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Original article

Influence of body mass index on health-related quality of life after surgical treatment of intra-articular distal radius fractures. A retrospective 7-year follow-up study

Influence de l'indice de masse corporelle sur la qualité de vie liée à la santé après traitement chirurgical des fractures articulaires de l'extrémité distale du radius. Étude rétrospective à 7 ans de recul

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ABSTRACT

Morbid obesity is associated with reduced health-related quality of life (HRQOL), increased morbidity and mortality. Little is known about the correlation between obesity and complex distal radius fractures (DRF). The purpose of this study was to examine the effect of being overweight on postoperative HRQOL after surgically treated intra-articular DRF. Fifty-three patients were included in this retrospective study with 7 years' mean follow-up (mean 7.2 ± 0.4, range 6.4–7.9 years) after volar plating of an intra-articular DRF (AO-type C). All patients were categorized by their body mass index (BMI) into two study groups: group 1 (normal weight) with a BMI < 25 (n = 24); group 2 (obese) with a BMI ≥ 25 (n = 29). HRQOL and functional outcomes were assessed through range of motion (ROM) and four different scores — the 36-item short form health survey (SF-36), the disability of arm and shoulder score (DASH), the Gartland and Werley score and the Castaing score — along with X-rays to measure volar tilt, radial inclination, radial length and articular congruity. All HRQOL assessments and clinical outcomes were correlated to BMI by comparing group 1 versus group 2. There was no difference in terms of postoperative ROM. The group of normal weight patients achieved slightly better but non-significant results for the Gartland and Werley score. No differences were seen in the DASH score or SF-36. There were also no differences regarding the Castaing score. Overall, normal and obese patients had no significant differences their HRQOL and functionality after volar plating of DRF.

Mots clés :
Fractures du radius distal
Indice de masse corporelle
Qualité de vie

RÉSUMÉ

L'obésité morbide est associée à une qualité de vie liée à la santé (HRQOL) réduite, à une morbidité et une mortalité accrues. On sait peu de choses sur la corrélation de l'obésité avec les fractures complexes de l'extrémité distale du radius (EDR). Le but de cette étude était d'examiner l'influence du surpoids sur la HRQOL postopératoire après fracture intra-articulaire de l'EDR traitée chirurgicalement. Cinquante-trois patients ont été inclus dans cette étude rétrospective suivie sur 7 ans (moyenne 7,2–0,4, extrêmes 6,4–7,9 ans) après ostéosynthèse par plaque palmaire d'une fracture intra-articulaire (type C de l'AO) de l'EDR. Tous les patients ont été classés selon leur indice de masse corporelle (IMC) en deux cohortes : groupe 1 (poids normal) avec un IMC < 25 (n = 24) ; groupe 2 (obèse) avec un IMC > 25 (n = 29). La HRQOL et les résultats fonctionnels ont été évalués par les amplitudes de mouvement (ROM) et quatre scores différents : enquête courte sur la santé sur 36 points (SF-36), the Disability of Arm and Shoulder (DASH) score, le score de Gartland et Werley, et le score de Castaing, respectivement, et des radiographies pour mesurer l'inclinaison palmaire, l'inclinaison radiale, la longueur radiale et la

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congruence articulaire. Toutes les évaluations de la HRQOL et les résultats cliniques ont été corrélés à l'IMC en comparant le groupe 1 au groupe 2. Il n'y avait aucune différence en termes de ROM postopératoire. Le groupe de patients de poids normal avait obtenu des résultats légèrement meilleurs mais non significatifs au score de Gartland et Werley. Aucune différence n'a été observée en ce qui concerne le score DASH. Des résultats similaires ont été observés pour le SF-36. Il n'y avait pas non plus de différences concernant le score de Castaing. Dans l'ensemble, les patients normaux et obèses n'ont montré aucune différence en termes de HRQOL et de fonctionnalité après ostéosynthèse par plaque palmaire de l'EDR.

1. Introduction

Obesity is a growing worldwide problem associated not only with internal ailments such as diabetes, hypertension or cardiovascular impairments, but also with orthopedic problems such as an increased risk for arthritis or limited physical function [1]. Several authors have reported a positive correlation between obesity and osteoporosis [2]. A higher risk of bone fractures in patients with lower bone mineral density due to osteoporosis was shown previously [3]. However, there is still no consensus on whether body mass index (BMI) affects the healing of fractures [4]. It has been reported that obese patients are faced with delayed healing and a higher rate of intra- and postoperative complications after surgically treated bone fractures [5]. Vincent et al. suggested that rehabilitation was less successful in obese than non-obese patients for orthopedic trauma [6]. In various fields of musculoskeletal surgery, obese patients have worse postoperative functional outcomes [6,7].

