Glenohumeral Osteoarthritis in the Young Patient

Evaluation and Management

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Preface

Glenohumeral osteoarthritis is a chronic progressive disease that affects patients of all ages. Treatment of this condition in young patients poses a clinical challenge, as younger patients are often more active and high demand than their elderly counter parts. Therapeutic options often need to be personalized to both the patient and demand of the affected shoulder – clinicians cannot utilize a one-size-fits-all approach for this disease process in the young patient.

The purpose of this book was to break down, in a concise manner, the numerous modalities associated with successful treatment strategies in young patients that present with symptomatic glenohumeral osteoarthritis. Treatment options are presented in a stepwise fashion and cover non-surgical as well as surgical options. Spotlights on surgical techniques are highlighted when appropriate.

Our mission was to deliver up-to-date treatment algorithms for this complex clinical diagnosis, highlighting how each option is altered based upon the patient being young and active. Chapter order was specifically chosen to sequentially increase based upon invasiveness. Each chapter is reinforced with up-to-date information and does not shy away from providing clinical rationale and evidence as to why the intervention can be successfully implemented in the young patient.

We anticipate that the clinician reader will enjoy the content presented within. The production of the book was a heavy lift from many providers across the continent. Each chapter was carefully edited to ensure readability and meet the goals and purpose of the publication.

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Burden of Glenohumeral Osteoarthritis in the Young Patient

1

Timothy Leroux and David Drynan

Introduction

Age is the overriding risk factor for osteoarthritis [1]. As such, physicians and treatments have been elderly focussed, presenting the difficult scenario of the young patient with shoulder arthritis. Treating the under 55-year-old patient with glenohumeral arthritis encompasses primary osteoarthritis, post-traumatic, instability, iatrogenic and other secondary causes of arthritis leading to cartilage destruction, pain and limited function.

The young patient, between 30 and 55 years old, with end-stage shoulder arthritis presents a unique treatment challenge given increased activity levels, higher expectations, and longer life expectancy. Young patients with arthritis can have their disease burden impact many phases of their life including affecting their working careers that may result in personal and financial implications.

Epidemiology

Before understanding the epidemiology of glenohumeral joint osteoarthritis, a definition of the condition must be common for comparison. Along with glenohumeral joint osteoarthritis, like other joints, the disease is a continuum of degeneration, cartilage loss and joint dysfunction. The natural history of this condition in the young or early phases is difficult to accurately assess and, as yet, has not been fully reported in the literature.

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The epidemiology of arthritis is not well established in the literature for age, region or functional status. Arthritis of the young is a worldwide issue, demonstrated by the WHO confirming arthritic pain affecting 0.9–2.3% of 18–29-year-olds and 0.8–12.5% of 30–39-year-olds. Interestingly, this study reported 40–49 and 50–59-year-olds had a −0.3–3.3% and 0.7–11.5% symptom reporting rate respectfully, thus the true incidence is likely higher.

Primary and secondary osteoarthritis of the shoulder are of concern and have a similar course. The rates are not well known, although larger studies of the post-instability arthropathy have been reported. Saltzman et al. have reported the rate of primary osteoarthritis of the shoulder is approximately 21% of those receiving total shoulder arthroplasty under 50 years of age, compared with 66% of those over 50, although this does not yield the overall incidence of shoulder arthritis in the young [2]. Several studies have assessed the long-term risk of arthritis against the natural history of the disease and following stabilisation interventions. The rate of shoulder instability is 8.2–21.9/100,000 persons and radiographic signs of arthritis to be 14–20% in 5-year follow-up studies [3–7]. Twenty-five-year follow-up data reported by Hovelius et al. described mild arthritis in 27% of patients following an instability event and moderate to severe in 34%. Plath and colleagues demonstrated that 69% will develop arthritis following arthroscopic Bankart repair for the treatment of anterior shoulder instability [8]. Although not all shoulder dislocations require surgical intervention, it does present a large burden of arthritic shoulders following instability, considering the peak incidence of first dislocation to be 41.5/100,000 in the 15–24-year age group [9, 10].

