



# The Popeye sign: a doctor's and not a patient's problem

Derek F.P. van Deurzen, MD<sup>a,\*</sup>, Frans L. Garssen, BSc<sup>a</sup>, Ronald N. Wessel, MD<sup>b</sup>, Gino M.M.J. Kerkhoffs, MD, PhD<sup>c,d,e,f</sup>, Michel P.J. van den Bekerom, MD, PhD<sup>a</sup>, Marieke F. van Wier, PhD<sup>a</sup>

<sup>a</sup>Department of Orthopedic Surgery, Shoulder and Elbow Expertise Center, Joint Research, OLVG, Amsterdam, the Netherlands

<sup>b</sup>Department of Orthopedic Surgery, St Antonius ziekenhuis, Utrecht, the Netherlands

<sup>c</sup>Department of Orthopaedic Surgery, Amsterdam University Medical Centres, Amsterdam, the Netherlands

<sup>d</sup>Academic Center of Evidence Based Sports Medicine (ACES), Amsterdam, the Netherlands

<sup>e</sup>Amsterdam Collaboration for Health and Safety in Sports (ACHSS), Amsterdam, the Netherlands

<sup>f</sup>International Olympic Committee (IOC) Research Centre of Excellence, Amsterdam, the Netherlands

**Background:** The Popeye sign is a frequently reported finding following long head of the biceps (LHB) surgery and may be more often detected by doctors than by patients. This study investigates agreement between patients and doctors regarding the presence of a Popeye sign following LHB surgery.

**Method:** This interobserver study investigates agreement between patients and consulting physicians with regard to assessment of a Popeye sign in patients following LHB surgery. Furthermore, this was compared with assessments by non-consulting physicians (observers) using digital photographs of the operated arm, taken both preoperatively and postoperatively. Data about gender, age, and body mass index (BMI) were collected to investigate their role in doctor's reporting of a Popeye sign. Patient's dissatisfaction with a Popeye sign in the operated arm was evaluated as well.

**Results:** Ninety-seven patients (mean age  $61 \pm 6.0$  years, 62% male) underwent LHB surgery. A Popeye sign was reported by 2 patients (2%) as opposed to 32 cases (40%) by consulting physicians, of which only 1 case was in agreement. Krippendorff's alpha (Kappa) for agreement between observers for preoperative photographs was 0.074 (95% CI  $-0.277, 0.382$ ) and 0.495 (95% CI 0.317, 0.659) for postoperative cases. Kappa between observers and consulting physicians for pre- and postoperative cases were 0.033 (95% CI  $-0.970, 0.642$ ) and 0.499 (95% CI 0.265, 0.699), respectively. Phi coefficient analysis showed a moderate, statistically significant correlation between male sex and Popeye sign identification. Rank-biserial calculation revealed negligible correlation between BMI and age with regard to detecting a Popeye sign by both consulting physicians and observers. Dissatisfaction about swelling in the upper arm was reported in 1 case, though in a location that did not correspond to the location of a Popeye sign.

**Conclusion:** The Popeye sign is more often identified by doctors than by patients after undergoing LHB surgery. BMI and age are not related to the detection of a Popeye sign, but sex is moderately correlated. Together with the low percentage of dissatisfaction of patients with this swelling, this signifies that a Popeye sign seems to be a doctor's rather than a patient's problem.

This study was approved by the OLVG Medical Ethical Committee (No. CWO0-2011-017).

Patients' data originate from the BITE trial which was registered in the Dutch Trial Register (NTR3255) January 12, 2012 (ClinicalTrials.gov ID NCT02655848, January 14, 2016). All patients who participated in the BITE trial completed written informed consent.

\*Reprint requests: Derek F. P. van Deurzen, MD, Department of Orthopedic Surgery, Shoulder and Elbow Expertise Center, JointResearch, OLVG, Oosterpark 9 1090 HM, Amsterdam, the Netherlands.

E-mail address: [d.vandeurzen@olvg.nl](mailto:d.vandeurzen@olvg.nl) (D.F.P. van Deurzen).

