



Research Article

Injuries of the shoulder sustained by Surfboard riders

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Summary

Background: To determine the spectrum of shoulder pathologies suffered by surfers.

Methods: Prospective descriptive study. Surfers with shoulder injuries who were referred to a sub-speciality orthopaedic shoulder private practice situated on the Northern beaches of Sydney (Australia) were recruited over a three-year period.

Results: 42 shoulders in 37 subjects were included-12 acute injuries (29.3%), 9 acute on chronic (22%) and 20 chronic injuries. Average age 48 years (range 20-72 years). Seventeen subjects (46%) had manual occupations and 20 subjects (54%) had office-based occupations. Spectrum of pathologies included rotator cuff tendon tears, long head of biceps tendon pathology, labral tears, acromioclavicular and glenohumeral joint osteoarthritis.

Discussion: There is a wide spectrum of acute and chronic shoulder injuries sustained by surfers. The most common presentation was for chronic pathology. The average age of 48 suggests that age may play a role in attritional/degenerative change and therefore an increased likelihood of injury.

Introduction

Surfboard riding (or surfing) is a popular and growing recreation worldwide. Although surfing is relatively safe, with a reported incidence of 2.2 injuries per 1000 hours in recreational surfers and 3.6 injuries per 1000 hours in competitive surfers [1].

Injuries of the shoulder girdle are common in surfers. The most recent and largest survey of 1348 surfers performed in Australia has identified that the shoulder is the most commonly injured body part constituting 16.4% of the total injuries [2]. Acute injuries of the shoulder girdle may be sustained due to direct trauma from the surfboard, fellow surfers and their boards, the sea floor or by the mechanical force of the wave. Chronic/overuse injuries of the shoulder girdle are more common than acute injuries and are presumed to occur due to a combination of repetitive paddling and pushing up into standing during the act of “catching” a wave. Paddling is defined as the act of propelling the surfboard with the arms while lying in a prone position on the board and constitutes up to 54+/-6.3% of the total time spent surfing [3]. The paddling action is similar to the arm movements performed while freestyle swimming, however, the fixed body position on a surfboard prevents rotation of the body, which occurs during swimming. The differing biomechanics may predispose surfers to unique shoulder injuries when compared with swimmers and other overhead athletes. The specific

biomechanics and spectrum of injuries of the shoulder sustained by surfers has not been exclusively studied. A possible contributing factor to chronic injuries of the shoulder in surfers may be an individual's occupation. One might hypothesise that a person who is employed in a manual labour occupation, particularly those who perform repetitive tasks at, or above shoulder height and under load, are potentially at greater risk of chronic injuries when surfing due to underlying degenerative/attritional change when compared with a person with a more sedentary/office-bound occupation. This study primarily aims to identify the spectrum and surgical management of shoulder injuries sustained by surfers. Secondly the study will assess the proportion of surfers with manual labour occupations who suffer chronic shoulder injuries compared with those surfers who have sedentary occupations. No study of this nature has previously been published.

Methods and Materials

Ethics approval was obtained prior to undertaking this study. Subjects were recruited prospectively between October 2012 and November 2015 when referred to a sub-speciality shoulder orthopaedic private practice situated on the Northern beaches of Sydney, Australia (GM) for assessment and management of shoulder pathology. All subjects were included, regardless of age if consent was obtained. By using a private practice of this nature, it is presumed that a trauma bias will be minimised. The inclusion criteria include: an injury to a "surfer" that occurred while in the act of riding a surfboard or chronic pathology for which, regular surfboard riding was considered to be a contributing factor. The definition of a "surfer" is the participation in surfboard riding at least once a month or on at least 12 occasions per year. Note must however, be made that the majority of surfers participate much more regularly than this definition. Individuals who undertake surfboard riding only were included. Those who undertake other surf related activities (body boarding, paddle boarding, kite surfing, body surfing) or did not fulfil the definition of a surfer were excluded from the study.

During the initial consultation, informed consent to participate in this study was obtained. Basic demographic details were collected such as age, sex, occupation and regularity of surfing. A clinical examination was also performed at the time of initial consultation. The radiological investigations and their findings were documented. Plain film radiographs were obtained for all the shoulders in this study. Standard projections obtained included an AP and a lateral scapular "Y" view. When indicated, AP internal and external rotation, axial (axillary) and lateral "outlet" views were also performed. Plain film imaging is an important component of the work up of shoulder injuries in surfers to assess the morphology of the acromion and to exclude an os acromiale. It is the opinion of the senior author (GM) that a curved type 3 acromion may be a predisposing factor for chronic shoulder pathology. Intra-operative pathological findings and details of surgical repairs were also obtained in subjects who underwent surgery.