Definition

Osteoarthritis, the clinical syndrome of joint pain and dysfunction caused by joint degeneration, affects more people than any other joint disease [1]. Primary OA or GH degenerative joint disease is a set of pathologies with a common pathophysiology – articular cartilage damage, dense subchondral bone, osteophytes, posterior glenoid erosion and posterior displacement of the humeral head [11].

Secondary osteoarthritis is due to conditions leading to abnormal cartilage loading or chondral damage, such as post-traumatic conditions, instability, chondrolysis or dysplasia.

The diagnosis of this condition includes history, examination and imaging studies.

Clinical Diagnosis

History and physical examination are important aspects of the workup for glenohumeral arthritis. Utilising a focussed history, the diagnosis, primary aims of the patient and potential barriers, and possible contraindications to specific management options are obtained. A clinical history is a tapestry of answers that increases the likelihood of the primary diagnosis, the sensitivity and specificity of individual questions is likely very low.

History Questions

- *Age*
- *Pain profile – location, character, radiation, associated features and aggravating and relieving factors, night pain*
- *Joint profile – stiffness? Clicking? Locking? Swelling?*
- *Functional profile – Able to dress? Comb hair? Hygiene? Work? Sports, recreational goals? Other demands for the function of the shoulder?*
- *Medical history and medications including prior surgeries*
- *Smoking – worse outcomes after arthroscopic rotator cuff surgery* [12]
- *Handedness*
- *Rehabilitation barriers – access to physiotherapy and care*

Examination

- *Look – scars, muscle bulk, wasting, swelling, erythema*
- *Feel – assess range of motion; when limited, place the hand on the shoulder and assess active and passive ranges whilst assessing for crepitus; feel for effusions, swelling, warmth and tenderness*
- *Move – A range of motion assessment shoulder be performed if not completed prior, flexion, abduction, internal rotation with radial styloid as guide, external rotation (sensitive sign for glenohumeral joint arthritis) assess scapular movement and look for dyskinesia*
- *Assess rotator cuff strength for consideration of anatomic arthroplasty; assess deltoid strength for reverse total shoulder; assess stability if primary cause of arthritis; assess biceps tendon for concomitant symptomatic disease*
- *Distal neurovascular exam*
- *Cervical spine assessment for radicular pain*

Radiographic Diagnosis

Multiple diagnostic classifications exist for glenohumeral joint arthritis. Classification systems include Samilson-Prieto, Allain and Gerber modifications, Kellgren-Lawrence, Weinstein, and Guyette. It is the author's preference to use the Kellgren-Lawrence classification to grade GH OA, secondary to its ease of use and widespread acceptance as seen in Table 1.1. Schumaier et al. surveyed 26 shoulder surgeons to assess the inter- and intra-correlation coefficients for the Kellgren-Lawrence classification and found 0.79 and 0.84 respectfully [13]. Although developed in 1955 and described for rheumatoid arthritis, this classification system has been adopted for use throughout the body but has been shown to be a poor predictor of treatment when it comes to shoulder arthritis in the young [13–15].

Multiple radiographic parameters are discussed in the literature regarding the increased risk of osteoarthritis, such as the critical shoulder angle (CSA), the angle subtended from the inferior margin of the vertical axis of the glenoid to the lateral edge of the acromion. Although a common cause of increased cuff tear arthropathy, a recent literature review by Zaid et al. has not shown any correlation with CSA, acromial index (AI), lateral acromial angle (LAA) and glenoid inclination (GI) and osteoarthritis [16].

