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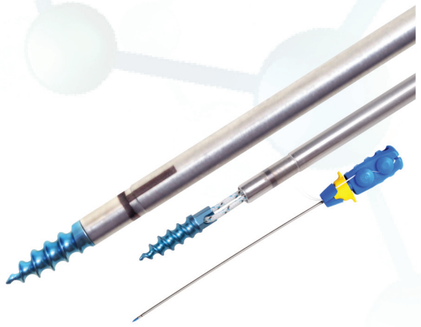

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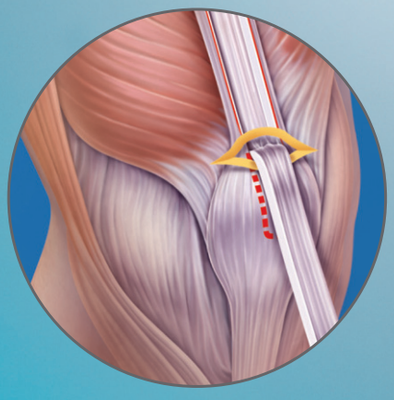

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Aims and Scope

Journal of Arthroscopy and Joint Surgery (JAJS) is the official and peer-reviewed publication of *International Society for Knowledge for Surgeons on Arthroscopy and Arthroplasty* (ISKSAA). The Journal is committed to bring forth scientific manuscripts in the form of original research articles, current concept reviews, meta-analyses, case reports and letters to the editor. The focus of the Journal is to present wide-ranging, multi-disciplinary perspectives on the problems of the joints that are amenable with Arthroscopy and Arthroplasty. Though Arthroscopy and Arthroplasty entail surgical procedures, the Journal shall not restrict itself to these purely surgical procedures and will also encompass pharmacological, rehabilitative and physical measures that can prevent or postpone the execution of a surgical procedure. The Journal will also publish scientific research related to tissues other than joints that would ultimately have an effect on the joint function. The journal is published three times in a year (Jan-Apr, May-Aug, Sep-Dec) by Reed Elsevier India Pvt.Ltd. Contributors are invited to submit their manuscripts in English through the Online Manuscript Management System at **http://ees.elsevier.com/jajs**

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Editorial

Journey to total hip arthoplasty

Hip joint is a mobile link between the trunk and the lower limb. It plays an important role in locomotion. Being a ball and socket joint it allows flexion extension, adduction, abduction, internal rotation and external rotation. These movements enable the person to adopt any posture for various activity of daily living, social occasions and at work and worship. Due to various causes like trauma, infection inflammation and degenerative processes etc., the hip joint may loose movements, become stiff, painful and deformed, severely jeopardizing its function. The patient may not be able to squat, sit cross legged or walk properly. These problems are as old as the history of man himself. The desire of the patient to have a mobile joint stimulated the surgeons to develop materials and methods to restore movement at ankylosed hip. Many attempts have been made to achieve movements with correction of deformity and relief of pain from time to time. Toward the end of 18th century attempt was made to replace femoral head with wooden block fixing it to the femur with plate and screws. Muscle flap, fascia, wall of the pig's bladder etc. were used for interposition between femoral head and acetabulum. The end result was failure and often disasterous.[1] The knowledge of biology, biomechanics, asepsis and compatability of the human tissues with these implanted materials was not known to the clinician.

John Rea Barton in 1927[2] reported his attempt to restore movements at the hip joint by creating a pseudoarthrosis in subtrochanteric region. Although this enabled the patient to sit properly in the chair yet the operation was unphysiological because main movers of the hip joint were inserted in the proximal fragment. The procedure has remained only of historical value. A better function was achieved by excising a bone segment from the neck of the femur. This was further improved by excision of the femoral head and neck by Girdle stone.[3] Bachelor[4] and Milch[5] tried to improve the stability after this procedure by doing osteotomy of the greater trochanter and fixing with the angled plate. Although good range of motion were restored at the hip, these produced shortening of the limb and appreciable limp.

