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*ORIGINAL STUDY*

# Shoulder arthroplasty for glenohumeral osteoarthritis: results from a comprehensive survey in Belgium and the Netherlands

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**The purpose of this survey in Belgium and the Netherlands was to assess treatment variation in glenohumeral osteoarthritis between experienced and less experienced orthopedic surgeons, and to investigate perioperative treatment after shoulder arthroplasty in a large group of orthopedic surgeons.**
**Orthopedic surgeons specialized in shoulder surgery were invited to complete a survey between November 2013 and February 2015.**
**Seventy-one percent of the approached surgeons com-pleted the survey. Less experienced surgeons (< 6 years) and surgeons from the Netherlands find patient characteristics (e.g. smoking p=0.01) more relevant than more experienced surgeons (≥ 6 years) and surgeons from Belgium.**
**Less experienced surgeons will less likely (p=0.001) perform resurfacing arthroplasty compare to experienced surgeons. The less and the experienced surgeons use similar indications for a reverse shoulder arthroplasty regarding age limit and cuff arthropathy without osteoarthritis.**
**Less experienced surgeon will more likely (p=0.003) prescribe a low molecular weight heparin during the hospital stay after a shoulder arthroplasty.**
**In this survey, we found a decrease in the use of resurfacing arthroplasty and a strong increase in the use of reverse shoulder arthroplasty.**
**Besides, there is little consensus concerning pre-operative planning, patient characteristics, surgical technique, and patient reported outcome measures.**
**Level of evidence: IV**

**Keywords :** glenoid ; arthroplasty ; surgery ; survey ; osteoarthritis ; shoulder.

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## INTRODUCTION

Glenohumeral osteoarthritis is a common source of pain and disability with a prevalence of 17% *(33)*. Shoulder replacement yields satisfactory results by improving range of motion, patient reported outcome measures and decreasing pain sensation *(7)*. In 2014 the Dutch Arthroplasty Register (LROI) added the registration of shoulder arthroplasties to existing hip and knee arthroplasty registry *(44)*.

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In the US, between 1990 and 2000 only a small increase in the number of shoulder arthroplasties was observed *(23)*. After the year 2000, the number of shoulder arthroplasties has been exponentially growing *(23)*.

In the Netherlands and Belgium the number of reverse shoulder arthroplasties increased and the number of anatomical arthroplasties decreased since 2014 *(58,59)*. Commonly used indications for performing a specific type of shoulder implant differ across the world and in literature *(1,10,16,48)*, an online survey was initiated in our two neighboring countries. Registration of patient reported outcome measures are not yet standardized and differ throughout the world, including the Netherlands and Belgium *(5)*. The purpose of this survey is to present an overview of the pre-operative planning, preferred type of implants, preferred surgical technique and postoperative procedures that are commonly applied in shoulder arthroplasty and to compare in neighboring countries. To assess whether years of experience may influence perioperative strategy we compared the results of the survey between experienced (≥6 years) and less experienced (<6 years) orthopedic surgeons.

## MATERIALS AND METHODS

Only orthopedic surgeons with a special interest in shoulder surgery, and all members of the Dutch Shoulder and Elbow Society and Belgian Elbow and Shoulder Society, were invited to participate in current online survey. A total of 181 orthopedic surgeons received an email invitation to log onto the website to complete the survey. The survey was available at www.shoulderelbowplatform.com from January 2014 until February 2015. During this period, the orthopedic surgeons who did not complete the survey, were encouraged to do so every three months. The participants could fill out the survey at their own pace, in multiple instances and at various computers if necessary.

Besides demographic information, participants were asked to answer various questions regarding shoulder implants, including type and brand of implant, implant choice, supports a national implant register, surgical approach, biceps treatment, use of low molecular weight heparin (LMWH), patient reported measures, and post-operative restrictions regarding activities. Specifically, we assessed differences between experienced (≥6 years) and less experienced (<6 years) orthopedic surgeons and differences between the orthopedic surgeons from the two neighboring countries.

The chi square test was used to compare between observed frequencies in one or more categories. A p-value of $<0.05$ was considered significant.

