We present the short- and medium-term clinical results of thermal shrinkage in selected groups of patients with multidirectional or capsular stretch-type instability. We treated 56 patients (61 shoulders) by laser-assisted capsular shrinkage (LACS) and 34 patients (38 shoulders) by radiofrequency (RF) capsular shrinkage. The two groups were followed for mean periods of 40 months and 23 months, respectively.

In the LACS group the mean Walch-Duplay score improved to 90 points 18 months after the operation, but then declined to a plateau of about 80 points; 59% of patients considered their shoulders to be ‘much better’ or ‘better’ but there was a failure rate of 36.1%. For the RF group the mean Walch-Duplay and Constant scores were 80 points at the various follow-up times; 76.3% of patients considered their shoulder to be ‘much better’ or ‘better’. RF failed in nine shoulders (23.7%). These results match some clinical series of patients with multidirectional instability, undergoing open inferior capsular shift, with a similar rate of failure. We believe that the minimal morbidity involved makes thermal shrinkage a viable alternative to open capsular shift in this difficult group of patients.

Arthroscopic management of glenohumeral instability has increased in popularity over recent years, but failure to eliminate capsular laxity has been cited as the major factor in cases of recurrence. The ligamentous component is an even more significant factor in the subgroup of patients with atraumatic multidirectional or capsular-type instability.

Thermal capsular shrinkage presents the prospect of reducing redundant capsule, and therefore may be a suitable method of treating capsular-type instability. In these patients, the primary complaint is often pain, and not dislocation, and the primary treatment is rehabilitation, although 40% of patients may not respond.1-6

The technique of thermal shrinkage has gained in popularity recently. Knowledge regarding the thermal effect of laser or radiofrequency on the capsular tissue of the human shoulder, however, is still limited,7-15 and the effect of thermal shrinkage on the mechanical properties of the capsule is uncertain.7,8,16-20 There has been no previous prospective, controlled study on the clinical outcome of thermal capsular shrinkage in a clearly defined group of patients with capsular-type instability.

Our aim therefore was to evaluate the longer-term clinical results of this treatment in a selected group of patients with this type of instability.

Patients and Methods

We began this prospective study in May 1995 using thermal capsular shrinkage to stabilise the shoulders of patients with capsular-type instability. We excluded patients with clinical traumatic unidirectional instability. Patients were selected by their history, clinical examination and arthroscopic findings.

The inclusion criteria were: 1) a history of either repetitive microtrauma or a minimal traumatic event leading to recurrent symptoms of instability (pain, subluxation or true dislocation); 2) clinical examination revealing generalised laxity, in association with signs of instability, either multidirectional or unidirectional (apprehension or reproduction of symptoms); and 3) arthroscopic findings of a voluminous capsule with increased joint volume, and easy ‘drive through’ sign, without a Bankart or Hill-Sachs bony lesion. Scuffing of the head or glenoid margins was accepted as
long as it was confined to the articular cartilage and did not involve bone.

Exclusion criteria were: 1) unidirectional instability with a history of significant trauma; and 2) a Hill-Sachs or Bankart lesion seen at arthroscopy. The indication for operative intervention was persistent pain or symptomatic instability, unresponsive to extended conservative management which included a programme to strengthen the rotator cuff, and the modification of activity, over a minimum of three to six months.

Between May 1995 and June 1997, 56 patients (61 shoulders) were treated using a holmium:YAG laser (Coherent Inc, Palo Alto, California). There were 34 men and 22 women with a mean age of 26 years (15 to 52) and the mean follow-up was 40.5 months (31 to 57). From June 1997 to February 1999, 34 patients (38 shoulders) were treated by radiofrequency (RF) capsular shrinkage. There were 18 men and 16 women with a mean age of 23.9 years (14 to 53), and the mean follow-up was 23 months (14 to 33). In the group undergoing laser-assisted capsular shrinkage (LACS) we did not exclude patients who had previously undergone open stabilisation, but in the RF group we excluded any patient who had had more than one open shoulder stabilisation procedure. Four patients had repeated RF treatment five to ten months after the first treatment, two had RF treatment 18 months and two years after LACS treatment and one had a second LACS procedure 18 months after the first. Three patients had an open stabilisation six to ten months after the last thermal treatment.

Informed consent was obtained from all the patients before inclusion in the study. An examination under anaesthesia, following the technique described by Cofield, Nessler and Weinstabl, was performed on all patients before operative intervention, in order to determine the main direction of instability. In the LACS group there were 30 patients with true multidirectional instability (MDI) and 31 with multidirectional laxity of whom 20 had anteroinferior instability, nine posteroinferior instability, one anterior instability and one posterior instability.

In the RF group there were 22 patients with true MDI, and 16 with multidirectional laxity of whom 14 had anteroinferior instability and two posteroinferior instability.

**Operative technique.** The shoulder arthroscopy was performed with the patient in the lateral decubitus position. The affected arm was supported with 2 to 4 kg of skin traction. Diagnostic arthroscopy of the glenohumeral joint was performed through a standard posterior portal to confirm the diagnosis. In all patients the capsular element was the major component of the instability.