**Level of evidence:** Level III; Interobserver Agreement Design; Diagnostic Study  
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**Keywords:** Shoulder; long head of the biceps; Popeye; reliability

The occurrence of a Popeye sign is a regular topic of debate in literature on the outcome of treatment of long head of the biceps (LHB) pathology.<sup>6,14</sup> The deformity arises as a result of the descent of the biceps muscle tendon unit leaving a gap inferior to the anterior part of the distal deltoid muscle and a bulge in the distal part of the anterior part of the upper arm.<sup>15</sup> This phenomenon can be seen after surgical treatment for LHB pathology such as LHB tenotomy, but may also occur after LHB tenodesis and spontaneous rupture of the LHB tendon.

Current literature reports widely varying percentages of the Popeye sign following both LHB tenotomy and tenodesis.<sup>4,6,9,10,14</sup> The reported range in incidence of the Popeye sign may have several reasons. One of the explanations may be the auto-tenodesis effect, occurring when the LHB tendon is entrapped in the bicipital groove owing to a mismatch between LHB tendon and bicipital groove diameter. Another possibility for divergence in reports of the Popeye deformity could be that its visibility varies with the amount of fatty and muscular tissue in the upper arm. It is hypothesized that the deformity might be obscured in patients with more fatty tissue in the upper arm and may therefore be related to body mass index (BMI). In contrast, in those with a more developed biceps muscle, the descended muscle may more visibly bulge. Gender-related differences in fat distribution and muscle mass might influence the appearance of a Popeye sign. With increasing age, the amount of muscular tissue in the upper arm will decrease, and therefore the visibility of a Popeye sign may decline with ageing. However, previous studies only suggested the relation between gender and the appearance of a Popeye sign and did not find any statistically significant impact of other factors such as BMI and age.<sup>12,13</sup> Perhaps the most important explanation for the widely ranging prevalence is that there is no validated method to objectively appraise this phenomenon, so assessment may differ between physicians. This hampers analysis and comparison of results of surgical trials with regard to this topic.

Several studies reported that patients do not seem to be bothered by the appearance of a Popeye sign.<sup>1,4,9,10</sup> In these studies, varying percentages of Popeye signs were reported. Kerschbaum et al<sup>9</sup> suggested that the grade of the deformity could vary per patient and may play a role in its identification and acceptance of it by the patient.

Werner et al<sup>19</sup> identified an increase in charges for performing LHB tenodesis in the United States. Nevertheless, the number of LHB tenodeses performed is still increasing.<sup>8,17</sup> One of the explanations may be that the Popeye sign is regarded as an undesired result of LHB

tenotomy. Patients may be informed about it as a possible complication of surgical treatment for LHB pathology, resulting in a preference for tenodesis. Awareness that a Popeye sign is more often detected by surgeons than patients and is not bothersome for patients may change the consideration to choose for LHB tenodesis into LHB tenotomy.

This study investigates agreement with regard to assessment of a Popeye sign between doctors and patients. Furthermore, the association between BMI and age regarding the assessment of a Popeye sign is investigated. Satisfaction with the deformity was evaluated as well. This study hypothesizes that the Popeye sign is more often identified by doctors than patients and is not conceived as bothersome by the patient.

## Materials and methods

### Patients

The assessed patients originate from the BITE trial, which was a randomized multicenter trial comparing the results of LHB tenotomy with LHB tenodesis when performed in conjunction with arthroscopic rotator cuff repair in patients older than 50 years.<sup>18</sup>

Eligibility for participation in the study was based on arthroscopically confirmed LHB pathology. In LHB tenotomy, the proximal biceps was bisected at its junction with the superior labrum.<sup>10</sup> LHB tenodesis was performed with similar arthroscopic release of the LHB origin followed by fixation of the LHB using the remaining sutures of the most anterior suture anchor that was used for the arthroscopic rotator cuff repair. Patients were blinded for treatment of the LHB tendon. Of 100 eligible patients, 3 cases were not available at 1-year follow-up for the current study because of missing photographs, clinical assessment, and patient questionnaires.

### Study design

This interobserver study investigates agreement between patients and doctors with regard to assessment of a Popeye sign. For this purpose, the following objectives are evaluated.