## RESULTS

Of the 181 invited orthopedic surgeons, 128 (71%) completed the survey. 105 of the 128 observers (82%) indicated to support a national shoulder arthroplasty registry.

Orthopedic surgeons with less than 6 years' experience were more ($p = 0.016$) supporting a national shoulder arthroplasty registry, in contrast to more experienced (≥6 years) orthopedic surgeons. There are more proponents of a national shoulder arthroplasty registry under Dutch orthopedic surgeons ($p < 0.0001$) compared to the respondents from Belgium. The demographics of the observers are reported in Table I.

Seven out of the 121 observers (6%) use only plain radiographs before performing a reverse shoulder arthroplasty. Most surgeons (71%) use MRI or CT besides plain X-ray before performing a reverse arthroplasty or total shoulder arthroplasty. See Table II for all observer's pre-operative planning diagnostics.

For responders with less than 6 years' experience, the presence of diabetes mellitus ($p=0.03$) and smoking habits ($p=0.01$) are more relevant compared to more experienced (≥6 years) orthopedic surgeon. For Dutch orthopedic surgeons, body mass index ($p=0.03$) and smoking habits ($p=0.0004$) are more relevant compared to the Belgian respondents. See table III for the evaluation of the patient characteristics in decision making.

Table I. — Demographics of participating surgeons (n=128)

| | | Total | Belgium | Netherlands | p | ≥ 6 years' experience | < 6 years' experience | p |
|---|---|---|---|---|---|---|---|---|
| Number of participants | | 128 | 44 | 84 | | 87 | 41 | |
| Mean age in years (range) | | 46 (32-68) | 46 (33-62) | 45 (32-68) | | 49 (38-68) | 38 (32-45) | |
| Mean experience as an orthopedic surgeon in years (range) | | 12 (1-35) | 14 (1-35) | 10 (1-30) | | 15 (6-35) | 3 (0-5) | |
| | | | | | | | | |
| Country in practice | Netherlands | 84 (66%) | | | | 50 (57%) | 34 (83%) | |
| | Belgium | 44 (34%) | | | | 37 (43%) | 7 (17%) | |
| | | | | | | | | |
| Member of national shoulder elbow society | | 123 (96%) | 43 (98%) | 80 (95%) | | 84 (97%) | 39 (95%) | |
| | | | | | | | | |
| Hospital of main practice | General | 100 (78%) | 38 (86%) | 62 (74%) | | 71 (82%) | 30 (73%) | |
| | University | 9 (7%) | 5 (11%) | 4 (5%) | | 6 (7%) | 3 (7%) | |
| | Private | 12 (9%) | 1 (2%) | 11 (13%) | | 8 (9%) | 4 (10%) | |
| | Other | 7 (5%) | 0 (0%) | 7 (8%) | | 3 (3%) | 4 (10%) | |
| | | | | | | | | |
| Shoulder arthroplasty/year | < 20 | 48 (38%) | 12 (27%) | 36 (43%) | | 26 (30%) | 22 (54%) | |
| | 20-50 | 66 (52%) | 25 (57%) | 41 (49%) | | 49 (56%) | 18 (44%) | |
| | > 50 | 14 (11%) | 7 (16%) | 7 (8%) | | 13 (15%) | 1 (2%) | |
| | | | | | | | | |
| Shoulder pathology in daily practice | < 30% | 13 (10%) | 2 (5%) | 11 (13%) | | 6 (7%) | 7 (17%) | |
| | 30-60% | 65 (51%) | 25 (57%) | 40 (48%) | | 43 (49%) | 22 (54%) | |
| | > 60% | 50 (39%) | 17 (39%) | 33 (39%) | | 38 (44%) | 12 (29%) | |
| | | | | | | | | |
| Performed | Resurfacing/ Stemless shoulder arthroplasty | 53 (41%) | 24 (55%) | 29 (35%) | 0.046 | 45 (52%) | 8 (20%) | 0.001 |
| | Hemi Shoulder arthroplasty | 102 (80%) | 34 (77%) | 68 (81%) | 0.079 | 74 (85%) | 28 (68%) | 0.050 |
| | Total shoulder arthroplasty | 112 (88%) | 40 (91%) | 72 (86%) | 0.572 | 77 (89%) | 35 (85%) | 0.823 |
| | Reverse shoulder arthroplasty | 116 (91%) | 44 (100%) | 72 (86%) | 0.021 | 80 (92%) | 36 (88%) | 0.671 |
| supports national shoulder arthroplasty registry | | 105 (82%) | 23 (52%) | 82 (98%) | <0.0001 | 66 (76%) | 39 (95%) | 0.016 |