Smith Peterson[6] initially prepared a mould of glass then of acrylic and resion and finally of vitallium which was given the name of Smith Peterson Cup. This cup covered the prepared head of femur and articulated with acetabulum. This produced quite satisfactory results lasting for few years. Ultimately the cup became loose and joint became painful requiring its removal. Judet[7] brothers designed a prosthesis which had a capital Part (head) segment and a stem. Capital component replaced the femoral head and the stem was fixed into the neck of the femur. It also met the same fate. Moore[8] and Thompson[9] designed intramedullary prosthesis consisting of a round head and a long intramedullary stem which was fitted into the medully canal of the femur. The head component articulated with the acetabulum. These were certainly better than the previous prostheses and are still in use in among patients of femoral neck fracture in geriatric patients. The problems often met with these were protrusio acetabuli and pain in the region of the hip and upper thigh requiring the removal of the prosthesis or substituting it with total hip arthroplasty. McKee Farrhar[10] & Phillip Wiles[11] designed a metallic cup and a stem somewhat similar to intramedullary stem of Thompson prosthesis. After preparation the cup was fixed to the acetabulum with screws or bone cement (methyl methacrelate) and stem in the medullary canal also with cement. The metallic joint produced sound during the movement and it became loose due to reaction of the local tissues to wear particles of metal.

Bipolar prosthesis was developed by Bateman[12,13] with the hope that it give would better results. The procedure of implantation is quite easy and taking short time. It is useful in patients with compromised health with life expectancy of <5 years. Though good results have been reported in >10 years followup.[13]

Charnley[14–16] designed non metallic cup first made of acrylic and later on of high density polyethylene and femoral component made of vitallium. Both the components were highly polished with the idea of decreasing the friction between the two and reducing the wear and tear of the implant. The results of this joint consisting of high density polyathelene cup and metallic stem were very good and the joint lasted for many years. Early complications were dislocation and infection which were improved by observing strict aseptic condition in the operation theatre and improvement in the operative technique. The delayed complications observed were aseptic loosening, osteolysis which required revision arthroplasty.[17–19]

Initially aseptic loosening was considered to be due to bone cement[20] and hence non cemented total hip was designed.

This consisted of a metallic shell with inner polyethylene lining. The metallic shell had granular outer surface and coated with hydroxyapatite for better corporation into the bone. The shell was fixed to the bone with screws and polyethylene lining was fitted into it. The femoral component was also designed in a way that the bone could grow into it. All these implants had monoblock femoral component. Further development produced modular type of femoral stem consisting of separate head component which could be fitted to the intramedullary stem. The size of the neck of the femoral component could be adjusted with the use of different sizes (length) of head which allowed adjustment of length the neck of the femur as well as the tension of the soft tissue. Even these types of non cemented joints had aseptic loosening. The blame now has shifted on the polyethylene cup or polyethylene lining. Wear particles of polyethylene cup produced reaction in the soft tissues leading to aseptic loosening and osteolysis on the acetabulars as well as the femoral side. In order to get rid of polyethylene from the total hip prosthesis, metal on metal and ceramic on ceramic joints were developed.[21,22] These had highly polished surfaces. Surface arthroplasty with coverage of femoral head with a metallic component articulating with metallic acetabular part was used in younger patients. These allowed vide a range of movements and the patients were able to squat and sit cross legged. The initial results were very encouraging. However, within few years, wear particles from the metallic cup and head started producing reaction in the soft tissues often leading to formation of tumour like lesions around the hip joint and metlosis. Revision arthroplasty had to be carried out in such cases and metal on metal joint has now gone out of market. Ceramic on ceramic joint are still in use. The problem faced with this prosthesis is squeaking sound and cracking of the cup resulting in pain in the region of hip. Now ceramic head on highly cross linked polyethylene cup and metallic head on cross linked polyethylene cup are latest to be used in total hip arthroplasty with improvement in the results reported. The cross linked polyethylene has very slow wearing property. Only time will show for how long these joints will last when implanted in young patients. Further research in these materials and development of new materials is still being carried out to design a joint which will last for the life of individual when planted in a young person.

Medical profession as well as the patients are anxiously waiting for the day when such a joint is made available to them.