### Agreement between patients and consulting physicians

Patients performed self-assessment on the occurrence of a deformity in the operated upper arm and filled out a questionnaire at 1 year after surgery. The occurrence of a Popeye deformity was also

assessed by consulting physicians in 6 participating centers at the 1-year follow-up visit. They completed a form answering the question whether a Popeye sign in the operated arm was present (yes/no). To compare the results of the currently presented study with previously reported research, we consider agreement between the patient and consulting physician the primary outcome of our study. The consulting physicians were experienced in appraising the occurrence of a Popeye sign and did not undergo specific training in assessing a Popeye sign for this study. Although blinding of the consulting physician for the treatment was intended, this was not feasible in all participating centers.

### Agreement of doctors with each other

To investigate if doctors agree with each other in the assessment of a Popeye sign, a group of observers assessed the presence of a Popeye sign using digital photographs of the operated upper arm. To compare the cosmetic aspect of the operated arm, photographs were obtained of the contralateral arm as well. To evaluate agreement within the group of observers, observers' reliability of preoperative and postoperative assessments of the photographs was investigated.

To standardize the photographs, patients were asked to flex both elbows to 90 degrees, holding both hands in a supinated position. Care was taken to obtain photographs in the frontal plane with both upper arms well presented. The photographs of patients' torso and arms were taken by the consulting physician during the preoperative visit and the final follow-up visit, using the digital camera of their mobile phone. The digital pictures were archived and coded for later assessment. Photographs were assessed for inclusion: both upper arms had to be fully visible. Pictures not taken according to protocol or taken in the operating room were excluded. Data collection for observers' agreement was done by presenting the digital pictures to the observers using a dedicated computer application. On the photographs, the operated arm was marked with a red arrow to ensure assessment of the correct arm. Data from the observers were collected and processed by an independent investigator who was not involved in surgical treatment of the patients (FG). FG developed an offline JavaScript application for rating the photographs. The application was run in Google Chrome for OSX (Mountain View, CA, USA). Using a Fisher-Yates shuffle, the photographs were presented in random order. The observers answered the question whether a Popeye sign in the operated arm was present (yes/no). The observers consisted of a group of 3 consulting surgeons taking part in the BITE trial (R.W., M.B., D.D.), including 2 from the same hospital and 1 surgeon who was not involved with the trial (G.K.). The observers were blinded for LHB treatment and for moment of photograph. To evaluate usefulness of the photographs for the purpose of assessing a Popeye sign, the observers were presented with

photographs taken both preoperatively and postoperatively. There was no time limit for appraisal of the digital photographs.

Agreement of observers' evaluation with that of the consulting physician was also assessed. For this comparison, the majority vote in the group of observers was determined. In case the number of confirmations of a Popeye sign were evenly divided, the assessment of the observer with the least amount of LHB procedures performed weighed less to determine the majority vote. To avoid observer bias due to possible recognition of the patient, observations made by a patient's consulting physician were excluded for this analysis. This resulted in missing data in the observers' assessments.

### Correlation of BMI and age with identifying a Popeye sign

Data on patient's sex, height, weight, and date of birth were collected to investigate the correlation of identifying a Popeye sign by both consulting physicians and observers with BMI and age.

### (Dis)satisfaction with Popeye sign

One year after surgery, patients were asked about the cosmetic appearance of the operated arm. In case a swelling in the operated upper arm was reported, additional questions were asked to verify that the swelling was located distally and was not present preoperatively. To further confirm a distal location of the bulge in the upper arm, patients were presented with a frontal image of a male torso and specifically asked to mark the location of their swelling. The patient-reported swelling was defined as a Popeye sign when marked in the distal two-thirds of the operated arm. Next to this, patients were asked whether they found the swelling unsightly and about (dis)satisfaction with the swelling on a 5-point Smiley rating scale (Fig. 1). Patients who reported a swelling in the upper arm that was not present before surgery and marked the swelling on a location corresponding with a Popeye sign were classified as having a possible Popeye deformity.

### Statistical analysis

Statistical analyses were performed using the SPSS software (version 22, IBM Corp, Armonk, NY, USA). For all analyses, a *P* value of <.05 was considered significant.

Inter-rater agreement for the observers was evaluated with Kappa because it is applicable to any number of raters, can handle missing data, and corrects for random chance.<sup>11</sup> Kappa <0.67 is regarded as very low, 0.67-0.8 low, and >0.80 valid. Because it is



Figure 1 Smiley rating scale.