Obese people may also react worse to avoid accidents. A higher BMI may lead to increased impaction forces especially at the wrist joint ending up in complex fractures. Distal radius fractures (DRF) are the most frequent fractures in humans. Due to the sophisticated anatomy and function of the wrist joint, DRFs demand high levels of treatment [8]. Most DRFs can be treated conservatively with anatomic reduction and immobilization through cast fixation. For displaced unstable intra-articular DRFs, surgical anatomic reduction with stable fixation is considered the gold standard [9].

However, postoperative treatment results have predominantly been evaluated by using objective clinical outcome scores. But in recent years, health-related quality of life (HRQOL) has become more important for quantifying subjective outcomes after surgically treated DRFs [10,11]. To the best of our knowledge, there is no data available on HRQOL comparing obese and normal weight patients after DRF.

Hence, the objective of our study was to answer following question: Do obese patients with a BMI ≥ 25 have a worse postoperative functional outcome and reduced HRQOL after surgically treated DRF? We hypothesized that improved functionality and HRQOL would be found in normal weight patients at 7 years' postoperative follow-up.

2. Patients and methods

2.1. Patients

The initial population consisted of 65 patients. Twelve patients were lost to follow-up: 3 died of causes unrelated to surgery, 9 could no longer be contacted. A total of 53 patients (35 females; 66%) were including in the current study. Patients were divided into two groups (group 1, group 2) according to their BMI. The BMI was calculated as follows: person's weight in kilogram (kg) divided by the square of her or his height in meter (m): BMI = kg/m^2. A BMI lower than 25 was considered as normal. Values of 25 or more were classified as overweight (pre-obese). A BMI of 30 or more was considered as obese (Table 1) [5].

In order to have two representative study cohorts, all included patients were divided based on a BMI threshold of 25: group 1 (BMI < 25) versus group 2 (BMI ≥ 25). All patients were weighed on the day of surgery on the same standardized and calibrated scale. One kilogram was subtracted from each patient's weight to account for clothing.

There were 24 (45%) normal weight patients with a mean BMI of 22 ± 2 and 29 (55%) obese patients with a mean BMI of 29 ± 3. No underweight patient was included (Table 2).

All 53 patients had suffered an intra-articular DRF (AO-type C) and underwent volar plating with the same system (I.T.S. Implant-Technologie-Systeme, Lassnitzhoehe, Austria). The complexity of the intra-articular fractures was furthermore subclassified according to the AO-Classification as a C1, C2 or C3 fracture. A radiologist and a senior surgeon classified the fractures. If they came up with different classifications, they reviewed the images together to achieve a consensus. The indication for the surgical approach as well as the surgical technique has been described previously [12].

2.2. Follow-up examination

After surgery, routine radiographic controls were performed at 4 and 12 weeks and then 1, 2 and 7 years (mean 7.2 ± 0.4, range 6.4–7.9 years) postoperatively for the purpose of this study.

Range of motion (ROM) was assessed with a goniometer during extension and flexion in the wrist joint, radioulnar deviation as well as the pronation and supination in neutral position. The goniometer was placed along the axis of rotation of the wrist joint. No bone density scan was performed in this study. The results were

Table 1
BMI according to the WHO.

Body mass index (BMI)	
< 18.5	Underweight
18.5–24.9	Normal range
≥ 25	Overweight
25–29.9	Pre-obese
≥ 30	Obese
30–34.9	Obese class I
> 30–34.9	Obese class II
≥ 40	Obese class III

Table 2
Patient data by BMI group.

	Group 1 (BMI < 25)	Group 2 (BMI ≥ 25)	*P*-value
n	24 (45%)	29 (55%)	n.s.
Female	17 (71%)	18 (62%)	n.s.
Age	59.5 ± 20.7	62.8 ± 15.6	n.s.
BMI	22.5 ± 2.1	28.9 ± 2.9	< 0.001

Age and BMI results presented as mean and standard deviation. n.s.: not significant.

compared between the normal (group 1) and obese (group 2) study cohorts.

All patients completed four different outcome scores: the 36-item short form health survey (SF-36) [13], the disability of arm and shoulder score (DASH) [14], the Gartland and Werley score [15] and the Castaing score [16]. The latter combines wrist function with radiographic data. Plain radiographs were used to measure volar tilt, radial inclination, radial length, and articular congruity to assess the Castaing score. The Gartland and Werley score consisted of a subjective evaluation of pain and an objective evaluation of wrist function on a demerit point system.

Patient-related subjective results were assessed by using the SF-36 and the DASH scores. The SF-36 is one of the most frequently used scores to evaluate a patient's health-related quality of life. The DASH score consists of 30 self-reported questions designed to measure upper extremity disability and symptoms.

