) | 31.2,40.1 | 2.38 | 1.85,3.03 | 2.13 | 1.75,2.63 |
| Modified Harris Hip Score (mHHS)[a] | | | | | | | |
| Pre-surgery | 53.4 (14.7) | | | | | | |
| 3 months | 76.8 (15.9) | 23.4 (22.0) | 17.5,29.3 | 1.60 | 1.13,2.22 | 1.06 | 0.72,1.40 |
| 6 months | 85.5 (11.4) | 32.1 (17.5) | 27.4,36.8 | 2.19 | 1.70,2.86 | 1.83 | 1.45,2.29 |
| 12 months | 91.3 (9.9) | 37.9 (18.2) | 33.1,42.8 | 2.59 | 2.04,3.27 | 2.09 | 1.69,2.65 |
| Oxford Hip Score (OHS)[a] | | | | | | | |
| Pre-surgery | 56.5 (13.5) | | | | | | |
| 3 months | 76.2 (14.4) | 19.7 (19.3) | 14.5,24.9 | 1.46 | 1.03,2.01 | 1.02 | 0.70,1.39 |
| 6 months | 81.0 (13.3) | 24.5 (18.4) | 19.6,29.4 | 1.82 | 1.40,2.34 | 1.34 | 1.03,1.65 |
| 12 months | 90.2 (9.3) | 33.7 (16.6) | 29.3,38.1 | 2.50 | 2.02,3.08 | 2.04 | 1.69,2.42 |

[a] mHHS and OHS transformed to a 0–100 scale to allow comparability with the VISA-G.

**Table 3**
Receiver operating characteristic curve analysis.

| 12 month change score | GRC ≥4 (n = 34/56, 60.7%) | GRC ≥3 (n = 47/56, 83.9%) |
|---|---|---|
| | AUC (95% CI) | AUC (95% CI) |
| VISA-G | 0.70 (0.56–0.81) | 0.88 (0.76–0.95) |
| mHHS | 0.72 (0.57–0.86) | 0.88 (0.77–0.99) |
| OHS | 0.79 (0.68–0.91) | 0.87 (0.75–0.98) |

GRC = Global rating of Change, VISA-G = Victorian Institute for Sport Assessment for Gluteal Tendinopathy, mHHS = modified Harris Hip Score, OHS = Oxford Hip Score, AUC = Area under the curve.

it was no more (or less) responsive to post-operative change compared with the mHHS or OHS, which were developed and are more commonly employed for patients with hip OA embarking on THA (Dawson et al., 1996; Nilsdotter and Bremander, 2011). This was a surprising finding given tendinopathy-specific condition PROMs have been shown to be superior to more generic tools (Macdermid and Silbernagel, 2015).

All PROMs exhibited correlations of similar size with perceived improvement (or not) reported by patients via the GRC scale. While this is the first time the VISA-G has been reported specifically in patients undergoing surgical reconstruction for HAT tears, and the similar post-operative change scores and correlations with perceived improvement across all PROMs may validate its use specifically in this population, there are known potential issues in using GRC scales in this way. The GRC scale is not without its own limitations. While this study employed a relatively short 12 month evaluation period, any GRC scale requires the patient to recall a pre-operative state. It is also unknown whether the construct, of which each individual patient formulates their evaluation, is similar or comparable (Kamper et al., 2009). As previously reported, recovery (from injury or surgery) is complex and multi-dimensional (Beaton et al., 2001), and while one patient may formulate their perceived change on pain and/or symptoms, another may employ functional capacity. Nevertheless, and acknowledging the aforementioned limitations, the 11-point GRC scale is a recognised and well accepted tool, administered in this study based on the recommendations of Kamper et al. (2009).

At 12 months post-surgery, the MIC was similar for the VISA-G and the mHHS, with the OHS performing slightly better. The MIC has not previously been reported for the VISA-G. The MIC for the mHHS has been reported as 8 points in patients undergoing hip arthroscopic surgery (Kemp et al., 2013), while the MIC for the OHS has been reported as approximately 11 points for cohort studies and 8 points for individuals undergoing THA (Beard et al., 2015). The higher MICs reported in the current study may suggest that recovery from HAT repair is less successful than THA and/or arthroscopic hip surgery, and that none of the commonly available measures have adequate sensitivity for this population. However, a measure of the amount of physical activity patients are participating in (VISA-G item 7), as well as the effect that pain has on the patient's weight bearing activity (VISA-G item 8), may provide valuable information about the amount of loading of the tendon that a person is achieving. Tendon loading rates are thought to be important in the tendon pain response (Cook and Purdam, 2009; Grimaldi and Fearon, 2015). These questions may be a valuable place to consider modifications of the VISA-G for the HAT population, in order to improve its sensitivity to post-operative change specifically in the HAT repair cohort.

Ceiling effects of PROMs may result in an under-estimate of patient recovery. While the OHS and HHS have been widely employed to evaluate the outcomes of HAT repair (Ebert et al., 2015, 2018), ceiling effects of these PROMs have previously been demonstrated (Nilsdotter and Bremander, 2011), albeit not in patients seeking improvement in pain and function via HAT repair. In this study, 32.1% and 23.2% of patients achieved the maximum score in the mHHS and OHS respectively, meaning both scores demonstrated a ceiling effect at 12 months post-surgery (Terwee et al., 2007). Comparatively, only one patient (1.8%) attained the maximum VISA-G score at 12 months. Given some impairments and activity limitations may require more than 12 months from the time of surgery to resolve (or may not resolve, such as pain with side lying), a PROM such as the VISA-G may assist in identifying persistent symptoms relevant to those with GTPS.

There are limitations that should be acknowledged in the current study. Firstly, 93% of patients were women and, while this may make the results less applicable to the male population, GTPS is a condition dominated by the female population (Lievense et al., 2005; Segal et al., 2007). Secondly, there is often an attempt to treat patients with GTPS (and HAT tear) with a number of conservative therapies prior to surgical treatment and, while the amount of cortisone injections each patient had undergone prior to pre-operative review was well documented, the timing of their last injection was not. Therefore, more recent injections may have altered the patient's report of pain at the time of pre-operative review, as well as affecting the patient's recollection of pain when completing the GRC scale at the varied post-operative time points. However, this would still have been the case for all PROMs.

## 5. Conclusion

This is the first time the VISA-G, a condition-specific PROM for GTPS, has been employed to evaluate the outcome of patients after HAT repair. Specific to this cohort, the VISA-G demonstrated acceptable internal and external responsiveness. The VISA-G demonstrated similar post-operative change scores and correlations with perceived improvement to the mHHS and OHS, though was more resistant to the ceiling effects exhibited by the latter PROMs in this surgical population. While this may provide benefit in using the VISA-G in these surgical patients, given the large MIC values calculated future research may seek to modify the content and weighting of individual domains to improve sensitivity to post-operative change specifically in the HAT repair cohort.

## Conflicts of interest

Three authors (JE, AF, AS) have no specific conflicts of interest, outside of the independent research grant awarded from the Hollywood Private Hospital Research Foundation (RF063) as outlined below. One author (GJ) has no conflicts specific to this study, though is a consultant to Corin (Australia), holds shares in Orthocell and Ramsay Health Care (both ASX listed), and receives some institutional support from Surgical Specialities.

## Ethical approval

Ethics approval was obtained by the Hollywood Private Hospital (HPH348).

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None.

## Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.msksp.2019.05.005.

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