Management of Acute Work-Related Shoulder Injuries by an Early Shoulder Assessment Program: Efficiency of Imaging Investigations

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ABSTRACT

Purpose: There has been a significant increase in the number of costly investigations of the shoulder joint over the past decade. The purposes of this study were to (1) describe the diagnostic imaging investigations ordered for injured workers seen at an Early Shoulder Physician Assessment (ESPA) program, (2) evaluate the impact of these investigations on final diagnosis and management, and (3) examine how efficient the program was by determining the appropriateness of referrals and whether costly imaging was justified. **Methods:** This was a retrospective review of the electronic files of injured workers who had been referred to an early assessment program because they had not progressed in their recovery or return-to-work plan within 16 weeks of the injury or reoccurrence. **Results:** The data of 750 consecutive patients—337 women (45%) and 413 men (55%), mean age 49 (SD 11) years—were reviewed. A total of 183 patients (24%) had been referred for further investigation. Of these, 90 (49%) were considered candidates for surgery (group 1), 58 (32%) had a change in diagnosis or management (group 2), and 17 (9%) had no change in diagnosis or management (group 3); 18 (10%) patients were lost to follow-up. We noticed a pattern in the type of diagnosis and the groups: full-thickness rotator cuff (RC) tear was the predominant diagnosis (Fisher's exact test [FET] = 0.001, $p < 0.0001$) for group 1. No statistically significant differences were found among the groups in the prevalence of labral pathology (FET = 0.010, $p = 0.078$), impingement syndrome (FET = 0.012, $p = 0.570$), partial-thickness RC tear (FET = 0.004, $p = 0.089$), or biceps pathology (FET = 0.070, $p = 0.149$). Ultrasound investigations were more prevalent in group 2 (FET = 0.004, $p = 0.047$). No pattern was found for use of magnetic resonance imaging and group allocation. However, all magnetic resonance arthrogram investigations (FET = 0.007, $p = 0.027$) had been ordered for patients who required labral or instability-related surgery. **Conclusions:** Of the injured workers we studied, 24% had further investigation, and the type and severity of pathology had affected the type of investigation. For the 165 patients who were included in groups 1–3, the ESPA was 90% efficient, with only 10% of patients not having had a change in diagnosis or management.

Key Words: early assessment programs; diagnostic imaging; occupational injuries; shoulder.

RÉSUMÉ

Objectif : le nombre d'investigations coûteuses pour blessures à l'épaule a beaucoup augmenté au cours des dix dernières années. La présente étude avait pour objectif de 1) décrire les investigations par imagerie diagnostique prescrites aux travailleurs blessés dans le cadre d'un programme d'évaluation médicale précoce de l'épaule (ÉMPÉ); 2) évaluer l'incidence de ces investigations sur le diagnostic final et la prise en charge; 3) examiner l'efficacité du programme en déterminant le bien-fondé des références et des examens d'imagerie. **Méthodes :** il s'agissait d'une revue rétrospective des dossiers électroniques de travailleurs blessés qui avaient été dirigés vers un programme d'évaluation précoce en raison d'un manque de progression par rapport à leur plan de rétablissement ou de retour au travail au bout de 16 semaines après la blessure ou une nouvelle blessure. **Résultats :** on a examiné les données de 750 patients consécutifs, soit 337 femmes (45 %) et 413 hommes (55 %), dont l'âge moyen était de 49 ans (écart-type : 11). En tout, 183 de ces patients (24 %) ont été dirigés vers un autre professionnel pour investigation supplémentaire. Sur ceux-ci, 90 (49 %) ont été considérés comme des candidats à l'intervention chirurgicale (groupe 1), le diagnostic ou la prise en charge a évolué chez 58 (32 %) d'entre eux (groupe 2) et la prise en charge ou le diagnostic a été confirmé chez 17 (9 %) d'entre eux (groupe 3); 18 (10 %) patients n'ont pas été revus. Nous avons remarqué une tendance dans le

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Contributors: Helen Razmjou conceived the idea, designed the study, supervised data extraction and entry, performed data analysis, and drafted the manuscript. Sandra Lincoln and Dragana Boljanovic performed clinical examinations and reviewed the electronic files of patients who were referred for investigation. Christopher Geddes performed clinical examinations of the sample used. Iona Macritchie, Caterina Virdo-Cristello, Danielle Medeiros and Robin Richards participated in program development. All authors were involved in conception of the study, data analysis interpretation, critical revision of the important content of the manuscript and approved the final version of the article.