All amounts in n(%)

Table II. — Pre-operative diagnostics (n=128)

| | X-ray | CT | MRI | X-ray and CT | X-ray, CT and MRI | X-ray and MRI | X-ray and US | X-ray, CT and US | NP |
|---|---|---|---|---|---|---|---|---|---|
| Resurfacing shoulder (n=71) | 8 (11%) | 4 (6%) | 3 (4%) | 20 (28%) | 2 (3%) | 19 (27%) | 1 (1%) | 9 (13%) | 57 (45%) |
| Hemi shoulder (n=107) | 7 (7%) | 7 (7%) | 2 (2%) | 39 (36%) | 7 (7%) | 27 (25%) | 6 (6%) | 10 (9%) | 21 (16%) |
| Total shoulder (n=120) | 4 (3%) | 5 (4%) | 3 (3%) | 39 (33%) | 15 (13%) | 31 (26%) | 4 (3%) | 13 (11%) | 8 (6%) |
| Reverse shoulder (n=121) | 7 (6%) | 5 (5%) | 4 (3%) | 53 (42%) | 9 (7%) | 24 (20%) | 4 (3%) | 13 (11%) | 7 (6%) |

All numbers in n(%)
US = Ultrasound, NP = not performing this type of arthroplasty

*Resurfacing/stemless hemi prosthesis*

Orthopedic surgeons with at least 6 years of experience are (p=0.001) more likely to perform a resurfacing/stemless shoulder arthroplasty compared to orthopedic surgeons with less experience (<6 years) (Table I). Seventy-two percent of the observers thinks overstuffing is the greatest risk for failure in resurfacing/stemless arthroplasty (Table IV).

More experienced surgeons will only slightly likely (ρ=0.60) perform reverse shoulder arthroplasty in patients without osteoarthritis (61%) compared to surgeons with less experience (55%). Both groups will perform reverse shoulder arthroplasty in patients younger than 70 years.

Belgian surgeons were more likely to perform a reverse shoulder arthroplasty in younger patients (<70 years) (ρ=0.013) and in cases with an irreparable rotator cuff rupture without glenohumeral osteoarthritis (ρ=0.042) compared to Dutch orthopedic surgeons (Table V).

*Surgical Approach*

Most observers (60%) prefer a subscapularis tenotomy as an arthrotomy technique in case of an anatomical shoulder (resurfacing-, hemi- and total shoulder prosthesis) arthroplasty. In case of reverse arthroplasty, 39% of the observers use a subscapularis tenotomy as an arthrotomy technique. Seventy out of the 121 observers (58%) prefer to use a deltopectoral approach for reverse shoulder arthroplasties. All techniques of arthrotomies are reported in Table VI.

When performing a hemi-, total- or reverse shoulder arthroplasty, 54-66% of all surgeons will perform a long head biceps tenodesis. All preferred biceps interventions are reported in Table VI.

Eleven of the 44 responding Belgian orthopedic surgeons (25%) use a LMWH during hospitalization after a shoulder prosthesis operation, compared to 71% of the Dutch orthopedic surgeons that responded (p<0.0001). Twenty-five of the 44 Belgian respondents (57%) do not use LMWH at all, compared to 12 of the 84 (14%) of the Dutch respondents (p<0.0001).

Observers with less experience (76%) are more likely (p=0.003) to use a LMWH during hospital stay compared to more experienced (≥6 years) orthopedic surgeon (46%). See table VII for all the observer's thrombosis prophylaxis.

After a hemi shoulder arthroplasty, 29 out of the 107 observers (27%), advise their patients to restrict activities to general daily living tasks and to do no sports, compared to 52% for non-impact sports (jogging and dancing) and light sports (swimming).