The same examiner performed all the follow-up investigations in an outpatient clinic. All patients gave written informed consent to participate in the study. The study was approved by our institutional review board (IRB00002556).

2.3. Statistical analysis

Standard descriptive statistics were used to summarize all baseline and follow-up parameters. Normally distributed data were summarized as mean and standard deviation, while the median was calculated for nonparametric data. Differences in continuous outcomes between follow-up visits were evaluated with ANOVA and Friedman tests and by post-hoc tests. The significance level was adjusted according to Bonferroni. Moreover, Student's *t* test and the Wilcoxon test were applied. For parametric data, correlations were carried out with use of the Pearson coefficient. For nonparametric data, Spearman correlations were assessed. The level of significance for all tests was set at $P < 0.05$ and all tests were two-sided.

3. Results

There was no difference in terms of postoperative ROM of the surgically treated wrist joint within both study cohorts at the 7-year follow-up (Table 3). Furthermore, we compared the results with the contralateral side and within the group (Table 4). Over the follow-up period, no significant differences were found. Patients had satisfactory results in both groups on the affected side and the contralateral side.

Table 3
Range of motion by BMI group.

	Group 1 (BMI < 25) (°)	Group 2 (BMI ≥ 25) (°)	*P*-value
Extension	66 ± 13	60 ± 10	0.06
Flexion	61 ± 13	60 ± 9	0.76
Radial deviation	30 ± 11	29 ± 8	0.58
Ulnar deviation	34 ± 11	37 ± 11	0.26
Supination	72 ± 17	70 ± 19	0.69
Pronation	84 ± 11	86 ± 9	0.50

Range of motion results presented as mean and standard deviation.

Table 5
Functional outcomes by BMI group.

	Group 1 (BMI < 25)	Group 2 (BMI ≥ 25)
Gartland & Werley		
G1, *n* (%)	20 (83)	21 (72)
G2, *n* (%)	4 (17)	7 (24)
G3, *n* (%)	0 (0)	1 (4)
Castaing	2.0 ± 0.5	2.0 ± 0.4
DASH (median ± SD)	34.5 ± 12	38.0 ± 14

The group of normal weight patients achieved slightly better results on the Gartland and Werley score. No significant differences were found regarding the DASH score (Table 5). With a median DASH score of 34.5 ± 12, the group of normal weight patients achieved better results than group 2 (median 38.0 ± 14), but this difference was not statistically significant.

No significant differences were found between the two study groups for the Castaing score.

With the SF-36, no significant differences were found between the normal weight and the obese group, although patients in the normal weight group achieved slightly better results in all subscales of the SF-36. The physical component scale (PCS: 51.1 ± 10.7 and 49.5 ± 11.8) of the SF-36 had slightly more divergent results than the mental component scale (MCS: 50.0 ± 8.5 and 48.8 ± 14.1) (Table 6).

4. Discussion

The incidence of obesity has risen dramatically [17]. The change in eating habits, the lack of physical activity and a general improvement of life expectancy may be responsible for this

Table 6
QOL results (SF-36) by BMI group.

	Group 1 (BMI < 25)	Group 2 (BMI ≥ 25)	*P*-value
PF	84.0 ± 20.5	78.6 ± 27.5	0.435
RP	81.3 ± 27.3	79.5 ± 35.4	0.846
BP	82.0 ± 27.76	80.4 ± 24.8	0.829
GH	74.8 ± 23.82	67.1 ± 23.5	0.242
VT	71.4 ± 25.73	66.0 ± 23.5	0.433
SF	92.2 ± 15.56	90.1 ± 21.8	0.684
RE	91.7 ± 16.67	88.5 ± 24.2	0.591
MH	79.0 ± 13.27	75.3 ± 17.8	0.415
PCS	51.1 ± 10.71	49.5 ± 11.8	0.597
MCS	50.0 ± 8.54	48.8 ± 14.1	0.717

All results presented as mean and standard deviation. PF: physical functioning; RP: role physical; BP: bodily pain; GH: general health; VT: vitality; SF: social functioning; RE: role emotional; MH: mental health; PCS: physical component summary; MCS: mental component summary.

Table 4
Analysis of range of motion.