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type de diagnostic et les groupes : le diagnostic de déchirure complète de la coiffe des rotateurs (CR) prédominait (test exact de probabilité de Fisher [TEPF] = 0,001, $p < 0,0001$) dans le groupe 1. On n'a constaté aucune différence importante du point de vue statistique dans les groupes pour ce qui est de la prévalence de pathologies du bourrelet (TEPF = 0,010, $p = 0,078$), du syndrome de conflit sous-acromial (TEPF = 0,012, $p = 0,570$), de la déchirure partielle de la CR (TEPF = 0,004, $p = 0,089$) et des pathologies du biceps (TEPF = 0,070, $p = 0,149$). Un plus grand nombre d'échographies a été observé dans le groupe 2 (TEPF = 0,004, $p = 0,047$). On n'a remarqué aucune tendance du recours à l'imagerie par résonnance magnétique par rapport aux groupes. Toutefois, toutes les arthrographies par résonnance magnétique (TEPF = 0,007, $p = 0,027$) ont été prescrites pour des patients qui nécessitaient une intervention relative au bourrelet ou à l'instabilité. **Conclusions** : parmi les travailleurs blessés que nous avons étudiés, 24 % ont fait l'objet d'une investigation supplémentaire. Le type et la gravité de la pathologie ont influencé le choix du mode d'investigation. Dans le cas des 165 patients des groupes 1 à 3, l'efficacité du programme d'ÉMPÉ s'est élevée à 90 %, le diagnostic ou la prise en charge n'ayant pas évolué que dans 10 % des cas.

Symptoms related to the shoulder joint are the third most common musculoskeletal complaint, after low back pain and knee pain, for which patients seek medical attention.^{1,2} Research has shown that shoulder conditions in the workplace contribute significantly to disability in injured workers^{3–7} and are among the most expensive compensated claims.⁸ Soft-tissue structures affected in such injuries commonly include muscles and tendons of the shoulder girdle and rotator cuff (RC), long head of the biceps, and capsulolabral injuries relating to instability. The prevalence of RC-related conditions such as impingement syndrome, tendinitis, and partial- and full-thickness tears is reported at approximately 65%–70%.⁶ Although age-related changes in RC tendons may be asymptomatic, traumatic and acute tears commonly seen in injured workers should be assessed with a thorough history and physical examination, diagnosed accurately, and treated appropriately to minimize muscle atrophy, stiffness, tear enlargement, and, in certain cases, RC arthropathy.^{9–11} The literature has shown a higher failure rate of surgical repair in larger RC tears,^{9–14} and failing to achieve an anatomical repair may contribute to delay in a worker's return to work or having a permanent disability.

The integrity of soft tissues of the shoulder is assessed using ultrasound (US), MRI, or magnetic resonance arthrogram (MRA). However, MRI and MRA are more costly than US; thus, patients need to wait longer to obtain them. Both US and MRI are useful tools in diagnosing tears in the RC and long head of the biceps, although, for superior labral anterior–posterior (SLAP) lesions, glenohumeral instability, and adhesive capsulitis, MRA is considered the better modality. With respect to the diagnostic accuracy of US, MRI, and MRA in characterizing full-thickness RC tears, a recent meta-analysis has shown that the three imaging modalities performed similarly for overall estimates of sensitivity (0.90–0.91) and specificity (0.93–0.95).¹⁵ For diagnosing partial-thickness RC tears, US and MRI have a similar sensitivity (0.68 and 0.67, respectively), and MRA has a higher sensitivity (0.83). For specificity, the three imaging modalities are reported to perform equivalently (0.93–0.94). For detecting SLAP lesions, MRI is 83%–90% sensitive and 99%–100% specific. MRA has sensitivity and specificity estimates of 98% and 99%, respectively.¹⁵