Twenty-nine out of the 120 observers (27%) advise to do only general daily living tasks and no sports, compared to 58% for non-impact sports (jogging and dancing) and light sports (swimming), after total shoulder arthroplasty.

After a reverse shoulder arthroplasty 42 out of the 121 observers (35%) advise to do only general daily

Table III. — Patient characteristics and decision making (n=128)

| Important in deciding an arthroplasty | Yes | No | Belgium (n=44) Yes | Netherlands (n=84) Yes | p | ≥6 yr. (n=87) Yes | <6 yr. (n=41) Yes | p |
|---|---|---|---|---|---|---|---|---|
| Diabetes | 48 (38%) | 80 (63%) | 14 (32%) | 34 (40%) | 0.4424 | 27 (31%) | 21 (52%) | 0.0283 |
| Body Mass Index (BMI) | 37 (%) | 91 (71%) | 7 (16%) | 30 (36%) | 0.0322 | 22 (25%) | 15 (38%) | 0.1834 |
| Smoking | 56 (43%) | 72 (57%) | 9 (20%) | 46 (55%) | 0.0004 | 30 (34%) | 25 (60%) | 0.0106 |

All numbers n (%)

Table IV. — Complications which poses the biggest problem after shoulder arthroplasty (n=128)

| | Infection | Fracture | Dislocation | Overstuffing |
|---|---|---|---|---|
| Resurfacing shoulder arthroplasty | 32 (25%) | 2 (2%) | 2 (2%) | 92 (72%) |
| Hemi shoulder arthroplasty | 85 (67%) | 14 (11%) | 29 (22%) | 0 (0%) |
| Total shoulder arthroplasty | 81 (64%) | 15 (12%) | 32 (25%) | 0 (0%) |
| Reverse shoulder arthroplasty | 76 (59%) | 23 (18%) | 29 (23%) | 0 (0%) |

All numbers n (%)

Table V. — Reverse shoulder arthroplasty (n=128)

| | Yes | No | Belgium Yes (n=44) | Netherlands Yes (n=84) | p | ≥6 yr. Yes (n=87) | <6 yr. Yes (n=41) | p |
|---|---|---|---|---|---|---|---|---|
| RSA in patients younger than 70 years | 95 (74%) | 33 (26%) | 39 (87%) | 56 (67%) | 0.013 | 65 (75%) | 30 (71%) | 0.863 |
| Age under limit for RSA | 50 (38%) | 78 (62%) | 11 (25%) | 39 (46%) | 0.030 | 32 (36%) | 18 (43%) | 0.442 |
| RSA in case of irreparable RC without OA | 76 (59%) | 52 (41%) | 32 (73%) | 44 (52%) | 0.042 | 53 (61%) | 23 (55%) | 0.603 |

All amounts in n(%)
RSA = reverse shoulder arthroplasty, RC = rotator cuff, OA osteoarthritis

living tasks and no sports, compared to 49% of the surgeons who advice to do only non-impact sports (jogging and dancing) and light sports (swimming).

After a total shoulder or reverse shoulder arthroplasty, 4% of the observers allow patients to lift heavy objects and allow high impact sports (weightlifting).

See Table VIII for all post-operative restrictions after shoulder arthroplasty.

Thirty-six percent of the surgeons (46 out of 128) do not no patient reported outcome measures. Eleven out of the 128 observers (9%) use only Constant scores to evaluate their surgical results after a shoulder arthroplasty. Two out of the 128 observers (2%) use only the Oxford Shoulder Score (OSS) after a shoulder arthroplasty. Twenty-one out of 128 observers (16%) use the OSS in combination with another scoring method. See table IX for all the observer patient reported outcome measures.