The data was statistically analysed and 95% confidence intervals were calculated for the subjects as a single group and when divided into two groups by occupation type.

Results

Forty-two shoulders were included in this study in 37 subjects. All recruited subjects were male. The average age of subjects was 48 years (range 20-72 years). Seventeen subjects (46%) had manual occupations and 20 subjects (54%) had office-based occupations. The median time in the occupation for both manual and office-based professions is 20 years. The median number of years surfed for the study group was 30 years.

Five subjects suffered bilateral pathology (13.5%), 10 left shoulder pathology (27%) and 22 right shoulder pathology (59.5%) (Table 1).

All subjects had plain film radiographs of the shoulder as part of their assessment. A total of 46 additional radiological investigations were performed on the 42 shoulders in addition to the plain film radiographs. This included: 6 ultrasounds, 39 MRIs and 1 CT (Table 2).

A variety of different shoulder pathologies were identified on imaging (table 3). Twelve injuries were reported as acute (29.3%), 9 as acute on chronic (22%), 20 as chronic (48.8%) and one was not documented (Table 1). The pathologies identified included tears of the rotator cuff in 23 patients (54.8%) and glenoid labral tears in 17 patients (40.5%). Acute long head of biceps tendon rupture (n=1); acromioclavicular joint dislocation (n=1); sub acromial impingement (n=2); acromioclavicular joint arthritis (n=6), glenohumeral joint osteoarthritis (n=3), long head of biceps tendon subluxation (n=8); acute fracture (n=2), acromioclavicular osteolysis (n=2) was also identified (Table 3).

A total of 44 surgical procedures were performed on 26 shoulders (61.9%). The procedures included: rotator cuff repair (n=15), biceps tenodesis (n=11), labral repair (n=10), acromioclavicular joint resection (n=5), glenohumeral stabilisation/capsular plication (n=3). Sixteen shoulders were being managed conservatively (38.1%) (Table 4). Conservative management included behaviour modification/restricted activity, physical therapy and a graduated return to activity.

Discussion

Shoulder pain is common in repetitive overhead sports, such as swimming, tennis, baseball and volleyball [4]. Although surfing is a relatively safe recreation, shoulder injuries comprise a significant proportion of the injuries sustained [2]. The purpose of

Table 1: Side and acuity of injury.

		Total N (%;95%CI)	Manual N (%;95%CI)	Office worker N (%;95%CI)
Side affected	Left	15 (36% (22.1,53.1))	5 (26.3% (9.7,53.5))	10 (43.5% (21.8,66.0))
	Right	27 (64% (46.9,77.9))	14 (73.7% (46.5,90.3))	13 (56.5% (34.0,78.2))
Chronic/Acute injury	Acute	12 (28.6% (16.1,45.5))	5 (26.3% (9.7,53.5))	7 (30.4% (11.3,52.2))
	Acute on chronic	9 (21.4% (10.6,37.6))	3 (15.7% (3.6,41.4))	6 (26.1% (8.2,47.2))
	Chronic	21 (50% (32.9,65.9))	11 (57.9% (30.8,78.5))	10 (43.5% (25.7,70.2))

Table 2: Imaging modalities.

	Total N (%;95%CI)	Manual N (%;95%CI)	Office worker N (%;95%CI)
US	6 (14.3% (5.4,28.5))	3 (15.8% (3.4,40.0))	3 (13% (2.8,33.6))
MRI	39 (92.9% (80.5,98.5))	19 (100% (82.3,100))	20 (87% (66.4,97.2))
CT	1 (2.4% (0.1,12.6))	1 (5.3% (0.1,26.0))	0 (0% (0,14.8))

Table 3: Diagnosis.

	Total N (%;95%CI)	Manual N (%;95%CI)	Office worker N (%;95%CI)
Rotator cuff tendon tear	23 (54.8% (38.7,70.2))	9 (47.4% (24.4,71.1))	14 (60.9% (38.5,80.3))
Labral tear	17 (40.5% (25.6,56.7))	10 (52.6% (28.9,75.6))	7 (30.4% (13.2,52.9))
AC joint osteoarthritis	6 (14.3% (5.4,28.5))	3 (15.8% (3.4,39.6))	3 (13% (2.8,33.6))
Glenohumeral joint osteoarthritis	3 (7.1% (1.5,19.5))	1 (5.3% (0.1,26.0))	2 (8.7% (1.1,28.0))
Acute fracture	2 (4.8% (0.6,16.2))	1 (5.3% (0.1,26.0))	1 (4.3% (0.1,21.9))
Sub acromial impingement	2 (4.8% (0.6,16.2))	2 (10.5% (1.3,33.1))	0 (0% (0,14.8))
Long head biceps tendon rupture	1 (2.4% (0.1,12.6))	0 (0% (0.17,6))	1 (4.3% (0.1,21.9))
Long head biceps tendon subluxation	8 (19% (8.6,34.1))	4 (21.1% (6.1,45.6))	4 (17.4% (5.0,38.8))
AC joint osteolysis	1 (2.4% (0.1,12.6))	0 (0% (0.17,6))	1 (4.3% (0.1,21.9))
AC joint dislocation	1 (2.4% (0.1,12.6))	0 (0% (0.17,6))	1 (4.3% (0.1,21.9))

Table 4: Surgery.