In Canada, the fees associated with plain X-rays and US are approximately \$40, whereas MRI and MRA cost about \$230. The Canadian Institute for Health Information has reported that, between 2010 and 2011, 1.6 million MRIs and 4.3 million computed tomography (CT) scans were performed on Canadian patients,¹⁶ and the use of imaging services is increasing national expenditures significantly, exceeding an estimated \$2.2 billion in operational costs each year.^{17,18} As the overall costs of diagnostics and treatment of injured workers continue to rise, any reduction is of growing importance to our health care system.

In light of this, the literature has indicated an interesting fact: A large percentage of costly imaging investigations ordered by primary care physicians are inappropriate, ranging from 26%¹⁹ to 63%.²⁰ In a study by Wylie and colleagues,²¹ primary care physicians did not document physical examinations in half the patients for whom they had ordered MRIs; this was an inefficient use of MRI. Documenting clinical indications improves the yield of positive imaging results from 13% to 58%.¹⁹ In a report on the overuse of medical imaging, Hendee and colleagues²² stated that approximately 20%–50% of imaging studies failed to provide information that improved patient welfare. Inappropriate use of medical imaging tests can also have adverse effects on patient safety (e.g., exposure to unnecessary radiation, allergic reactions to injectable contrast), significantly increase health care costs, and have a negative impact on wait times.

Imaging findings lead to a more accurate diagnosis only when they are accompanied by relevant history and proper clinical examination. Therefore, considering that imaging modalities are only an adjunct to diagnosis, their cost should be weighed against the value of the information they can add to the clinical decision-making process. Another common indication for advanced imaging is injured workers who cannot participate in a thorough physical exam because of pain, stiffness, weakness, anxiety, or a combination of these.

Early access to specialty assessment centres managed by trained physical therapists and orthopaedic surgeons can facilitate quicker investigations, any necessary surgical consultations, and better managed and improved functional outcomes. However, early assessment centres for

injured workers are a new concept in Canada, and their efficiency has not been systematically examined. The purpose of this study was threefold: to (1) describe the diagnostic imaging investigations ordered for injured workers seen in an Early Shoulder Physician Assessment (ESPA) program, (2) evaluate the impact of these investigations on final diagnosis and management, and (3) examine how efficient the program was by determining the appropriateness of referrals and whether costly imaging was justified. We hypothesized that referring injured workers with acute shoulder injuries to specialized examiners in a timely fashion would facilitate management and reduce unnecessary and costly investigations.

METHODS

Access to an ESPA program was initiated by the Ontario Workplace Safety and Insurance Board in 2012²³ to facilitate the management of workers with shoulder injuries. A referral to these clinics is initiated by case managers. The objectives of the program are to make a thorough and early shoulder assessment and provide a clear diagnosis and recommendation for evidence-based shoulder treatment. The early assessment allows timely investigations and identifies candidates for surgery. Although patients who are potential surgical candidates may be referred to this clinic, those with clear indications for surgery (e.g., major RC and labral tears, frank glenohumeral dislocations) should be directly referred to a shoulder surgical specialty program (SSP). In addition, patients with acute inflammatory arthropathy, infection or fracture at the site of injury, neoplasm, or advancing or unexplained neurological or sensory deficits are considered clinically inappropriate for this program.

Study design

This study was a retrospective review of the electronic files of injured workers who had been referred to an ESPA program and were seen from November 2012 to September 2014. All patients included in this study had been seen by one orthopaedic surgeon with fellowship training in shoulder surgery and specialized physical therapists with postgraduate training and experience in shoulder examination. To establish a baseline level of perceived disability, all patients completed the Shortened Disabilities of the Arm, Shoulder, and Hand (QuickDASH)²⁴ questionnaire before they were seen by the clinicians; the clinicians then completed a standardized, fillable PDF form that included details about how the injury had occurred, symptoms, available investigations, and clinical examination. The assessment of the patients involved reviewing the results of previous investigations and treatment ordered by family physicians, obtaining the patients' medical history, and performing range-of-motion and strength tests as well as clinical tests for differential diagnosis of shoulder pathology. Recommendations for further treatment and work restrictions were provided and new investigations ordered if they were deemed necessary.