## DISCUSSION

This online survey reports several perioperative topics concerning shoulder arthroplasty for glenohumeral arthritis in Belgium and the Netherlands, demonstrating a large variation in pre-operative planning, patient selection, type of implants, surgical techniques, thrombosis prophylaxis, outcome

Table VI. — Arthrotomy technique in case of primary osteoarthritis and biceps intervention.

| | Anatomic SA | Reverse SA |
|---|---|---|
| | n=298 | n=121 |
| Arthrotomy | | |
| SS tenotomy | 180 (60%) | 47 (39%) |
| Peel off SS of MT | 41 (14%) | 19 (16%) |
| Osteotomy of MT | 62 (21%) | 8 (7%) |
| Rotator interval | 10 (3%) | 28 (23%) |
| Other | 5 (2%) | 19 (16%) |
| | | |
| Biceps | | |
| Tenodesis | 200 (67%) | 65 (54%) |
| Tenotomy | 89 (30%) | 54 (45%) |
| None | 9 (3%) | 2 (2%) |
| | | |
| NP | 86 (29%) | 7 (5%) |

All amounts in n(%)
SA = Shoulder arthroplasty, SS = subscapularis, MT = minor tubercle, NP = not performing this type of arthroplasty

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assessment with patient reported outcome measures and post-operative restrictions.

This study should be interpreted in the light of the following strengths and weaknesses. In literature, online surveys achieve an average response rate of 43% *(36)*. With 128 responses (71%) from all the invited surgeons (181), this is the largest and most complete survey on this topic in currently available literature. The large group allows subgroup analyses as well as comparisons between orthopaedic surgeons from the two countries. There were some limitations that should be considered when interpreting the results and conclusions of this survey.

The overall conclusion of the present study is that there is a wide variation regarding the evaluated topics on performing shoulder arthroplasty. The 4 most interesting findings were: First, in 2014, 834 anatomical shoulder arthroplasties were performed in the Netherlands. This number decreased to 797 (-4.4%) in 2015 *(58)*. In Belgium a decrease of the anatomical prosthesis of 13.7% (350 to 302) was seen between 2015 and 2016 *(59)*. This is in line with our study, we found a decrease in the use of anatomical arthroplasty, especially the resurfacing/ stemless arthroplasty. The shoulder resurfacing/ stemless arthroplasties are more likely performed by experienced (≥6 years) orthopedic surgeons. Less experienced (<6 years) orthopedic surgeons are likely to perform a total or reverse shoulder arthroplasty, instead of a hemi shoulder arthroplasty. This is in contrast with the study of Mann et al. *(30)*. These authors concluded that hemi shoulder arthroplasty is a procedure commonly performed for primary glenohumeral osteoarthritis among recent orthopedic graduates (p<0.001). Shoulder fellowship trained surgeons were more likely to use a total shoulder arthroplasty for this indication *(30)*. The authors believe the resurfacing arthroplasties are less popular by less experienced orthopedic surgeons because of its less predictable outcome possibly due to less control of lateralisation and varus/valgus of the humeral component.

Second, the number of reverse shoulder arthroplasties strongly increased since 2011 *(21)*. Criticasters of the increased use of reverse arthroplasty sometimes refer to this phenomenon as “reversomania”. This increase is also seen in in Belgium and the Netherlands. In the Netherlands,

Table VII. — Low molecular weight heparins as thrombosis prophylaxis after shoulder implant surgery (n=128)

| | | Belgium (n=44) | Netherlands (n=84) | p | ≥6 yr. experience (n=87) | <6 yr. experience (n=41) | p |
|---|---|---|---|---|---|---|---|
| Only during hospital stay | 71 (55%) | 11 (25%) | 60 (71%) | <0.0001 | 40 (46%) | 31 (76%) | 0.0031 |
| 2 weeks | 6 (5%) | 4 (9%) | 2 (2%) | | 5 (6%) | 1 (2%) | |
| 4 weeks | 3 (2%) | 2 (5%) | 1 (1%) | | 3 (3%) | 0 (0%) | |
| 6 weeks | 11 (9%) | 2 (5%) | 9 (11%) | | 11 (13%) | 0 (0%) | |
| None | 37 (30%) | 25 (57%) | 12 (14%) | <0.0001 | 28 (32%) | 9 (22%) | 0.3247 |

All amounts in n(%)