Table 1.1 Kellgren-Lawrence classification and modification for shoulder [13, 14]

Grade	Original description	Shoulder modification
0	None	No arthrosis
1	Doubtful	Possible joint space narrowing, possible osteophyte lipping
2	Mild	Definite osteophytes, definite joint space narrowing
3	Moderate	Multiple osteophytes, definite joint space narrowing, some sclerosis, possible deformity of bone contour
4	Severe	Large osteophytes, joint space narrowing, severe sclerosis, definite deformity of bone contour

Ultrasound (US)

Ultrasound is not utilised in the diagnosis of GH OA, although frequently patients arrive with US results from their local practitioner. It can be useful in diagnosing effusions and capsular changes with osteoarthritis, but as a primary diagnostic modality, it has limited value. US can be used to assess associated conditions with osteoarthritis, such as long head of bicep tendon pathology or rotator cuff tears lesions, although MRI is becoming more common where financially able to provide the service.

Computed Tomography (CT)

CT is the gold standard for the diagnosis and classification of glenohumeral arthritis allowing for 3D imaging, interpretation and planning with printing and modelling. This modality has formed the basis for the Walch classification of glenoid morphology in glenohumeral osteoarthritis, shown in Figs. 1.1 and 1.2 [17]. Walch and colleagues have described the arthritic shoulder with 53.5–59% type A, 32–39.5% type B and 5–9% type C, although the average age groups were greater than 60 years and may not pertain to the young active patient [17, 18].

Osteoarthritis is evident with CT scanning of the shoulder, allowing for advanced knowledge of the subtle signs and early changes of arthritis that may be missed with standard 2D imaging (see below). CT scanning offers highly accurate diagnostic value and can globally define the disease burden to the joint; furthermore, it is a modality that is widely available at most centres. The 3D assessment of the joint has allowed industry partners to develop 3D modelling of prostheses, surgical planning software and predictive range of motion modelling. 3D printing has allowed patient-specific implant guides to be manufactured for additional assistance and accuracy with surgical steps and intraoperative navigation.

CT findings for osteoarthritis

Humerus:

- Subchondral sclerosis
- Subchondral cysts
- Osteophytes

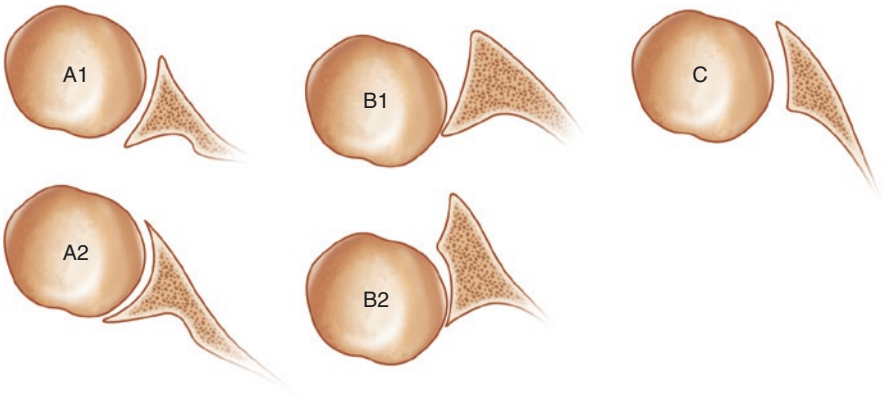

Fig. 1.1 Walch et al. 1999, original classification of glenoid morphology in osteoarthritis. (Reproduced with permission [17])