**Table I** Patient's reporting of a swelling in the operated arm

	LHB surgery	Swelling matching Popeye location	Confirmed by consulting physician	Confirmed by observers during photographic evaluation	Patient dissatisfied with the swelling
Patient 1	Tenotomy	Yes	Yes	1/4	No
Patient 2	Tenotomy	Yes	No	1/2	No
Patient 3	Tenodesis	No	No	3/4	Yes
Patient 4	Tenotomy	No location marked	No	No photographs	No

LHB, long head of the biceps.

not natively included in SPSS, the KALPHA macro package was introduced in SPSS to compute Kalpha.<sup>7</sup>

Correlation between identification of a Popeye sign and gender was calculated using Phi coefficient because it is designed for the comparison of truly dichotomous distributions, that is, distributions that have only 2 points on their scale.<sup>16</sup> A Phi coefficient of  $-0.1$  to  $0.1$  was interpreted as no or very weak correlation,  $-0.3$  to  $-0.1$  or  $0.1$  to  $0.3$  as weak,  $-0.5$  to  $-0.3$  or  $0.3$ - $0.5$  as moderate, and  $-1.0$  to  $-0.5$  or  $0.5$ - $1.0$  as strong correlation.

Rank-biserial correlation was calculated to investigate the association of BMI and the occurrence of a Popeye sign.<sup>3</sup> The same correlation was calculated between Popeye diagnosis and age. A correlation value of  $0.00$ - $0.30$  was interpreted as negligible,  $0.30$ - $0.50$  as low,  $0.50$ - $0.70$  as moderate,  $0.70$ - $0.90$  as high, and  $0.90$ - $1.00$  as very high.

## Results

### Patients

Of the 97 patients included in the current study, 50 underwent LHB tenotomy and 47 LHB tenodesis. Mean age at time of operation was  $61 \pm 6.0$  years. Most patients were male (62%), and the overall mean BMI was  $26.8 \pm 3.7$ . Thirty-one percent of patients were within a healthy BMI range, 50% was overweight, and 19% was considered obese.

### Patient's assessment of a Popeye sign

Four of 97 patients reported a swelling in the operated arm (Table I). Three of these patients marked the location of this swelling in the provided frontal picture of a male torso. Of these 3 patients, 2 marked the swelling at a location corresponding with a Popeye sign. One of these patients was reported as having a Popeye sign by the consulting physician. The patient who did not mark a location and the patient who marked the noncorresponding location were both

not reported with a Popeye sign by the consulting physician.

Dissatisfaction with the reported swelling was reported by 1 patient. However, this patient marked the swelling at a location that did not match the location where a Popeye sign could occur. Moreover, the consulting physician did not report a Popeye sign either. In contrast, 3 of 4 observers reported a Popeye sign in this patient.

### Consulting physician's assessments

At 1-year follow-up, 80 of 97 patients were assessed by their consulting physician for the occurrence of a Popeye sign. Of these, 40 had undergone LHB tenotomy and 40 LHB tenodesis. The physicians reported a Popeye sign in 32 patients (40%), of which 19 were in the tenotomy group and 13 in the tenodesis group ( $P = .17$ ).