Table VIII. — Restrictions after shoulder arthroplasty (n=128)

| | Resurfacing (n=71) | Hemi shoulder (n=107) | Total shoulder (n=120) | Reverse shoulder (n=121) |
|---|---|---|---|---|
| Non-impact[a] and light sports[b] | 25 (35%) | 56 (52%) | 70 (58%) | 59 (49%) |
| Sports with risk of falling[c] | 18 (25%) | 18 (17%) | 16 (13%) | 15 (12%) |
| Lifting heavy objects and High impact sports[d] | 3 (4%) | 4 (4%) | 5 (4%) | 5 (4%) |
| No restrictions in daily living[e]/ no sports[f] | 22 (31%) | 29 (27%) | 29 (24%) | 42 (35%) |
| Do not perform that kind of arthroplasty | 57 (45%) | 21 (16%) | 8 (6%) | 7 (5%) |

All amounts in n (%); a for example jogging and dancing; b for example swimming; c for example skiing and tennis; d for example weightlifting; e movement based and limited by pain; f only general daily living tasks.

Table IX. — Patient reported outcome measures n=128

| Post-operative questionnaires n | | This questionnaire alone n (%) |
|---|---|---|
| VAS | 57 | 8 (6%) |
| OSS | 20 | 2 (2%) |
| DASH | 27 | 1 (1%) |
| SST | 26 | 2 (2%) |
| Constant score | 41 | 11 (9%) |
| Other | 5 | 4 (3%) |
| None | 46 | 46 (36%) |
| Combination of a mentioned questionnaires | | |
| 2 | 24 (19%) | |
| 3 | 17 (13%) | |
| 4 | 6 (5%) | |
| 5 | 2 (2%) | |

N = every time this questionnaire is used, alone or in combination with another of multiple other questionnaires. VAS = Visual Analogue Scale, OSS = Oxford Shoulder Score, DASH = Disabilities of the Arm, Shoulder and Hand, SST = Simple Shoulder Test

the number of reverse shoulder arthroplasties for example, increased from 1225 in 2014, to a total of 1501 in 2015 (+22.5%) *(58)*. And in Belgium, the reverse shoulder prosthesis increased between 2015 and 2016 by 31.9% (1626 to 2144) *(59)*.

More than 50% of the surgeons may perform a reverse shoulder arthroplasty for a symptomatic non-repairable massive cuff tear without radiographic degeneration of the glenohumeral joint. This in line with the Food and Drug Administration (FDA), who approved the reverse shoulder arthroplasty in 2004. They stated it was indicated to treat cuff arthropathy in patients above 70 years *(3,10,11,12,35,52)*. Over time, the indications have expanded and it is currently being used for several diagnoses, including fracture sequelae *(4,10,25,26,31,50)*, revision arthroplasty *(4,10,19,27,49)*, instability *(10,49)*, and tumors *(2,10,32,49,54)* as well. Literature also supports the use of reverse shoulder arthroplasty in patients with a massive rotator cuff tear with pseudo-paralysis in the absence of glenohumeral arthritis when conservative treatment has failed *(4,6,10,14,15,47,49,51,53)*. Based on our survey, experienced orthopedic surgeons use the same indications for reverse shoulder arthroplasty as orthopedic surgeons with less experience. However, responders from Belgium will more likely perform a reverse shoulder arthroplasty in younger patients (<70 years) (p=0.013) and will more likely perform a reverse shoulder arthroplasty in patients with an irreparable rotator cuff rupture without glenohumeral osteoarthritis (p=0.042) compared to Dutch orthopedic surgeons. We believe because of more predictable outcome of the reverse shoulder arthroplasty and possible less surgical demanding procedure compared to the total shoulder arthroplasty, this might also be the reason of the increased number of the reverse shoulder arthroplasty and the "reversomania".