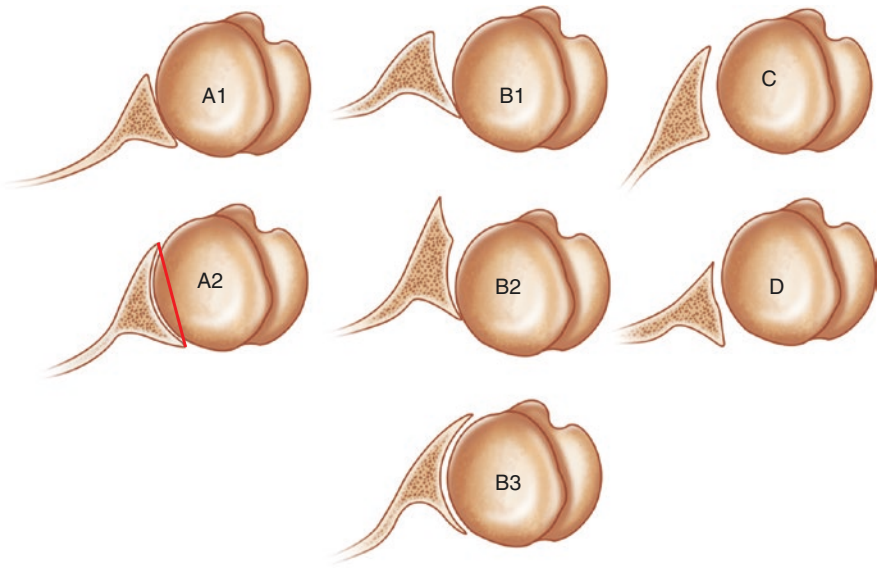

Fig. 1.2 Modified Walch classification by Bercik et al. 2016. Including type B3 and D utilising CT. (Reproduced with permission [19])

- Deformity and collapse
- Version and varus/valgus alignment
- Prior implant assessment

Glenoid:

- Subchondral sclerosis
- Subchondral cysts
- Osteophytes

- Deformity/version/wear pattern/inclination
- Prior anchor placement and bone loss

Joint:
- Joint loss
- Effusion
- Loose bodies
- "Subluxation"

Associated:
- ACJ arthritis
- Loose bodies
- Cuff integrity tears and muscle bulk
- Prior soft tissue procedures/bony procedures
- Planning for implant – vault assessment, bone loss, humeral resection, balancing

Walch et al. have shown the breakdown of glenoid types in their published classification utilising CT scans [17]. This research group demonstrated a high inter- and intra-correlation coefficient and updated breakdown of shoulder arthritis demographics with respect to glenoid morphology, as seen in Table 1.2. These findings have been corroborated across the literature [18].

Magnetic Resonance Imaging (MRI)

A recent study has utilised MRI descriptors to classify and predict shoulder arthroplasty outcomes. Cartilage thickness, oedema, glenoid bone loss and version changes with arthritis are easily seen with MRI. These descriptors are used to determine the severity of the arthritis along with cuff pathllogy, ACJ assessment, labral and biceps pathology. Osteoarthritis grading for knee MRI has been developed, including Whole-Organ Magnetic Resonance Imaging Score, Knee Osteoarthritis Scoring System and Boston Leeds Osteoarthritis Knee Score, allowing for

Table 1.2 Inter- and intra-reliability with glenoid classifications [17, 19–22]

Study	Inter-observer reliability	Intra-observer reliability	Classification
Pajolli et al. 2019	0.132	0.305–0.545	Original Walch classification
Lowe et al. 2017	0.26–0.34	0.47–0.6	Original Walch classification
	0.23–0.26	0.61–0.73	Original Walch with MRI
Bercik et al. 2016	0.391	0.604	Original Walch classification
	0.703	0.882	Modified with A2, B3 and D
Kidder et al. 2012	0.545	0.874	Partial Walch classification, A, B, C only
Nowak et al. 2010	0.508	0.611	Original Walch classification
Walch et al. 1999	0.65–0.7	0.65–0.7	Original Walch classification

crossover of MRI descriptors for arthritic changes to be used along with Shoulder Osteoarthritis Severity (SOAS) Score [23].

There is no shoulder-specific MRI classification for osteoarthritis. Cartilage thickness, oedema, glenoid bone loss and version changes with arthritis are easily seen with MRI. These descriptors are used to determine the severity of the arthritis with MRI reporting, but no specific grading exists for the shoulder. Osteoarthritis grading for knee MRI has been developed, including Whole-Organ Magnetic Resonance Imaging Score, Knee Osteoarthritis Scoring System and Boston Leeds Osteoarthritis Knee Score, allowing for crossover of MRI descriptors for arthritic changes.