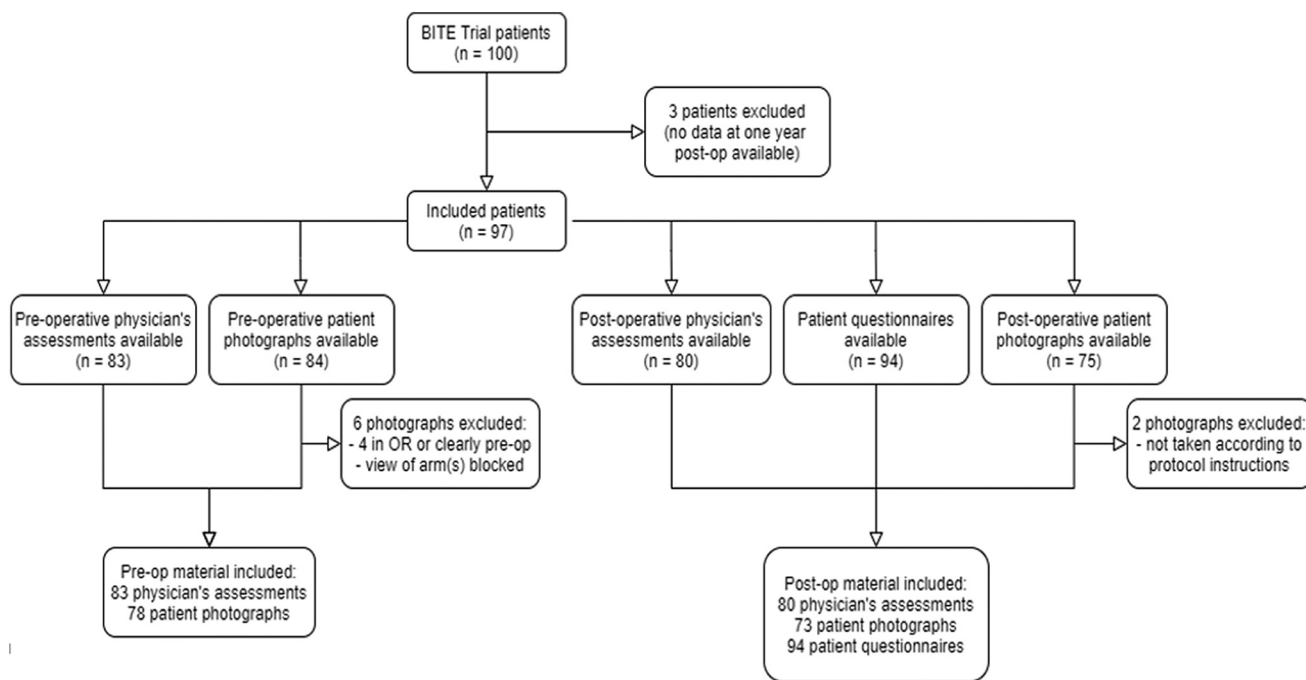
### Agreement between patients and consulting physicians

Two of 97 patients (2%) as opposed to 40% of consulting physicians reported a Popeye sign. In only 1 patient the patient-reported Popeye sign was in agreement with the assessment of the consulting physician (Table I).

### Observers' assessment of a Popeye sign

Preoperative photographs were available for 84 patients. Of these, 6 were excluded because in 2 cases the upper arm was not fully exposed and in 4 were taken in the operating room and clearly identifiable as not having undergone LHB surgery. Follow-up photographs were available for 75 patients. Of these, 2 were excluded because photographs were not taken according to protocol.

In total, 78 preoperative photographs and 73 photographs at 1-year follow-up were assessed for presence of a Popeye



**Figure 2** Flow chart patients, questionnaires, and photographs.

sign (Fig 2). Observer 1 reported a Popeye sign in 8.0% of the preoperative and 50.0% of the postoperative photographs. For observers 2, 3, and 4, these were, respectively, 6.8%, 14.4%, and 19.2% for the preoperative photographs and 34.8%, 46.4%, and 52.1% for the postoperative photographs. Calculation of the majority vote of the observers' identification of Popeye sign indicated a draw in 1 preoperative case and 4 postoperative cases that was settled according to the observer's career time number of shoulder procedures.

**Interobserver agreement**

Preoperative Kalpha was 0.074 (95% CI -0.277, 0.382), signifying a very low correlation. Although patients were not operated yet, the majority vote of the observers indicated the presence of a Popeye sign in 6 cases. Kalpha for the 1-year follow-up assessments was 0.495 (95% CI 0.317, 0.659), signifying a very low correlation.

**Agreement between observers and consulting physicians**

Kalpa was calculated when both majority vote of observers and consulting physician's assessment were available. Seventy-eight preoperative cases were available for calculation of Kalpa. Kalpa for preoperative agreement regarding the presence of Popeye sign was -0.033 (95% CI -0.970, 0.642). At 1-year follow-up, both evaluations were available for 61 cases. Kalpa for postoperative agreement

**Table II** Phi coefficient between sex and identification of a Popeye sign

	n	Phi	P value
Sex of consulting physician	80	-0.316	.005
Sex of observers	73	-0.346	.003

**Table III** Rank-biserial correlation between age or BMI and identification of a Popeye sign

	n	Correlation	P value
Age of consulting physician	80	-0.059	.605
BMI of consulting physician	79	-0.109	.338
Age of observers	73	-0.080	.499
BMI of observers	72	-0.055	.647

BMI, body mass index.

with regard to the presence of a Popeye sign was very low, 0.499 (95% CI 0.265, 0.699).