Patient population

Patients referred to the ESPA program were workers with shoulder injuries who had not progressed in their recovery or return-to-work plan within 16 weeks of the injury or reoccurrence. The diagnoses included subacromial bursitis, RC tendinitis, osseous subacromial impingement, acromioclavicular (AC) joint pathology, and RC tears. Patients with significant pathology—such as osseous subacromial impingement, full-thickness RC tears, glenohumeral instability, or SLAP lesions—and who had required RC decompression or repair, stabilization, or labral repair were referred to the SSP for surgical consultation.

Data collection

Electronic files of the patients who had been sent for further investigations were reviewed, and the results of the investigations and any subsequent changes in management were documented. Clinical data were extracted from the PDF forms completed by the clinicians, and investigation results were captured from follow-up reports. Patients with ordered imaging who had been lost to follow-up were excluded from the study. Approval to use the existing data was obtained from the Research Ethics Board of the Sunnybrook Health Sciences Centre.

Impact and efficiency of imaging investigations

Patients were divided into three groups on the basis of the impact of diagnostic investigations on overall patient care. Group 1 consisted of patients who were referred for surgery after the investigation (pre-surgical). Group 2 consisted of those for whom investigation had changed their clinical diagnosis or overall management. Group 3 consisted of those for whom investigation had not changed clinical diagnosis or management but had been required to confirm the diagnosis or justify further management.

The efficiency of the ESPA program was measured on the basis of (1) the appropriateness of the referral to the program (e.g., surgical candidates with documented full-thickness RC tears, symptomatic instability, or traumatic SLAP tears were considered inappropriate) and (2) the percentage of patients whose diagnostic imaging was justified (percentage of surgical patients plus percentage of patients whose diagnosis or management had changed after imaging investigation). Figure 1 shows the referral algorithm proposed to improve efficiency, and Figure 2 shows the flowchart for the study.

Statistical analysis

Descriptive statistics (number, mean, SD, minimum, and maximum) were developed for variables of interest for the full sample, patients who were directly referred to the shoulder SSP for consideration of surgery, and those who had required further investigations. The impact of an investigation and the type of diagnosis were then examined for the three groups. The level of disability, as measured by QuickDASH²⁴ and the numeric

Figure 1 Algorithm for early assessment referral.

*SLAP lesions and instability-related labral tears require more definitive diagnostic investigations.

US = ultrasound; FTRCT = full-thickness rotator cuff tear; SLAP = superior labral anterior–posterior; PTRCT = partial-thickness rotator cuff tear; SSP = surgical specialty program; ESPA = Early Shoulder Physician Assessment.

pain rating scale (NPRS), and having abnormal pain behaviour were compared between those in group 3, who had costly investigations without a change in diagnosis or management, and those in groups 1 and 2, whose investigations were justified. Chi-square tests or Fisher's exact tests (FETs) were used for categorical data, and parametric and non-parametric analyses were used for continuous data, as appropriate. Statistical analyses were performed using SAS version 9.1.3 (SAS Institute, Cary, NC). Statistical results are reported using two-tailed p values with significance set at $p < 0.05$.

RESULTS

In 23 months, 750 consecutive patients were seen: 337 women (45%) and 413 men (55%), with a mean age of 49 (SD 11) years (range 19–77 y). Table 1 shows the demographics, type of investigations, and final diagnostic categories for the full sample and three sub-groups.

Types of diagnostic imaging

Of the 750 patients, 183 (24%) had been referred for further investigation: 53 women (29%) and 130 men (71%), mean age 51 (SD = 11) years (range 19–76 y). Of

these 183, 138 (75%) required more costly investigations: MRI (70%), MRA (4%), and CT scan (1%).