	Group 1 (BMI < 25)			Group 2 (BMI > 25)			*P*-value Group 1 & 2	
	Affected side (°)	Contralateral side (°)	*P*-value	Affected side (°)	Contralateral side (°)	*P*-value	Affected side	Contralateral side
Extension	66 ± 13	63 ± 13	0.477	60 ± 10	56 ± 16	0.256	0.06	0.067
Flexion	61 ± 13	59 ± 11	0.723	60 ± 9	55 ± 10	0.078	0.76	0.162
Radial deviation	30 ± 11	27 ± 11	0.296	29 ± 8	24 ± 8	0.020	0.58	0.283
Ulnar deviation	34 ± 11	31 ± 7	0.326	37 ± 11	34 ± 11	0.235	0.26	0.283
Supination	72 ± 17	68 ± 18	0.436	70 ± 19	68 ± 22	0.608	0.69	0.893
Pronation	84 ± 11	83 ± 9	0.832	86 ± 9	82 ± 18	0.299	0.50	0.713

All values are presented as mean ± standard deviation.

development, especially in industrial countries. Obesity has become a central public health issue worldwide [18].

Although DRFs are the most common fractures in humans, to the best of our knowledge, nothing has been published yet on functional or postoperative HRQOL data in obese and non-obese patients after volar plating. Hence, we performed a 7-year follow-up study of the postoperative functional outcomes, ROM and HRQOL by comparing 24 patients with a BMI < 25 with 22 patients with a BMI ≥ 25.

A comprehensive evaluation after surgically treated DRF requires reliable, validated measures of functional and subjective outcomes. Several studies have reported correlations between obesity and health-related quality of life [19]. It was clearly shown that obesity is associated with a reduced quality of life [5]. Interestingly, studies have reported that moderate obesity correlates positively with bone mineral density and might be protective for osteoporosis [20]. Large population-based studies could not confirm these findings [21]. It is well known that physical activity protects against the development of osteoporosis [22].

So far it has not been determined if obesity might influence functional outcomes and HRQOL after surgically treated intra-articular DRF. Independent of BMI, earlier studies have reported good results regarding the HRQOL after intra-articular DRF [10,11]. These findings are consistent with several studies on both HRQOL and postoperative functional outcomes in the short and medium term [10].

Comparing our normal weight and obese study group, we found no significant difference in the Gartland and Werley, DASH, SF-36, and Castaing scores. There was no significant difference in HRQOL between obese and non-obese patients with DRF. Consequently, the outcomes for obese patients are as satisfactory as the normal weight patients in our study. Our results suggest that obesity does not influence postoperative HRQOL after DRF. These findings are contrary to our study hypothesis. Gupta et al. reported similar results for patients after hip arthroscopy [23]. In terms of postoperative ROM, our study results are comparable with recent published outcome data [24]. Both study groups achieved satisfactory postoperative ROM.

In contrast to other studies, we found no significant differences between the normal weight and obese study groups in HRQOL and functional results over the 7-year follow-up period after surgically treated DRFs [25]. Other published studies reported significantly worse HRQOL in patients with osteoporosis as well as in patients with postoperative osteoarthritis [10]. However, we were not able to determine the correlation between BMI and osteoporosis or osteoarthritis in our cohort.

According to Ebinger et al., obesity is associated with more complex DRFs, even after low impact trauma, especially in elderly patients [26]. In contrast, a study with 114 patients found no correlation between obesity and the severity of DRF [27]. In our study, only patients with complex intra-articular DRF were included. No correlation between fracture complexity and the patients' weight was found. Moreover, we subclassified all intra-articular fractures according to the AO-classification in C1, C2 and C3 fractures. No significant differences were found between these groups, although the statistical power was limited due to the small group sizes.

A possible reason for lack of significance between our study groups may be related to a relatively low mean BMI (29 ± 3) in the obese study group. According to the WHO definition, a BMI between 25.00 and 29.99 is defined as overweight or pre-obese [28]. Furthermore, obesity is divided in low-risk (class I: 30.00–34.99), moderate risk (class II: 35.00–39.99) and high risk (class III: 40 or greater). Studies reporting on clinical outcome data for various medical disorders showed satisfactory results for pre-obese patients, but worse outcome results for severely or morbidly obese patients [4,21]. However, due to the limited number of participants, a representative subdivision between pre-obesity, obesity and morbid obesity was not possible.

Our study was limited by the small cohort size and by a relatively high dropout rate due to the long study period (7 years). Hence, our work might be underpowered due to the small sample size. Furthermore, there is controversy about whether BMI is an appropriate parameter to categorize obese patients. It has been suggested that body fat percentage might be a better measurement for obesity [29].

5. Conclusion

We did not find any significant differences between normal and obese patients after volar plating of DRF in our study group. There was also no statistically significant difference in HRQOL. We conclude that BMI might not influence the outcomes after surgically treated DRFs. Our results need to be confirmed in larger cohort studies including comparisons between various classes of obese patients.

Disclosure of interest

The authors declare that they have no competing interest.

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