Fluid-sensitive MRI slices are best used to determine marrow oedema and early changes in the cartilage, especially fat-suppressed images. Current research evaluating novel MRI sequences and technology include Cartilage Quantification and Composition Assessment to yield better assessment of the cartilage.

MRI has been compared to CT for the assessment of osteoarthritis of the shoulder. Lowe et al. assessed the inter- and intra-observer reliability of MRI and Walch classification, finding good reliability for type A1, A2, B1 glenoid, but poor with B2 and C glenoid morphology [20].

Nuclear Medicine (NM)

Bone scans and positron emission tomography are rarely used in the clinical setting of investigating arthritis, but will show increased uptake and bone turnover in the arthritis setting, but with minimal bone architectural changes.

Arthroscopic Diagnosis

Diagnosis during arthroscopy may be an expected or unexpected event. The expected diagnosis may be confirmation when performing a joint salvage procedure. The unexpected diagnosis may occur as when performing a stabilisation procedure or addressing other soft tissue concerns. During these procedures, the arthroscopic evaluation may confirm cartilage lesions or diffuse arthritis. The difficulty in the second situation is to the management and decision making intraoperatively. The specific treatment and decision making will be determined by the clinical history, examination, symptoms and other soft tissue findings. These treatment options will be addressed in later chapters.

Trends in Diagnosis

The diagnosis of symptomatic GH OA in the young and active population is increasing in prevalence. This fact is in part due to increased knowledge of the condition, increased sporting uptake and increased use and availability of advanced imaging, such as MRI. The sensitivity of MRI allows for the early diagnosis of cartilage

lesions and osteoarthritis when investigating other pathology, such as instability, that is the likely primary cause of the secondary glenohumeral osteoarthritis.

Financial Burden

The economic burden of shoulder arthritis is significant, to the individual, health care practitioner and the health care system as a whole. The US Department of Labor Statistics, 2018 published data regarding days of work missed due to shoulder conditions to be over 68,000 days. Arthritis specifically coded 20 days' work lost due to shoulder OA. Of the 68,000 shoulder injuries and loss of work days in 2018, the average time away from work was 27 days, almost 32,000 days of work lost from injuries or exacerbation of shoulder conditions [24]. This lost time from work results in a significant impact on the patients' function, income, work abilities, hobbies, lifestyle and quality of life. Additionally, it can impact individuals around them.

The Health Care System

Obtaining accurate numbers of cost are difficult with the myriad of treatment options, pathogenesis for the disease, patient follow-up and outcome reporting. Several investigators have assessed the cost of shoulder arthroplasty with respect to other total joint arthroplasty and subsets of shoulder arthroplasty. Bhat et al. have assessed the cost of total shoulder arthroplasty and hemiarthroplasty in the young arthritic shoulder in both a literature review and economic model. They showed for the 5279 young arthritic shoulders reported in the literature, a total shoulder arthroplasty would cost the health care system $125.5mil and hemiarthroplasty $132.5mil, including projected revisions and longevity of prostheses. This figure is for those reported in the literature, a small percentage of those young patients with glenohumeral arthritis. The expectation for demand of total shoulder arthroplasty is to increase 8.2% per year in the under 55-year-old population and increase 333.3% between 2011 and 2030 [25].

The Patient

The impact on the patient includes employment options, hobbies, lifestyle, home life, chronic pain, quality of life and financial strains. The economic impact for patients has been difficult to quantify in the literature, but quality of life assessments have been made. Financial impacts can be extrapolated from employment data from the US Department of Labor, showing 32,000 days' missed work due to shoulder injuries, with a high percentage being in manual labour occupations [24, 26].