Impact of diagnostic imaging

Of the patients referred for further investigation, 90 (49%) were considered candidates for surgery (group 1), 58 (32%) had a change in diagnosis or management (group 2), and 17 (9%) had no change in diagnosis or management (group 3). In group 3, 10 patients (6%) had costly investigations (e.g., MRI of shoulder or cervical spine) that had not changed their management. A further 18 patients (10%) were lost to follow-up.

Diagnostic imaging and types of pathology

For surgical candidates, full-thickness RC tear was the predominant diagnosis; for group 1, 57 patients (63%) had this diagnosis, compared with 2 patients in Group 2 (3%) and 1 in Group 3 (6%; FET = 0.001, $p < 0.0001$). Group 1 had the lowest prevalence of AC joint pathology: 2 patients (2%) compared with 7 in Group 2 (12%) and 2 in Group 3 (12%; FET = 0.004, $p = 0.026$). There were no statistically significant differences among the groups in the prevalence of labral pathology (FET = 0.010,

Figure 2 Early assessment referral flowchart.

ESPA = Early Shoulder Physician Assessment; SSP = surgical specialty program.

$p = 0.078$) or less severe pathologies such as impingement syndrome (FET = 0.012, $p = 0.570$), partial-thickness tear (FET = 0.004, $p = 0.089$), or biceps pathology (FET = 0.070, $p = 0.149$).

Patterns in diagnostic imaging and group allocation

Group 2 had the highest percentage of US investigations: 10 (17%) compared with 6 (7%) for Group 1 and 0 (0%) for Group 3 (FET = 0.004, $p = 0.047$). There was no pattern between ordering MRIs and group allocation, although MRI was the predominant test in all three groups: For Group 1, it was 68 (76%); for Group 2, it was 38 (66%); and for Group 3, it was 10 (59%; $\chi^2 = 2.25$, $p = 0.316$).

Table 2 shows the details for patients with MRIs whose management did not change. No statistically significant differences were found in disability level, as measured by the QuickDASH or NPRS, or in abnormal pain behaviour between those in group 3 who had had an MRI and those in the other two groups ($p > 0.05$). All eight MRA investigations (FET = 0.007, $p = 0.027$) were ordered for patients who required surgery for labral pathologies (group 1). The only CT scan ordered was also for a patient in group 1 (FET = 0.300, $p = 1.00$).

Appropriateness of referrals

Of the 750 patients referred to an ESPA program, 55 were redirected to the shoulder SSP for surgical consultation because they had already had sufficient diagnostic testing and required surgery. The majority of these

patients had an US (39, or 71%) or MRI (31, or 56%); some had both. One patient had a CT scan of the shoulder.

Efficiency of management

For the 165 patients who were included in groups 1–3, the ESPA was 90% efficient; only 10% of patients did not have a change in diagnosis or management. Of these patients, only 6% had costly investigations.

DISCUSSION

The principal finding of this study is that of the 750 injured workers with an acute shoulder injury who had been referred to an ESPA program, only 183 (24%) had required further investigations; of these, 58 (32%) had a change in diagnosis or management, and 90 (49%) required surgery. Seventeen of 165 patients (10%) did not have a change in diagnosis or management, and, of those, only 10 (6%) had had costly investigations. These findings indicate that management of acute shoulder injuries is facilitated by referring patients in a timely manner (within 16 weeks of injury or reoccurrence) to specialized examiners who can order evidence-based investigations on the basis of clinical findings and provide effective management. Thus, referring patients to an ESPA program can potentially reduce the number of unnecessary and costly investigations ordered without proper clinical examination.