Third, in literature, there is no consensus regarding either type or duration of thrombosis prophylaxis. The incidence of a venous thromboembolism (VTE) after shoulder arthroplasty is estimated between 0.2%-16% *(9,29,34,41,57)*. Arthroplasty for

fractures, advanced age, female gender and previous diagnosis of malignancy were all associated with increased risk for VTE *(9,29,34,41,57)*. An aspirin based thrombosis prophylaxis protocol in the form of 325 mg enteric-coated tablets twice a day for 6 weeks was used in this study by Willis et al. *(55)*. However, the efficacy of aspirin as prophylaxis in this study is debatable with a VTE prevalence of 16% *(41,55)*. Jameson et al. suggested in their study that thrombosis prophylaxis might not be required, even in high-risk patients, and that it could be potentially harmful *(22)*. Saleh et al. did not find a higher incidence of VTE if bone cement was used in their study *(41)*. Despite the absence of consistent evidence, the American Academy of Orthopaedic Surgeons suggests that perioperative mechanical and/or chemical prophylaxis should be used to prevent VTE in the treatment of shoulder arthroplasty *(20)*. In 2007, the National Institute for Health and Clinical Excellence (NICE) recommended that all orthopedic inpatients be offered low molecular weight heparins (LMWH) for the duration of their hospital stay *(18)*. In contrast to this, in 2010 the same institute (NICE) recommended that patients should not routinely be offered VTE prophylaxis undergoing upper limb surgery *(45)*.

In our survey, we found only 55% of the respondents to use LMWH during hospital stay after shoulder arthroplasty operations. However, the less experienced orthopedic surgeons will more likely ($p=0.003$) use LWWH during hospital stay compared to the more experienced orthopedic surgeons.

Lastly, in our survey, we found 65% of the orthopedic surgeons assessed outcome using patient reported outcome measures. Furthermore, little consensus was found on which type or combination to assess outcome of shoulder arthroplasty. In literature, currently more than 20 different region-specific and condition-specific outcome instruments are being used to determine the functional outcomes, level of pain and quality of life, after shoulder surgery *(24,28,37,56)*. Because of the absence of a single set of universally accepted shoulder outcome measurements, many different outcome instruments for various shoulder conditions continue to be reported in the literature *(37)*. Oh et al. concluded, that there is no single shoulder outcome instrument superior to the others in terms of measurement properties. The comparison of the surgical result is not possible due to the different outcome instruments focusing on different topics (pain, function, disability, independency) *(37)*. Lo et al. pointed out that most outcome measures consist of physician generated questionnaires; therefore, the items in the measurement tools are those that physicians deem to be important and not necessarily those that are important to patients *(28)*. At the time of the start of the Dutch National Implant Registration of Shoulder Arthroplasties, a taskforce composed a set of outcome measures to assess the results of shoulder arthroplasties. To avoid overloading the patient with too many questions, careful consideration was made regarding the amount and type of questions. Adhering to the COSMIN principles the following tools were selected to assess pain, function and social well-being *(46)*. Pain is assessed with a numerical rating scale (NRS) in rest and during activities *(17)*. Social well-being is evaluated with EQ-5D *(38)*. Although the Western Ontario Osteoarthritis of the Shoulder (WOOS) has been adopted in most Scandinavian Registries *(8,13)*. The Oxford Shoulder Score (OSS) was selected as the primary outcome score to assess shoulder arthroplasties in the Dutch National Implant Registry. The authors suggest, the orthopedic community should use one or two patient reported outcome measures for shoulder arthroplasties. This would facilitate comparison between orthopedic surgeons, implants and hospitals.

Performing shoulder arthroplasty can be technically challenging and, therefore, have a greater potential for technical errors and complications than many of the other arthroplasty types *(43)*. With the increasing number of shoulders being surgically treated with an arthroplasty, we advocate including all types of artificial shoulder joints into a national database. Although the benefits of a shoulder arthroplasty registry are obvious *(39,40)*, the value of a joint registry is dependent on accuracy and completeness of the data entered *(42,44)*.

In conclusion, insight in perioperative management in end stage glenohumeral osteoarthritis

by orthopaedic surgeons in Belgium and the Netherlands was provided. Also, a comparison between experienced and less experienced orthopaedic surgeons was made. A decrease in the use of resurfacing arthroplasty and an increase in the use of reverse shoulder arthroplasty was found. Furthermore, there was little consensus concerning pre-operative planning, patient characteristics, type of implant, surgical technique, thrombosis prophylaxis, outcome assessment with patient reported outcome measures and post-operative restrictions for the patients. Further research is essential to gain additional information to support evidence based guidelines concerning these topics.

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