**Phi coefficient**

Phi coefficient for correlation between gender and Popeye sign identification was calculated for both observers' assessments and consulting physician's assessments. Table II shows a moderate relationship between gender and Popeye sign identification for both observers and consulting

physicians, both statistically significant. Consulting physicians reported a Popeye sign in 52% of male and 20% of female patients. For the observers, this was 57% and 23%, respectively.

### Rank-biserial correlation

Correlation of both BMI and age with a Popeye deformity were calculated, for both observers' assessments and consulting physician's assessment. Table III shows negligible negative correlations of both patient age and patient BMI with the Popeye deformity, all not statistically significant different.

### Discussion

This study investigated agreement of patients and doctors with regard to the presence of a Popeye sign in patients who underwent either LHB tenotomy or LHB tenodesis. The most important finding was that a Popeye sign was reported by only 2% of all patients as opposed to 40% of all cases by the consulting physicians. In only 1 patient, the consulting physician and patient agreed on the presence of a Popeye sign and the patient was not bothered by it. Agreement between the observers on the presence of a Popeye sign as assessed using photographs was very low, both preoperatively and postoperatively. A moderate relationship was found between patient gender and Popeye sign identification. Furthermore, neither BMI nor age was related to reporting a Popeye sign by the doctors in this study. Finally, just 1 patient reported a bothersome swelling in the upper arm, but this finding was likely something else than a Popeye sign.

Regardless whether doctors agree on the presence of a Popeye sign, the low number of patients that self-reported a Popeye sign in this study signifies that only a few patients will notice a deformity in the upper arm after undergoing LHB surgery at all. Agreement between observers was calculated using Kappa, which was originally developed in the field of psychology to determine the similarity of data collected by different raters. Inter-rater reliability can be increased by providing a consistent test environment and by training the assessors. However, a consistent environment for the consulting physicians was not feasible because of the multicenter design of the study. Therefore, digital photographs taken in a standardized fashion were used to aim for a consistent environment of assessment. Furthermore, patients were consulted by physicians with experience in assessing the results of LHB surgery.

Several authors previously reported on the agreement between patients and doctors regarding the presence of a Popeye sign following LHB surgery.

Boileau et al<sup>1</sup> retrospectively investigated 69 patients with irreparable rotator cuff tears undergoing LHB surgery and identified 24 patients with a Popeye sign. Sixteen of

these patients (67%) had noticed the deformity. However, none of these patients were bothered by its presence. Koh et al<sup>10</sup> prospectively studied 90 patients following either LHB tenotomy or tenodesis, of which 15 (17%) were diagnosed with a Popeye sign. Similar to the findings of Boileau et al,<sup>1</sup> none of these patients were unsatisfied or bothered by it.<sup>10</sup> Duff and Campbell<sup>4</sup> investigated acceptance of LHB tenotomy in 117 consecutive patients, including younger individuals, and reported a Popeye sign in 72 (57%) of all cases. Of these, 34 (27%) reported a deformity in the upper arm. In contrast to our results and previous studies, 4 patients (11%) were bothered by the deformity in the upper arm. However, none of these patients requested a revision procedure. If their study would have been performed in a randomized fashion, written informed consent could have deselected these patients, and the reported percentage of Popeye signs could be lower. Kerschbaum et al<sup>9</sup> performed either LHB tenotomy or tenodesis in 85 elderly patients and identified 59 patients (70%) with a Popeye sign. Almost similar to our study, only 5 of these patients self-reported a deformity in the upper arm.

The prevalence of a patient-reported deformity after LHB tenodesis and LHB tenotomy therefore appears to be very low, as does dissatisfaction with the deformity. Nevertheless, in case of a bothersome Popeye sign, operative repair can be considered. Millett reported on this procedure in patients who after a previous LHB tenodesis or chronic LHB rupture were dissatisfied with this deformity.<sup>5</sup> Improvement was obtained in 12 of 17 patients after spontaneous rupture and in all patients after revision of previous LHB tenodesis.