The results of the present study are consistent with the available literature that has compared general practitioners with physical therapists and orthopaedic surgeons

Table 1 Demographics, Types of Investigations, and Final Diagnostic Categories for the Full Sample and Sub-Groups

	No (%)		Age, y		No (%)	
	Participants	Sex	Mean (SD)	Range	Investigations	Final diagnostic categories
Full sample	750 (100)	F: 337 (45) M: 413 (55)	49 (11)	19–77	n/a	n/a
Patients referred directly to SSP	55 (7)	F: 14 (25) M: 41 (75)	53 (10)	23–72	Available: US: 39 (71) MRI: 31 (56) CT scan: 1 (2)	FTRCT: 34 (62) Impingement: 29 (53) Biceps pathology: 24 (44) PTRCT: 13 (24) SLAP lesions: 2 (4) GH OA: 1 (2) Adhesive capsulitis: 1 (2) Instability: 1 (2)
Patients referred for further investigation	183 (24)	F: 53 (29) M: 130 (71)	51 (11)	19–76	Ordered: MRI: 128 (70) US: 18 (10) EMG: 15 (8) MRA: 8 (4) CT scan: 2 (1) Blood test: 2 (1) Bone scan: 2 (1)	n/a
Group 1 (pre-surgical)	90 (49)	F: 20 (22) M: 70 (78)	48 (12)	24–71	Ordered: MRI: 68 (76) MRA: 8 (9) US: 6 (7) CT scan: 1 (1) EMG: 1 (1)	FTRCT: 57 (63) Impingement: 37 (41) Biceps pathology: 22 (24) PTRCT: 19 (21) Instability: 6 (7) SLAP lesions: 4 (4) ACJ: 2 (2) Adhesive capsulitis: 2 (2) GH OA: 2 (2)
Group 2 (management changed)	58 (32)	F: 22 (38) M: 36 (62)	47 (12)	19–68	Ordered: MRI: 38 (66) US: 10 (17) EMG: 8 (14) EMG: 8 (14) Blood test: 1 (2) Blood test: 1 (2)	Impingement: 29 (50) PTRCT: 21 (36) Biceps pathology: 7 (13) AC J: 7 (13) FTRCT: 2 (3) Adhesive capsulitis: 1 (2) Instability: 1 (2)
Group 3 (management not changed)	17 (9)	F: 5 (29) M: 12 (71)	47 (11)	24–68	Ordered: MRI: 10 (59) EMG: 6 (35) Bone scan: 2 (12)	Impingement: 9 (53) Biceps pathology: 5 (29) PTRCT: 3 (16) ACJ: 2 (12) FTRCT: 1 (6) Brachial plexus: 1 (6) CS pathology: 1 (6)
Patients with costly investigations	10 (6)				MRI (shoulder): 9 (90) MRI (CS): 1 (10)	
Lost to follow-up	18 (10)	F: 5 (28) M: 13 (72)	51 (11)	23–71	n/a	n/a

Note: Some diagnoses and investigations overlapped.

SSP = surgical specialty program; F = female; M = male; US = ultrasound; CT = computerized tomography; FTRCT = full-thickness rotator cuff tear; PTRCT = partial-thickness rotator cuff tear; SLAP = superior labral anterior-posterior; GH OA = glenohumeral osteoarthritis; MRA = magnetic resonance arthrogram; EMG = electromyography; AC J = acromioclavicular joint; CS = cervical spine.

Table 2 Demographics of Patients Whose Diagnosis Had Not Changed with MRI Investigations

Subject	Age, y	Sex	No. of days between injury and assessment	How injured	Medication	Comorbidity	Level of disability			Diagnosis before and after imaging
							Quick DASH	NPRS	APB	
1	49	M	93	Traction	Analgesic	None	84	7	No	Impingement
2	39	M	119	Pulling/pushing	None	None	36	7	Yes	Impingement, biceps pathology
3	54	M	92	Pulling/pushing	Analgesic	None	28	4	No	Impingement
4	39	M	55	Pulling/pushing	None	None	68	8	No	Impingement
5	56	F	111	Repetitive activities	Analgesic, muscle relaxant	Arthritis	68	4	No	FTRCT, biceps pathology
6	68	M	92	Direct trauma	None	None	56	6	No	Impingement
7	40	M	76	Pulling/pushing	Analgesic	Hypertension	60	7	No	Biceps pathology
8	49	F	83	Other	NSAID	Diabetes, hypertension	43	5	No	Impingement
9	44	M	240	Other	NSAID	None	75	4	No	OA of ACJ
10*	48	M	84	Pulling/pushing	None	Diabetes	48	6	No	Impingement

Note: There was no statistically significant difference between this group and the rest of the patients in QuickDASH, NPRS, or APB.