REFERENCES

1. Evarts CM, Kendrich JI. Symposium on arthroplasty of the hip knee. *Ortrhop Clin North Am*. 1971;2:93–111.
2. Barton JR. On the treatment of ankylosis by formation of artificial joint. *J N Amer Med Surg*. 1927;3:279–292.
3. Girdle Stone GR. Pseudarthrosis discussion of treatment of unilateral osteoarthritis of the hip joint. *Proc Roy Soc Med*. 1995;38:363.
4. Bachelor JS. Pseud-arthrosis for ankylosis of the hip. *J Bone Joint Surg*. 1949;31b:135.
5. Mileh H. Surgical treatment of stiff hip the resection angulation operation. *Clin Orthop*. 1963;31:48–57.
6. Smith Peterson MN. Arthroplasty of hip new method. *J Bone Joint Surg*. 1939;21A:269–288.
7. Judet J, Judet R. The use of an artificial femoral head for arthroplasty of the hip joint. *J Bone Joint Surg*. 1950;32B:166–173.
8. Moore AT, Bohlman HR. Metal hip joint. A case report. *J Bone Joint Surg*. 1943;25A:688–692.
9. Thompson FR. Two and half years experience with the vitallum intramedullary prosthesis. *J Bone Joint Surg*. 1954;36A:489–502.
10. McKee GK, Watson Farrar J. Replacement of arthritis hip by the McKnee prosthesis. *J Bone Joint Surg (Br)*. 1966;48B:245–259.
11. Wiles P. The surgery of the osteoarthritis hip. *Br J Surg*. 1958;45:488–497.
12. Bateman JE. The classic single assembly total hip prosthesis preliminary report. *Clin Orthop*. 1974;441:8–76.
13. Bateman JE, Berenji AR, Bayne O, Greyson ND. Long-term results of bipolar arthroplasty in osteoarthritis of the hip. *Clin Orthop Relat Res*. 1990;251:54–66.
14. Charnley J. Arthroplasty of hip a new operation. *Lancet*. 1961:1129.
15. Charnley J. The bonding of prosthesis to the bone by cement. *J Bone Joint Surg*. 1964;t46B:518–596.
16. Charnley J. Reaction of bone to self curing acrylic cement. *J Bone Joint Surg*. 1970;52B:390.
17. Harris MH, Schillar AL, Scholar JH, Frieber RA, Scot R. Extensive localized bone resorption in the femur. Following total hip arthroplasty. *J Bone Joint Surg*. 1976;58A:612–618.
18. Jone LC, Hungerford DS. Cement disease. *Clin Orthop*. 1987;225:192–206.
19. Hollworth U, Cotogno G. *Total hip replacement state of art challenges and prospects, European Commission*. Luxen Bourg: Joint Research Centre, Institute of Health and Consumer Protection; 2012:25279–25282. ISBN 978-92.
20. Lusty PJ, Tai CC, Sen Hoy RP, Walter WL, Walter WK, Zicat BA. Third generation alumina on alumina ceramic bearings in cement less total hip arthroplasty. *J Bone Joint Surg (Am)*. 2007;89:2676–2683.
21. Migaud H, Duthan S, Krantz N, Vasseur L, Girard J. Cementless metal on metal versus ceramic on polyethylene hip arthroplasty in patients less than 50 years of age a comparative study with twelve to fourteen years followup. *J Bone Joint Surg Am*. 2011;93:137–142.
22. Korovessis P, Petsinis G, Repanti N, Repanti T. Metallosis after contemporary metal on metal: total hip arthroplasty. *J Bone Joint Surg Am*. 2006;88:1183–1191.

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4. Discussion

Broken femoral nail removal is not an uncommon procedure in orthopedic surgery for removing an intact nail various universal retractor are available, it is the broken nail which pose a surgical challenge especially when fracture site is united.

In general, the proximal portion of a broken nail is routinely removed without difficulty while challenge remains in the part of distal segment removal. For this instance, closed technique has been usually attempted as a primary procedure because of two reasons 1. Patient will have additional scar on his thigh which was not there from previous surgery. 2. Fracture is already united even after opening distal site we need to refracture that site in order to deliver distal fragment of nail.

For broken cannulated nails, the distal portion can be removed by antegrade and retrograde method each of them have their own advantages and shortcomings.

There are as many studies done in past to develop technique in order to deliver distal fragment[1–5] but in these techniques many instruments such as hook, femoral head cork screw, smaller nail, multiple guide wires, and guide wire with washer have been recommended to be used as an extractor.[1,6–11] in order to preserve the surrounding soft tissue.

