Heterotopic Ossification following primary Reverse Total Shoulder Arthroplasty

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INTRODUCTION:

The available data on heterotopic ossification following implantation of reverse total shoulder arthroplasty is limited. Most studies in the literature include occurence of those in their radiographic analysis, however, mostly without specifically including those into the analysis. Only the study of Verhoste et al analyzed 132 cases in more detail revealing a 30% prevalence of heterotopic ossification.

It was the aim of this study to determine occurrence of heterotopic ossification following reverse total shoulder arthroplasty implantation and to analyze impact on clinical outcome in a larger cohort. It was hypothesized that higher degrees of heterotopic ossification might influence the outcome.

METHODS:

A prospectively followed database of patients who underwent implantation of a reverse total shoulder arthroplasty at one tertiary referral center was retrospectively analyzed including the time period between September 2009 and February 2018. The prevalence of heterotopic ossification was evaluated in primary cases at a minimum follow-up of 2 years.

All basic demographic data, clinical outcomes (Constant-Murley-Score, Subjective Shoulder value, range of motion), complications and reoperations were collected. Heterotopic ossifications were classified as type 1a (Islands of bone within the soft tissue), type 1b (bone spurs on the inferior neck), type 1c (incomplete ankylosis)(**Figure 1**), type 2 (combination of bone spur and islands of bone), and type 3 (complete ankylosis).

Subsequently, the effect of heterotopic ossification on clinical outcome was calculated with stratification for occurrence of any complication.

Further, predictive factors for occurrence of heterotopic ossifications were calculated using multivariable regression modeling.

RESULTS:

A total of 663 reverse shoulder arthroplasties (627 patients, mean age 72 ± 9 years, 60 % female) were available for analysis at a mean follow-up of 5 ± 4 years. Of those, 524 shoulders were free of any complication. At 2 years, heterotopic ossifications were seen in 59% (392 of 663) of the cases with type 1a in 108 (16%), type 1b in 226 (34%), type 1c in 19 (2.8%) and type 2 in 39 (5.9%) (Figure 1). No type 3 was seen. Analysis over time revealed a progression of heterotopic ossification, especially at mid-term follow-up of 5 years reaching 66% (**Figure 2**).

Heterotopic ossification had a significant impact on abduction and flexion at 2 years follow-up, especially for type 1c with 118° ± 26° compared to 131° ± 24° in type 1a. Similarly, the abduction reached 117° ± 35° in type 1c compared to 138 ± 30° in type 1a. While Constant Score pain, internal rotation and external rotation did not yield significant differences, strength was also impaired in type 1c compared to type 1a with values of 2.44 ± 2.12 kg and 3.52 ± 2.18 kg abduction strength, respectively (**Table 1**). Overall analysis of Constant Score revealed no relevant difference between the groups with values of 68 ± 15 for no ossification, 70 ± 13 in type 1a, 67 ± 13 in type 1b, 64 ± 13 in type 1c, and 68 ± 14 in Type 2. Analysis of all 663 patients including those with complications revealed similar results.

Further risk factor analysis revealed no predictors for occurrence of heterotopic ossification also including complications and revision into the statistical analysis ($p = 0.443$ and $p = 0.930$, respectively).

DISCUSSION AND CONCLUSION:

The main finding of this analysis of 663 cases (524 after exclusion of complications) was progression of heterotopic ossification over time from 3% perioperatively to 59% at 2 years and 66% at 5 years. Further, heterotopic ossification significantly effected abduction and flexion, especially in type 1c (incomplete ankylosis). The effect on clinical outcome was only mild, but again, pronounced in type 1c.

It is important to know that heterotopic ossification has a significant effect on range of movement to guide patient's expectations. However, the overall clinical outcome measured as Constant-Murley-Score was only mildly influenced, mainly because heterotopic ossification does not cause pain. Unfortunately, no specific risk factors could be identified in our analysis. Before conducting the study, the authors thought that occurrence of complications might be associated with heterotopic ossification which was not the case. Other specific risk factors still need to be identified.

Detailed analysis of heterotopic ossification is rare in the literature. The most relevant study was published by Verhofste et al in 2016 including a total of 132 cases. The authors described HO in 30% of the cases with a mean study follow-up of 36 months (range, 12 to 84 months) which is less compared to our cohort with 58% at two years and 66% at five years. One reason for the higher rate in our cohort might be the longer follow-up because the study of Verhofste and our study revealed a clear progression over time.

The study was limited by the retrospective design of a prospectively followed cohort. Secondly, the radiographic analysis was only conducted by one reader. Third, it is difficult to attribute the clinical outcome to only one factor which is why complications were excluded in one part of the analysis.

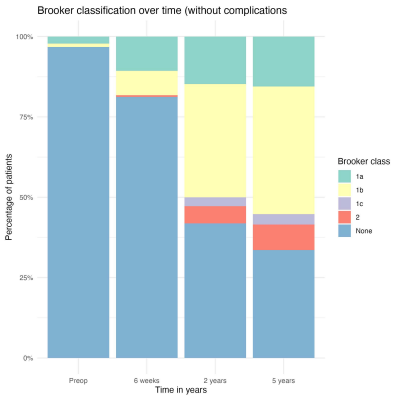

Table 1: Clinical outcome related to heterotopic ossification (excluding complications)

Characteristic	N	1a, N = 85[1]	1b, N = 191[1]	1c, N = 15[1]	2, N = 29[1]	None, N = 227[1]	p-value[2]
Constant score absolute	524	70 ± 13	67 ± 13	64 ± 13	66 ± 14	68 ± 19	0.043
Constant Score relative (%)	524	84 ± 14	80 ± 15	79 ± 14	83 ± 15	81 ± 17	0.13
Subjective Shoulder Value (%)	519	82 ± 18	78 ± 20	86 ± 11	76 ± 18	81 ± 20	0.030
Constant Score pain	524	13.61 ± 2.13	13.40 ± 2.37	13.30 ± 3.10	13.69 ± 2.07	13.32 ± 3.02	0.4
Flexion (°)	524	131 ± 24	127 ± 24	118 ± 28	128 ± 28	126 ± 24	0.3
Abduction (°)	524	106 ± 30	106 ± 29	117 ± 26	106 ± 31	106 ± 30	0.017
External rotation(°)	524	26 ± 16	27 ± 16	28 ± 10	30 ± 15	30 ± 17	0.3
Constant Score Internal Rotation	524	5.40 ± 2.81	4.89 ± 2.66	5.00 ± 2.45	4.59 ± 2.14	5.28 ± 2.88	0.3
Strength (kg)	523	3.52 ± 2.18	3.14 ± 2.02	2.44 ± 2.12	3.03 ± 2.40	3.25 ± 1.94	0.2

[1] Mean ± SD

[2] Kruskal-Wallis rank sum test