An inside-outside technique was used to define and establish the anterior portal within the rotator interval, ensuring access to the inferior glenoid and capsule. The heat from the laser or the RF probe was applied to the inner aspect of the shoulder capsule in the areas of principal instability which had been identified on examination under anaesthesia. Through the anterior portal the thermal energy was applied to the anterior, inferior and rotator interval regions; an accessory posteroinferior portal was used for its application to the axillary recess and the posterior capsule if required.

The technique consisted of ‘painting’ the inside of the joint capsule, and moving the probe when the tissue shrank. Because the volume of the joint decreased with the treatment it was started in the areas most difficult to reach, and then moved to the more accessible areas. We felt that it was important not to burn the capsule but to gauge the surface response. During the procedure an assistant kept a hand on the deltoid area to detect any possible twitches which would signify that the probe was near the axillary nerve. A biopsy of the capsule was taken before and after the treatment for electron-microscopic (EM) studies. The energy settings. The holmium:YAG VersaPulse laser was used at low power to produce non-ablative ‘shrinking’ of the capsule. The mean power setting was 12 W (4 to 19), the mean energy 1.13 J (0.5 to 1.6) and mean total energy 3.1 kJ (0.5 to 6.2). The energy settings for the Oratec monopolar RF generator (Oratec Interventions Inc, Mountain View, California) were 40 W, 67°C. Using the Mitek VAPR bipolar system (Ethicon, Johnson & Johnson, Westwood, Massachusetts) we aimed to use the minimal effective settings, which were in the range 14 to 20 W, but were usually 14 to 18 W. The application of thermal energy in all cases was controlled according to the observed tissue response.

**Postoperative rehabilitation.** The first 12 patients to undergo the LACS procedure were managed in the same way as after open stabilisation, that is, immobilisation in a sling with a body belt for three weeks, then a sling without a body belt for a further three weeks. This was followed by a range of active exercises. The remaining patients were allowed to mobilise as soon as pain allowed, usually between four and seven days after surgery. Movement in the mid-range was unrestricted but patients were advised to avoid extremes for the first six weeks. Proprioceptive physiotherapy and isometric exercises for the rotator cuff and scapular stabilisers were initiated within the first week.

The patients were followed clinically at 3 weeks, at 3, 6, 9, 12, 18 and 24 months and yearly thereafter. Clinical evaluation recorded the Constant and Walch-Duplay scores with regard to pain, stability, mobility and return to sport or daily activities, and finally the patients’ own impression.

**Results**

**LACS.** Figure 1 shows the mean Walch-Duplay and Constant scores after treatment. These improved with time up to 90 points 18 months after the operation but then declined to a plateau at about 80 points. At 57 months the score was somewhat skewed since the failures were not included.

After the procedure 59% of the patients felt ‘much
better’ or ‘better’ but 15 (24.5%) had a further dislocation, in eight after significant trauma and in seven after minimal trauma. All had been asymptomatic until the traumatic incident. One patient dislocated his shoulder after falling from his motorcycle 18 months after treatment. Until then he had had a stable pain-free shoulder. He had a further LACS procedure and 28 months later had a stable shoulder again. The remainder of the traumatic dislocations were as a result of accidents at various intervals between 6 and 14 months after surgery. The seven patients who dislocated again after minimal trauma did so between 3 and 24 months after surgery. Seven patients had recurrent subluxations and/or symptoms of instability. They were progressing well at the beginning but deteriorated with time. Two female patients had had at least three previous failed open stabilisations. One of these had multiple subluxations by the first postoperative visit at three weeks. The other remained stable six months after the procedure. Both were noted to have a very scarred capsule at the time of the LACS procedure. Overall, the rate of failure for the LACS patients with time, was 36.1%.

Radiofrequency (RF). Figure 2 shows the mean Walch-Duplay and Constant scores at the various follow-up times. After the procedure 76.3% of patients considered their shoulder to be ‘much better’ or ‘better’. RF treatment failed in nine shoulders (23.7%): two patients had further traumatic dislocations and seven had atraumatic dislocations, subluxations or pain (Fig. 3). Repeat RF procedures have been performed on six patients; four had a second RF treatment five to ten months after the first, and two had RF treatment 18 months and two years, respectively, after LACS.

Clinically, patients felt more stable after the first treatment, but after several months their shoulders deteriorated, although, subjectively, they remained better than before their first treatment.

During the second RF treatment the response to capsular shrinkage was similar to that observed at the first treatment, but additional changes were observed on EM. Ultrastructural alterations included a general increase in the cross-sectional diameter of collagen fibrils and loss of the distinct edge of the fibrils. Specimens taken before the repeated treatment showed that the changes remained with reappearance of the cross striation. Immediately after the second treatment there were further significant changes with an increase in the diameter of the fibrils of two- to threefold. Three patients underwent open stabilisation six to ten months after the treatment. The EM changes in these patients remained unchanged. In two the open stabilisation failed and they had recurrent instability.