Franklin et al[1] described their experience with the treatment of 60 broken femoral or tibial nails. In their series, 20 distal fragments were extracted without auxiliary surgical methods and 28 nail fragments were removed using long hooks. The hooks that were used have a profile that is similar to the profile of Ender pin extractors.

Brewster et al[2] and Hahn et al[12] also endorsed the removal of reamed nails with the use of long hooks. However, they mention that the hooks can slip several times at the tip of the nail, become stuck in the distal fragment, and bend (or even break) inside the nail.[13] These complications prolong the patient's surgery and exposure to the image intensifier, test the surgeon's patience, and increase the risk of postoperative complications.[14]

Giannoudis et al[15] described the extraction of fragments with special tools, such as long graspers and hooks. This technique involves the use of long trephines, hooks, and auxiliary pins. The technique is costly and labor-intensive, but it is a good alternative method, especially for fractures of rigid and unreamed tibial nail.

Levy et al[14] described yet a different surgical approach in which they impact a nail of smaller diameter than the original nail inside the distal fragment of a broken reamed femoral nail to facilitate local impaction and anterograde extraction.

Middleton et al[8] suggested filling the internal space of a cannulated nail with several guide wires to allow the anterograde extraction of the distal fragment.

Maini et al[16] proposed passing an olive guide wire through the distal fragment of cannulated femoral nail and then filling the nail with long Steinmann wires to facilitate its removal.

Marwan and Ibrahim[13] described a technique in which they pass a metallic wire through the middle of the fractured nail and through its distal hole. They then fasten this wire to the distal fragment through a small incision at the level of the distal hole.

Riansuwan et al[10] described a technique of retrograde impaction. Again in this technique knee arthrotomy is require which further pose complication like knee stiffness, infection, condylar fracture etc.

In our method of nail extraction we neither use any extra incision or pose patient to any risk of image intensifier by using simple traditional sequential K-nail reaming we were able to extract out distal cannulated broken segment of nail and have excellent outcome of patient on follow up.

Conflicts of interest

All authors have none to declare.

REFERENCES

1. Franklin JL, Winquist RA, Benirschke SK, Hansen Jr ST. Broken intramedullary nails. *J Bone Joint Surg Am*. 1988;70:1463–1471.
2. Brewster NT, Ashcroft GP, Scotland TR. Extraction of broken intramedullary nails–an improvement in technique. *Injury*. 1995;26:286.
3. Charnley GJ, Farrington WJ. Laparoscopic forceps removal of a broken tibial intramedullary nail. *Injury*. 1998;29:489–490.
4. Hak DJ, McElvany M. Removal of broken hardware. *J Am Acad Orthop Surg*. 2008;16(2):113–120.
5. Whalley H, Thomas G, Hull P, Porter K. Surgeon versus metalwork-tips to remove a retained intramedullary nail fragment. *Injury*. 2009;40(7):783–789.
6. Acharya M, Alani A, Almedghio S. The fish hook technique of extracting broken intramedullary nails. *Acta Orthop Belg*. 2008;74(5):686–688.
7. Magu NK, Sharma AK, Singh R. Extraction of the broken intramedullary femoral nail—an innovative technique. *Injury*. 2004;35(12):1322–1323.
8. Middleton RG, McNab ISH, Hashemi-Nejad A, Noordeen MHH. Multiple guide wire technique for removal of the short distal fragment of a fractured intramedullary nail. *Injury*. 1995;26(8):531–532.
9. Park SY, Yang KH, Yoo JH. Removal of a broken intramedullary nail with a narrow hollow. *J Orthop Trauma*. 2006;20(7):492–494.
10. Riansuwan K, Carter C, Nercessian O. Removal of broken long gamma nail: a modified guide wires technique. *J Trauma Acute Care Surg*. 2008;64(2):517–519.
11. Wise DJ, Hutchins PM. Novel method for removal of a broken GK femoral nail. *Injury*. 1996;27(4):294–295.
12. Hahn D, Bradbury N, Hartley R, Radford PJ. Intramedullary nail breakage in distal fractures of the tibia. *Injury*. 1996;27:323–327.
13. Marwan M, Ibrahim M. Simple method for retrieval of distal segment of the broken interlocking intramedullary nail. *Injury*. 1999;30:333–335.
14. Levy O, Amit Y, Velkes S, Horoszowski H. A simple method for removal of a fractured intramedullary nail. *J Bone Joint Surg Br*. 1994;76:502–503.
15. Giannoudis PV, Matthews SJ, Smith RM. Removal of the retained fragment of broken solid nails by the intramedullary route. *Injury*. 2001;32:407–410.
16. Maini L, Upadhyay A, Aggarwal A, Dhaon BK. A new method of removing a fractured interlocked nail. *Injury*. 2002;33:261–262.