The financial impact is not only due to income loss but also expenditure for treatment. Mulieri et al. showed no change with formal physiotherapy following

shoulder arthroplasty compared to physician and patient directed rehabilitation, although their estimates included 1 hour appointments with a physiotherapist for rehabilitation to be approximately US$100. With additional travel, physician visits, allied health input and decreased income during the recovery, the personal financial impact is significant [27].

The overall impact of shoulder arthritis is not just financial; Gartsman et al. published self-assessment data regarding the impact of shoulder pain, including arthritis, that showcased the impact on par with diabetes mellitus, depression and congestive heart failure [28]. The increased demands, expectations, goals and limited options confirm glenohumeral arthritis in the under 55-year-olds is a very difficult problem to manage.

Age-Related Concerns

Treatment of shoulder arthritis in the elderly has a tried-and-true algorithm, with arthroplasty displaying predictable results. A specific treatment is less well defined in the young and active patient. The physical demands are increased, the activity levels are elevated, the longevity of the implants is predictability less, whilst the underlying pathology is often more complex [2, 29]. Total shoulder arthroplasty outcomes are less reliable with post-traumatic osteonecrosis as the primary cause for the osteoarthritis, along with decreased range of motion and humeral head subluxation, all of which are increased in osteoarthritis of the young [30, 31]. The concerns with arthroplasty are the functional goals of the patient and if the prosthesis can yield predictable results that maintain longevity of the implant. Due to these limitations with current arthroplasty, alternative treatments such as arthroscopic debridement, chondral treatments, injection therapy and biologic resurfacing and arthroplasty are considered.

Functional Demands

Patients under 55 have a higher functional demand and are less often willing to settle for activity modification as a treatment option for their shoulder arthritis. These demands include occupation, physical muscle bulk, activity level, sporting and hobby activities and the financial demands of young active people in the workforce with a chronic condition. The increased functional demands, functional goals and the duration of survival of the intervention lead to further management difficulties with glenohumeral arthritis in the young patient.

Joint Salvage Outcomes

Multiple interventions including pain-relieving procedures such as injections, debridement and joint preservation procedures including cartilage grafting and

biologic resurfacing have their indications and limitations. Biologic resurfacing has been shown to improve shoulder function, particularly constant scores, although the radiographic arthritis progression is evident at an 8-year follow-up [32]. The proven longevity for these interventions is not yet well established, and the possible compromise of future primary total shoulder arthroplasty is a consideration in the young arthritic patient.

Arthroplasty Longevity Outcomes

The longevity of current prostheses is a primary reason for the difficulty in managing young patients with glenohumeral osteoarthritis. The functional demands and activity goals for patients under 55 years are increased compared with the elderly arthroplasty practice and prosthesis candidates. This factor may be why Sperling et al. found only 50% of patients with a total shoulder arthroplasty under the age of 50 were satisfied [33]. Although a dated reference, it does highlight the increased expectations of prostheses, function, feel and demands of the younger person with glenohumeral arthritis. Bartelt et al. showed that in patients younger than 55 years, 87% of patients felt better or much better than they were preoperatively, but did not mention the patient's overall satisfaction rate with the shoulder prosthesis [34]. Newer interventions such as a pyrocarbon interposition arthroplasty have shown a 90% survival at almost 4 years, but almost 80% had progression of disease with humeral medialisation and pain [35]. In this cohort, 10% were revised to reverse total shoulder replacements at an average of 38 months (20–60 months) [35].