	Total N (% ,95%CI)	Manual N (% ,95%CI)	Office worker N (% ,95%CI)
Surgery			
Yes	26 (61.9% (45.6,76.4))	13 (68.4% (43.5,87.4))	13 (56.5% (34.0,78.2))
No	16 (38.1%)	6 (31.6%)	10 (43.5%)
Surgery type			
Rotator cuff repair	15 (57.7% (36.9,76.6))	6 (46.2% (19.2,74.9))	9 (69.2% (38.6,90.9))
Biceps tenodesis	11 (42.3% (23.4,63.1))	5 (38.5% (13.9,68.4))	6 (46.2% (19.2,74.9))
Labral repair	10 (38.5% (20.2,59.4))	5 (38.5% (13.9,68.4))	5 (38.5% (13.9,68.4))
AC resection	5 (19.2% (6.6,39.4))	3 (23.1% (5.0,53.8))	2 (15.4% (1.9,45.4))
Stabilisation/ Capsular plication	3 (11.5% (2.4,30.2))	2 (15.4% (1.9,45.4))	1 (7.7% (0.2,36.0))

this study was to assess the spectrum of shoulder injuries suffered by surfers without the bias of an emergency/trauma setting. As a consequence, approximately 49% of pathologies in the subjects recruited were chronic in nature and a further 22% were acute on chronic. The most common pathologies encountered in this population were rotator cuff and glenoid labral tears.

It is important to clarify that, although in this study, a surfer has been defined in this study as someone who participates in surfboard riding at least once a month or on at least 12 occasions per year, the majority of subjects recruited into this study have a significantly greater participation than the definition provided. Most participants in this study surf greater than 9 months per year, however, there may be significant variation in frequency of participation based on seasonality and even from week to week. This is an important consideration given the majority of the injuries reported in this study are chronic in nature and thus may have an attritional component.

In addition, the average age of 48 appears to be older than expected. This may reflect that recruitment was performed via a private sub-specialty shoulder orthopedic practice, which is more likely to manage chronic rather than acute injuries. On the Northern beaches of Sydney and in many beach communities, there is a high proportion of surfers who have been surfing from a young age. Many individuals learn to surf as a child or teenager and continue to surf regularly throughout their lives. Many have been actively surfing for a number of years. As a consequence, degenerative change and attrition are presumed to be significant contributors to the etiology of shoulder injuries in this population.

The freestyle stroke while swimming is the most comparable action when compared to surfboard paddling, however, the biomechanics are different due to lack of body rotation while paddling on a surfboard. In addition, the surfer's position relative to the water due to the size and buoyancy of the surfboard relative to a swimmer, the requirement to propel both the surfer and surfboard and the inability to kick also places different stressors on the shoulder girdle. The paddling motion while prone on the surfboard to propel the surfer away from the shoreline in preparation to catch a wave and then paddling towards the shoreline while in the act of catching the wave has been shown to constitute a significant proportion of the time the surfer is in the water. We postulate that surfboard paddling may contribute to greater shear force on the dorsal aspect of the rotator cuff and the sub acromial bursa when compared with swimmers. As a consequence, in surfers with shoulder impingement and cuff tears the senior author (GM) recommends rehabilitation of core strength and spinal extension endurance and the development of a rounder paddling action with a lower elbow action. This is in comparison to freestyle swimmers who employ high elbow action.

Pushing up from a prone to a standing position may stress the anterior structures of the shoulder such as the long head of biceps tendon, subscapularis and anterior supraspinatus tendons, the anterior capsuloligamentous structures and anterior

labrum. In particular, a repetitive push up motion may effectively result in upper subscapularis tendinosis and tears and subluxation of the long head of biceps tendon into partial thickness, degenerative subscapularis tendon tears. Anecdotally, this is a common finding in the older surfer.