In two cases we observed a twitch of the deltoid caused by irritation of the axillary nerve while shrinking the medial recess with RF, but no nerve damage occurred.

Discussion

The first clinical report of the use of a holmium:YAG laser for shoulder capsular shrinkage was in 1994. Patients included in that multicentre pilot study had traumatic or atraumatic, uni- or multidirectional instability, with a mean follow-up of six months. An excellent or good result was achieved in 93%, fair in 5% and poor in 2%. Hardy et al reported a success rate of 100% at follow-up at one year in 18 patients with chronic anteroinferior instability associated
with Bankart lesions. The latter were reattached using either intraosseous screws or transosseous sutures, and the capsular redundancy was then addressed using the laser to shrink the capsule. Attribution for the short-term result is uncertain. We selected only patients with capsular instability and used only one mode of treatment.

There was a relatively high rate of failure in the LACS group (36.1%), with 24.5% of shoulders redislocating. However, more than half of the redislocations (53.3%) followed significant trauma. Of the other patients who were failures but who did not sustain any trauma, two had undergone several previous inferior capsular shift procedures. Both failed quickly. The quality of the capsule appeared to be poor at the time of the LACS procedure, with little apparent shrinking observed. We therefore excluded from the RF study any patient who had had more than one previous open stabilisation. In the LACS group, nine patients had had one open stabilisation before the LACS procedure. They are all currently asymptomatic. The remaining patients with non-traumatic dislocations all had good results for the first ten months after surgery.

The RF group showed stable scores of around 80 points throughout the follow-up period: 76.9% were satisfied and felt ‘much better’ or ‘better’ after the treatment. The treatment failed in nine patients (23.7%), however, of whom two had traumatic and seven atraumatic dislocations. All showed early failure between three and six months after the shrinkage. Repeated application of thermal shrinkage provided lasting stability in four of these patients, reducing the failure rate to 15.7%. These findings are encouraging, and it
seems likely that there is a place for repeated RF procedures.

The effect of thermal shrinkage on the mechanical properties of the capsule and ligaments remains uncertain. Several studies have found reduction in strength and stiffness of the tissue after laser treatment. Hayashi et al. however, described a study in rabbits showing significant shrinkage of the capsule without altering its viscoelastic properties. Schaefer et al. on the other hand found that the patellar tendon of rabbits began to stretch under physiological loads at four weeks after laser treatment; at eight weeks it was approximately 5% longer.

Wallace et al. reported detrimental effects of RF on the viscoelastic properties of the medial collateral ligament in rabbits. Selecky et al. however, found that the strength of the ligament was not compromised by LACS in a human cadaver model.

Our postoperative rehabilitation was originally as for open stabilisation procedures, with immobilisation for six weeks. We subsequently allowed early mobilisation, with no increase in the rate of failure. The patients were advised to avoid extremes of movement for the first six weeks after treatment.

Williams expressed concern about thermal damage and iatrogenic defects in the capsule. We have not seen such complications. We used the minimal effective settings of thermal energy which were adjusted according to the response of the tissue.

Long-term ultrastructural changes of the shoulder capsule, as examined by EM, have shown no evidence of the formation of scars; cumulative changes on repeated RF application were noted.

There is evidence from a cadaver study that thermal shrinkage gives improved stability by restricting gleno-humeral translation. Such evidence is lacking in vivo, however, and the physical shortening of tissues may stretch with the passage of time. It has also been suggested that there may be an improvement in the quality of the collagen. Proprioceptive function may be impaired in shoulder instability and joint laxity, and it is postulated that this is part of the underlying pathology in patients with capsular-type instability. Warner, Lebhart and Fu found that these proprioceptive defects are corrected after open surgery. We have shown in another study that after tightening the capsule by thermal shrinkage there is an improvement in proprioception. We do not believe that the beneficial effects of thermal shrinkage are simply the result of mechanical restriction caused by scarring of the capsule. In those patients in whom thermal shrinkage failed, requiring open surgery, we found that there was no difficulty in performing a capsular shift procedure with a thicker capsule.

The results of open surgical treatment by inferior capsular shift are less satisfactory in patients with capsular-type instability. Cooper and Brems reported an incidence of recurrent instability of 10% to 15% after open stabilisation by inferior capsular shift. In all cases the patient reported that the condition of the shoulder had progressively deteriorated over time. A worsening of results over time was also reported by Hawkins, Kinkel and Nayak in whose study 12 (39%) of 31 shoulders had unsatisfactory results following an open procedure with inferior capsular shift, after follow-up of three to five years. Altchek et al. described a modified inferior capsular shift using a medially performed T-plasty with a recurrence rate of 10%. Treacy, Savoie and Field reported a recurrence rate of 12% after arthroscopic capsular shift using a transglenoid suture technique in patients with MDI.

Our results match those of some reported series of patients with MDI undergoing open inferior capsular shift. Although they do not equal the best reported results we believe that the minimal morbidity involved, the outcome score of 80 points throughout the follow-up period, and the lack of significant complications, make this procedure a viable alternative to open capsular shift in this difficult group of patients.

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

References