With regard to patient-specific parameters and identification of a Popeye sign, a moderate correlation for patient's gender and negligible correlation for patient's age or BMI was found. These findings are similar to the results of Lim et al,<sup>12</sup> who found a Popeye sign in 76% of male and 31% of female patients. Accordingly, Mirzayan et al<sup>13</sup> reported a Popeye sign in 81% of male and 19% of female patients. Possible explanations for this difference between genders may be found in gender-based differences in muscle mass and fat distribution.

In literature, the occurrence of a Popeye sign in patients older than 50 years is more often registered by doctors than patients.<sup>1,4,9</sup> As younger patients may be more concerned with a cosmetic deformity of the upper arm, the relatively low percentage of patients' reported Popeye signs in our study may have been higher if patients younger than 50 years had been included.

The widely ranging percentages of Popeye signs in literature furthermore raise the question if physicians agree on the assessment of a Popeye sign. The low agreement among observers in our study may either indicate that photographs are not suitable for identification of a Popeye sign or support that there is no consensus with regard to the assessment of a Popeye sign. If the latter is true, the

reported incidences of a Popeye sign in previously reported meta-analyses have to be seen in a different perspective.

There are several limitations with regard to the interpretation of our results. First, objective parameters to identify a Popeye sign following LHB surgery have not been clearly described in literature. Not only determining the presence but also grading the deformity is a subjective assessment and may explain the low agreement in our study. Beside this, there could be more explanations for the low agreement between patients and consulting physicians and observers with regard to assessment of a Popeye sign. Although photographs were taken with high-resolution digital cameras in a standardized fashion, appraisal of a Popeye sign using photographs may be hampered because of factors such as lighting and exposure. In clinical practice, the operated arm can be inspected in 3 dimensions and physical examination may further reveal an altered contour of the operated arm. The low agreement with regard to preoperative assessments by observers of patients who were not even operated yet may indicate that photographs are not suitable to assess the presence of a Popeye phenomenon. This may further serve to explain the low agreement in the group of observers.

A third limitation is that patients had to sign informed consent with regard to LHB treatment when participating in the BITE study and were therefore aware of the possible occurrence of a Popeye deformity. Using participants from the BITE study therefore introduced a selection bias as it could be argued that the patients who would be bothered about the occurrence of a deformity would not participate in the study at all. This may be reflected by the low number of participants that reported a Popeye deformity and were not dissatisfied by it.

Furthermore, given the average age of patients in our study is older than 50 years, the results are not readily generalizable to the whole population of patients with LHB pathology.

Given the low agreement between patients and consulting physicians, the findings of our study suggest that the Popeye sign is mostly a doctor's perceived problem. Although similar conclusions were reported in previous studies,<sup>1,4,9,10</sup> assessment by observers using photographs and analysis of agreement was not performed before. Similarly, the association of BMI and age with regard to identifying a Popeye sign was not yet investigated previously as well.

Future research should aim to develop an objective standard to assess the presence of a Popeye sign. Consensus about when asymmetry in the bicipital region becomes a Popeye sign could help in developing an objective standard. The limitations that are associated with assessing digital photographs could be avoided with a prospective cohort study implementing clinical assessment of the operated upper arm instead of using photographs. Subsequent training of the assessors may further improve reliability for diagnosing a Popeye sign.<sup>2</sup> Determining inter-rater agreement by multiple physicians per patient

and multiple observers may result in even more accurate results. Evaluation of patients' self-assessment and satisfaction of a deformity in the upper arm following LHB surgery may further elucidate the relevance of the Popeye phenomenon.

Supported by the results of our study, patients may be informed that a possible deformity in the upper arm following LHB surgery is unlikely recognized by themselves and if recognized probably not bothersome. In case the deformity is not tolerated, a revision procedure may be performed.<sup>5</sup>

## Conclusion

The Popeye sign is more frequently identified by doctors than by patients older than 50 years after undergoing LHB surgery and are likely easier identified in male patients than in female patients. Furthermore, patients are not dissatisfied by a Popeye deformity of the operated arm. BMI and increasing age are not related to the detection of a Popeye sign in this group of patients.

## Disclaimer

The BITE study was conducted with financial support of the Research Foundation OLVG, Dutch Arthroscopy Association, and Smith and Nephew. These parties were not involved with analysis of data or writing of the manuscript.

The authors, their immediate families, and any research foundations with which they are affiliated have not received any financial payments or other benefits from any commercial entity related to the subject of this article.

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