The hypothesis that manual labour (blue collar) workers are more likely to suffer shoulder injuries due to attritional factors due to repetitive upper limb activities, at and above shoulder height in the workplace, when compared to more sedentary (white collar) workers was not successfully demonstrated in this study. This is despite a number of studies that have identified an association between manual labour occupations that involve repetitive overhead and/or repetitive lifting and tears of the rotator cuff tendons [5-10]. Seidler demonstrated a dose-response relationship between cumulative duration of work with highly elevated arms and symptomatic supraspinatus tendon tears [6]. For a cumulative duration of 3195 hours of work above shoulder level, the risk of a supraspinatus tendon rupture is an elevated odds ratio of 2.0 (95% CI 1.1-3.5). The cumulative duration of carrying/lifting of heavy loads also yields a positive dose-response relation with disease, with an adjusted odds ratio of 1.8 (95% CI 1.0-3.2). When “blue collar workers” are compared with “white collar workers”, the odds ratio for lesions of the supraspinatus tendon is significantly elevated to 1.5. The risk of a supraspinatus tendon lesion is elevated to an odds ratio of 11.5 (95% CI 2.5-52.5) in subjects having worked more than 10 years as construction worker or interior worker (includes plasterers, insulators, glaziers, terrazzo workers, construction carpenters, roofers, and upholsterers) [6]. Svendsen performed direct measurements using whole-day inclinometers in a random sample of machinists, car mechanics and house painters and identified an age-adjusted odds ratio of 1.27 (95% CI 1.02-1.60) for a 5-month increase in the total number of full-time working months spent with the arm elevated $>90^\circ$ [8].

Given the average age of subjects in this study is 48, it may be postulated that age-related changes may contribute to shoulder pathology in older surfers. The aetiology of rotator cuff disease is likely multifactorial, including age-related degeneration, micro trauma, macro trauma and further predisposing factors such as smoking, hypercholesterolemia, and genetics [11]. Milgrom [12], documented a prevalence of 5% of partial or full thickness tears of the rotator cuff in the fourth decade of life, 11% in the fifth decade, 50% in the seventh decade and 80% in the ninth and tenth decades using ultrasound [12]. Similarly, Tempelhof [13], identified a prevalence of supraspinatus tendon tears in 13% of subjects aged 50-59 years, 20% of subjects aged 60-69 years, 31% of subjects aged 70-79 years, and 51% of subjects over the age of 80 [13].

Regular surfers have well developed rotator cuff and peri scapular musculature, which may actually be protective in tradesmen/blue collar workers with repetitive overhead demands when compared with tradesmen with the same demands who do not surf. Further research is recommended to further evaluate this hypothesis.

A variety of labral tears were identified on both imaging and at surgery, which included SLAP (superior labrum anterior and posterior), inferior and posterior tears. It is important to note, that given the average age of 48 years in this study, SLAP II tears (involves the antero-superior, direct superior and postero-superior labrum) are a common finding in the general population, not just surfers, and may be asymptomatic. In our study, SLAP repair and biceps tenodesis was performed in symptomatic patients over the age of 45. In patients under the age of 45, SLAP repairs and a superior glenohumeral ligament releases were performed. The rationale of the superior glenohumeral ligament release is to minimise post-operative loss of external rotation.



Acute injuries of the shoulder girdle may occur more commonly in surfers than other overhead activities, given the unpredictability of a number of environmental factors. These include: the size and nature of the wave, the depth of the water, the type of seabed (sand, rocks, coral), the number and proximity of other surfers and the length and type of surfboard. The greater the size of the wave, the greater potential there is to be thrown off the wave awkwardly. Shallow, rocky or coral sea floors may increase the risk of acute fractures and dislocations. Close proximity to other surfers and smaller, lighter boards used by the individual surfer may increase the risk of the surfboard becoming a projectile and causing blunt or penetrating (from the fins, nose, deck, tail or rails of the surfboard) trauma to the shoulder girdle or other areas of the body. Other factors intrinsic to the surfer include: the familiarity with the surf break, level of experience/length of time surfed and familiarity with the surfboard used. More inexperienced surfers, particularly those who are surfing a surf break that is unfamiliar to them may be more prone to an acute injury.

Limitations

The greatest limitation of this study is the small sample size, which undoubtedly limits the power of the study to make definitive conclusions. The subjects presenting to one shoulder surgeon in one location may also introduce population bias.

Conclusion

This study has identified a wide spectrum of shoulder pathologies that a surfer may sustain, which includes tendon (rotator cuff and long head of biceps), labral, bony and capsular/chondral (involving the glenohumeral and AC joints). The most common presentation was due to chronic pathology. Unfortunately, the sample size limited assessment of differences in prevalence and types of injuries sustained by surfers with manual labour occupations compared with sedentary occupations. A larger study of this nature is recommended in the future. An average age of 48 in our study population was an unexpected finding. This suggests that age-related change may be an important factor in the development of shoulder pathology and is important for public health initiatives and education.

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