Several case series and cohort studies have assessed the survival rate of total shoulder arthroplasty in the under 50-year-old patient and shown results as high as 97% at 10 years for total shoulder arthroplasty [33]. This rate has not been matched in many other longitudinal studies, or the arthroplasties in the young are from the Australian Orthopaedic Association National Joint Replacement Registry (AOANJRR). According to the AOANJRR, the survivorship of hemi-resurfacing for osteoarthritis in patients less than 40 years of age is 77.2% at 9 years, with 80% of those hemi-resurfacings being converted to total shoulder arthroplasty. Total shoulder arthroplasty has improved survival and functional results compared to hemiarthroplasty. Hemiarthroplasty, specifically resurfacing of the humerus, in both less than 40 years old and the 40–55-year groups displays a revision rate of 22.8% at 9 years. A slightly higher revision rate can be found in the stemmed prosthesis in patients under 40 years of age. Total shoulder arthroplasty in the less than 40-year-old and 40–55-year groups has relatively high revision rates, 20.7% revision at 8 years for less than 40, and 19.1% at 10 years for 40–55-year age group. This is higher than the cumulative rate of revision at 12 years of 14.8% for stemmed total shoulder arthroplasty and 6.4% for reverse total shoulder arthroplasty at 10 years [36, 37]. Reverse total shoulder arthroplasty in the young has a high revision rate, with insufficient data for less than 40-year subset and 4.7% at 5 years for the 40–55-year group [37].

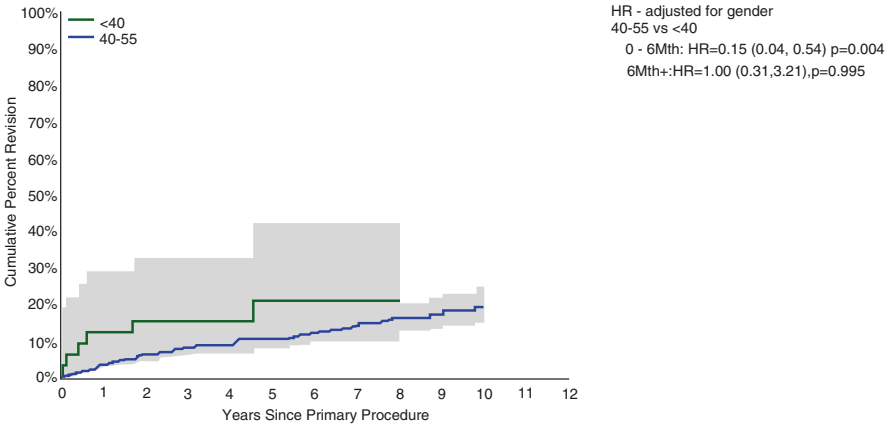

Fig. 1.3 Cumulative percent revision of primary total stemmed shoulder replacement by age for osteoarthritis. Australian Orthopaedic Association National Joint Replacement Registry data. (Reprinted with permission)

Figure 1.3 represents the current revision rates for anatomic and reverse total shoulder arthroplasty in the less than 40 and the 40–55-year age ranges. The registry data does not contain functional results, satisfaction or pain scales for the patients. The increased revision rates must be interpreted to reflect the difficult nature of arthritis in the young and options for revision and poorer results following prior surgery. Carroll et al. and Sperling et al. have demonstrated revision rates from hemiarthroplasty to total shoulder arthroplasty are inferior to primary total shoulder arthroplasty and revision rates are 12% higher if a prior operation occurred on the shoulder [33, 38]. The longevity of modern implants is improving, along with function, bone preservation and ease of revision, but the lifespan of the prosthesis is still far shorter than the lifespan of the patient and often less able to yield the functional results desired.

Key Points

Prevalence

About 15–20% of the 8–12/100,000 with shoulder instability will develop glenohumeral arthritis. The specific rate of primary glenohumeral arthritis is unknown, although the demand for total shoulder arthroplasty in the under 55-year age group is increasing 8% yearly.

Burden financially

$23,700 and $25,000 is the refunded cost per patient for total shoulder and hemiarthroplasty in an economic model for younger patients with glenohumeral osteoarthritis. The impact of shoulder injuries on the workplace is combined 32,000 days lost per annum.

Age-Related Concerns

Younger patients with increased physical demands, goals, work and family commitments, muscle bulk and underlying pathology for secondary osteoarthritis