*MRI was conducted of the cervical spine.

QuickDASH = Shortened Disabilities of the Arm, Shoulder, and Hand; NPRS = numeric pain rating scale; APB = abnormal pain behaviour; FTRCT = full-thickness rotator cuff tear; NSAID = non-steroidal anti-inflammatory drug; OA = osteoarthritis; ACJ = acromioclavicular joint.

in assessing musculoskeletal disorders. Two studies have shown that a large proportion (from 26%¹⁹ to 63%²⁰) of costly imaging studies ordered by primary care physicians were inappropriate. Other investigators²¹ have shown that orthopaedic surgeons and non-surgical sports physicians were significantly more likely than primary care physicians to order an MRI of the knee joint based on appropriate physical examinations and basic radiographs. In that study, primary care physicians documented physical examinations in only half of the patients for whom MRIs had been ordered, which resulted in an inefficient use of MRI in this group. Still other studies have reported reductions of up to 50% in the use of such investigations when physical therapists working in direct access settings have privileges for ordering imaging.^{25–27}

The decision to refer patients for diagnostic imaging in ESPA programs is based on the clinical reasoning of trained practitioners, and because of the thorough assessment and justification for management, it has the potential to save money on at least two levels. First, shortening the time frame can reduce disability and facilitate conservative and surgical management. Second, an early assessment by a specialized centre can reduce how often general and primary physicians order costly and potentially unnecessary imaging.

Direct referral for surgical consultation

Of the 750 injured workers who had been referred to an ESPA program, 55 (7%) were referred directly to a shoulder SSP because they had presented with a documented, symptomatic full-thickness RC tear. In these

cases, being referred to an ESPA program may delay management and, in patients with traumatic large RC tears, may have a detrimental impact on reparability and the final response to surgery. Therefore, consistent with the available literature^{28,29} and guidelines published by Health Quality Ontario and the Ministry of Health and Long-Term Care,³⁰ we recommend that educational strategies be provided for primary care physicians to order basic imaging investigations such as plain radiographs and US in a timely and appropriate manner. In rare cases, when the US indicates the possibility of SLAP lesions (e.g., paralabral cysts) or instability-related labral tears, additional investigations, such as MRA, may be required. Patients with a clear indication for surgical consultation should then be referred directly to an SSP to reduce the delay in receiving appropriate treatment.

Considering that the accuracy of a US is affected by the radiologist's level of training,^{31,32} we recommend that injured workers receive this investigation in facilities such as a university-affiliated hospital or clinic where a radiologist with a musculoskeletal specialty is available.

Some guidelines already exist for assessing the initial imaging of patients with acute shoulder pain. For example, the American College of Radiology Appropriateness Criteria²⁸ are evidence-based guidelines for specific clinical conditions. These guidelines are developed and reviewed by extensively analyzing the current literature from peer-reviewed journals and applying a well-established consensus methodology. According to these criteria, plain radiographs should be the initial screening modality for acute shoulder injuries, followed by US or

MRI, depending on how a patient presents. The criteria state that US, together with appropriate local expertise, such as musculoskeletal radiology fellowship training,^{31,32} can be excellent in depicting RC tears, impingement, and long head of the biceps pathology. MRI is more appropriate in patients aged older than 35 years and in the presence of a suspected RC tear and subacromial osteophytes.

A panel of specialists from a variety of medical disciplines has provided an algorithmic approach to the imaging evaluation of suspected RC disease.²⁹ The panel suggested plain radiographs for patients with a history of trauma aged older than 40 years to rule out calcific tendinitis and bony irregularities of the greater tuberosity. US was considered the next best investigation for evaluating suspected RC abnormalities on the basis of the nearly equivalent accuracy of US and MRI for full- and partial-thickness RC tears,^{15,33} combined with the fact that US is cheaper,³⁴ has greater patient acceptance,³⁵ and has no contraindications. In addition, the literature has shown that US can provide sufficient information about fatty degeneration and atrophic changes of the RC muscles.^{29,36–38} The Health Quality Ontario and Ministry of Health and Long-Term Care guidelines,³⁰ which serve as a compendium of the evidence-based rationale and clinical consensus, also suggest using plain radiographs and US as the initial investigations for patients with degenerative disorders of the shoulder joint.

