The Effect of Technological Innovations in Reverse Total Shoulder Arthroplasty on the Rate of Periprosthetic Acromion and Scapular Spine Fractures

Todd Phillips, MD[1], Albert Mousad, MD[1], Casey Baleckas, MD[1], Jonathan Levy, MD[1]

[1] Levy Shoulder to Hand Center at the Paley Orthopedic & Spine Institute, Boca Raton, FL

Abstract:

Introduction: Innovations in reverse shoulder arthroplasty (rTSA) have helped to improve outcomes and avoid complications. These advances include improvements in implant design, surgical techniques, and supportive technologies. The original Encore RSP (Enovis, Austin, TX) design featured a modular humeral shell implanted using minimal humeral bone resection often resulting in humeral lengthening. The next iteration featured a monoblock stem with further evolution in press fit techniques. In 2014 ingrowth metal, proximal fins and extended geometry were added to facilitate metaphyseal ingrowth. In 2018, a smaller diameter shell was introduced, allowing surgeons to better match patient anatomy. Finally, in 2022, three-dimensional (3D) pre-operative planning software was used on all patients allowing a more calculated understanding of how to avoid early arc impingement and over lateralization of the final construct (**Figure 1)**. The purpose of this study was to evaluate the impact of these technological evolutions in rTSA on the incidence of acromion and scapular spine (ASF) fractures. The authors hypothesize that the rate of ASF in rTSA has decreased over time due to these innovations.

Methods: A retrospective case series from January 2007 to December 2024 was conducted. All patients who underwent reverse total shoulder arthroplasty using a single implant system (Enovis, Austin, TX) with a single surgeon were included. Patient-specific, intraoperative, and post-operative variables were collected. Cohorts were formed based upon the utilization of the technological advances described above. Descriptive statistics were utilized to analyze significant differences between the cohorts, while regression and moving average statistics were used to assist in analyzing trends in the data over time.

Results: 2,380 patients met inclusion criteria - 2068 primary rTSA (86.89%) and 312 (13.11%) revision rTSA. The total incidence of ASF was 128 (5.37%) – 115 primary (89.84%) and 13 revision (10.15%). There was no difference in the rate of observed ASF between primary rTSA and revision rTSA. 29 (22.65%) ASFs occurred in cuff intact (CI) patients and 99 (77.34%) ASFs in cuff deficient (CD) patients. There was a significant decrease in the rate of ASF through the study period ($p<.001$) between each cohort representing a technological innovation ($p<.001$, $p<.001$, $p=.001$, $p<.001$ respectively). Regression analysis of the data revealed a logarithmic best-fit with $R^2=0.765$. Moreover, analysis showed that the variance in the rate of ASFs when using pre-operative planning software (0.45%) was significantly different that the time periods where 3D planning was not utilized (5.33%) ($p=.008$). Lastly, the rate of CI versus CD patients did change over time (**Figure 2**) approaching non-significant differences between the groups after 2014 ($p=0.025$).

Conclusion: This study shows that since 2007 each iteration of technological advancement in reverse total shoulder arthroplasty has significantly decreased the periprosthetic acromion and scapular spine fracture rate. In this study, the newest technological advancement – 3D pre-operative planning – has not only significantly decreased the observed ASF rate but has also significantly decreased the variability of ASF incidence in our patient population. It is posited

that this is due to the ability to avoid early arc impingement – < 70° used as a threshold – and precent excess humeral lateralization. To our knowledge this is the first study showing the direct utility of pre-operative planning on patient outcomes.