In our sample of 750 injured workers, most of whom had been seen within a short period after their injury (<16 wk), 183 (24%) had required further investigations, and, of those, 138 (75%) had required costly investigations. These investigations were justified for 148 patients (81%), including surgical candidates and those who had had a change in diagnosis or management. However, management had not changed for 10 patients (6%) who had undergone MRI despite careful consideration regarding ordering costly investigations. These patients had a less severe pathology, varying from impingement to partial-thickness RC tear, and the MRI did not change the pre-test diagnosis or management.

In our study, the QuickDASH scores showed that group 3 patients were not more disabled and did not have higher levels of abnormal pain behaviour. However, in the absence of a clear diagnosis, or in certain medical or legal cases, an MRI may help to clarify diagnosis or facilitate a return to work. The literature has indicated overuse of medical imaging in the presence of medico-legal liability.^{39,40}

In this study, the majority of pre-surgical patients (group 1) had full-thickness RC tears, whereas patients in groups 2 and 3 had less severe RC pathology, such as impingement syndrome or partial-thickness RC tears. Therefore, consistent with the available literature and expert panel opinions, it is recommended that the type of imaging be based on the severity of the symptoms and

clinical signs of significant weakness, atrophic changes, or deformity. An MRI is recommended as the preferred test to assess full-thickness RC tear size in patients for whom an RC repair is being considered. Patients with osteoarthritis of the AC joint and subacromial osseous impingement with or without tendinopathy or partial-thickness tears may also benefit from decompression surgery (resection of lateral clavicle and acromioplasty). US is a highly accurate test for detecting RC pathology;^{15,41,42} it is equivalent to an MRI in its impact on clinical management and superior to an MRI in terms of safety, availability, and cost. Therefore, in the absence of significant clinical signs of a full-thickness tear, US is an efficient investigation in candidates for decompression. An MRA is indicated only for younger patients and those whose mechanism of injury suggests labral pathology, which may benefit from glenohumeral stabilization or SLAP repair.

This study involved a retrospective analysis of the data of consecutive injured workers and therefore has the limitations that are inherent in retrospective studies. Although the data were extracted from standardized forms, the analysis was limited to available variables. For example, the reasons that the clinicians ordered investigations were not available, and indications for ordering new imaging investigations could not be directly examined.

Future research

The cost of imaging for work-related shoulder injuries is substantial. Future studies should attempt to identify factors that affect ordering costly imaging in patients whose management does not change. Costly imaging such as MRI and MRA should perhaps be reserved for patients for whom a diagnosis cannot be achieved using other modalities.

CONCLUSIONS

In the present study, 24% of workers referred for an early assessment of their shoulder injuries required further investigations; of these, 32% had a change in diagnosis or management, and 49% required surgery. For the 165 patients who were included in groups 1–3, the ESPA was 90% efficient; only 10% of patients did not have a change in diagnosis or management. Timely referral of workers with acute shoulder injuries to specialized examiners facilitated management and reduced unnecessary and costly investigations.

KEY MESSAGES

What is already known on this topic

Increasing use of imaging services has been shown to have a significant negative impact on national expenditures, with a large percentage of costly investigations failing to provide information that improves patient welfare.

What this study adds

Information on the use of imaging investigations in injured workers is quite limited. The present study is the first to examine the pattern of ordering imaging investigations and the overall efficiency of a new service that gives injured workers early access to a specialty clinic after a shoulder injury. Our study found that such early referral can help reduce the number of costly and unnecessary investigations and can improve the efficiency of medical management by giving patients a timely referral for conservative treatment or surgical consultation.

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