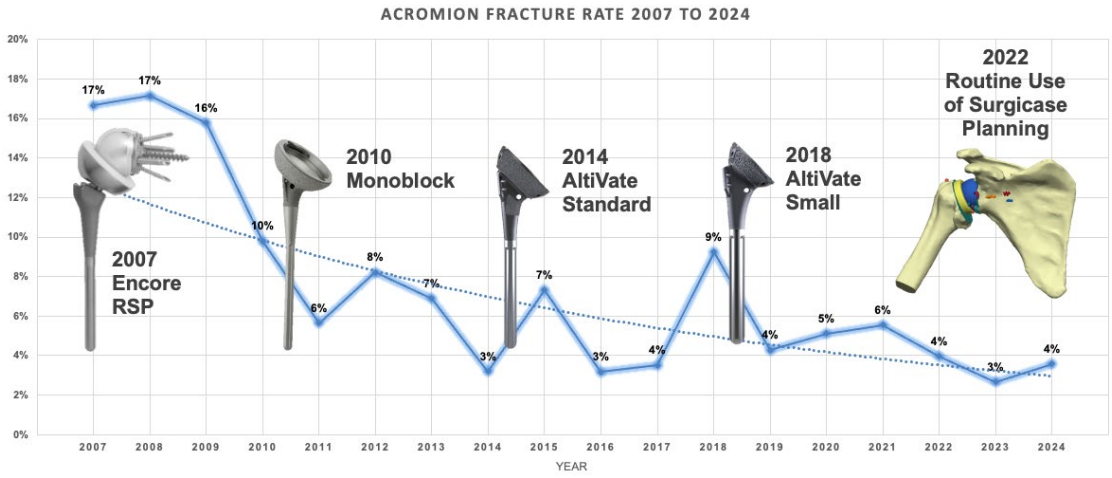

Figure 1 – Regression analysis of the observed incidence of periprosthetic acromion and scapular spine fracture (ASF) over the study period - 2007 to 2024 (Logarithmic best-fit R^2=0.765). Technological innovation cohorts are overlayed with their time points of utilization.

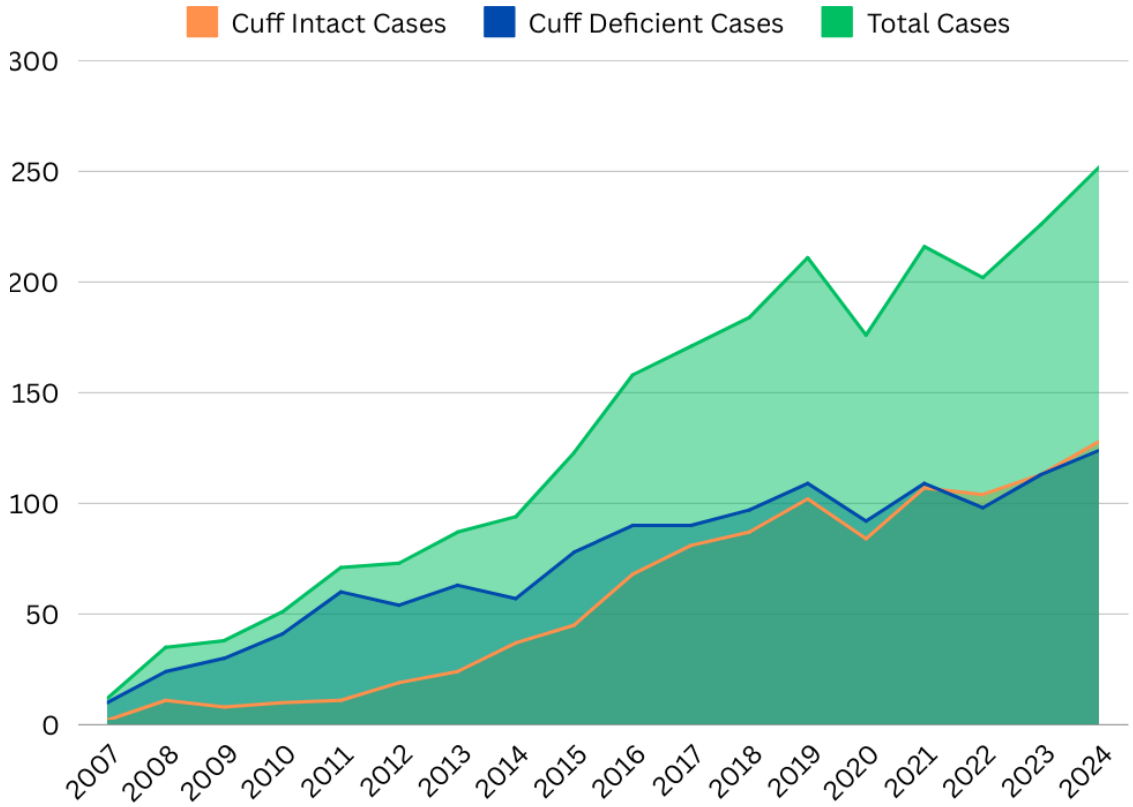

Figure 2 – Overlayed line graphs showing the trends of total cases, cuff intact (CI) cases, and cuff deficient (CD) cases over the study period from 2007 to 2024. After 2014 the differences between CI and CD rTSA cases was non-significant.