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Original Article

Polytetrafluoroethylene patches for massive rotator cuff tears: An update of current concepts

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ABSTRACT

Introduction: Rotator cuff tears are one of the most important causes of shoulder disability and are highly prevalent in most western populations. Massive rotator cuff tears present inherent challenges for the orthopaedic surgeon. Patch augmentation with polytetrafluoroethylene (PTFE) felt patches has become increasing popular over the last decade. The aim of this review is to summarize the available literature on PTFE patches in massive rotator cuff tears.

Method: A search of MEDLINE and EMBASE was performed. The authors further searched available literature using Google Scholar and the reference lists of selected articles. A total of eleven studies (four animal and seven clinical) were found.

Results and discussion: Animal and clinical studies have shown that PTFE patches are biomechanically and biologically sound, and have established optimal patch dimensions. Complications with the use of the patch have been minimal, although the outcome of biologic reaction at the patch-bone interface requires further work.

Conclusion: Longer-term clinical studies and randomized controlled clinical trials are needed. Further work is needed to better understand the biologics of the patch and its incorporation into the graft-host tissue interface.

1. Introduction

Rotator cuff tears are one of the most important cause of shoulder disability, accounting for 4500,000 specialist visits and over 250,000 surgical procedures performed in the USA every year.[1] Despite recent surgical advancements in their management, recurrence/re-tear rates range from 40 to over 90%.[2,3] Failure is often due to suture pull out at the suture-tendon interface,[4] with age as a negative factor.

The definition of massive rotator cuff tears remains controversial. Although most surgeons currently define a tear as massive when there is detachment of at least two complete tendons, some continue to use the older Cofield definition of a tear greater than 5 cm in size.[5,6] In contrast to small or large rotator cuff tears where techniques for surgical management

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have yielded satisfactory results, there is no consensus on the best way to manage massive tears with a wide variety of treatment options at the disposal of the orthopaedic surgeon.[5,6]

The optimal goal of any rotator cuff repair is restoration of original biology and biomechanics. In chronic massive rotator cuff tears, the low elasticity of the tendon due to its replacement by biomechanically inferior scar tissue leads to reduced tissue mobility and impairs our ability to directly suture-tendon to bone. If left untreated, massive rotator cuff tears will lead to persistent defects, weakness, and poor outcomes, and can cause uncoupling of forces across the glenohumeral joint, with resulting unstable shoulder kinematics and ultimately, osteoarthritis.[5,7]

Tendon reconstruction, a method popular in the past for large and massive tears, involves relatively large-scale surgeries and is an unrealistic option due to the high prevalence rates of rotator cuff tears in the community. To this effect, a synthetic material may be inserted between tendon and bone for repair. Studies have shown that augmentation of rotator cuff repair with a scaffold can reduce pain and lead to higher satisfaction and function compared to non-augmented repairs.[8–10]

The rationale for using a scaffold device for rotator cuff repair may include mechanical augmentation by "off-loading" the repair at time zero and for some period of post-operative healing, or biologic augmentation by improving the rate or quality of healing, or both.[11] It is hypothesized that to achieve any biomechanical benefit, scaffold devices should have robust mechanical and suture-retention properties and be applied in a surgically appropriate manner.[12] Synthetic devices may have little impact on the biology of repair healing; however their ability to maintain mechanical properties over time may function to mechanically stabilize the repair construct until host tissue healing can occur.[11]

Cardiothoracic, vascular and general surgeons have been using non-absorbable synthetic materials for many years for the reconstruction of large vessels, the heart and abdominal wall. These materials have had low infection rates, few adhesions, and good mechanical strength and suture-retention. There is no consensus or clear guidelines as to what is the safest or most efficacious augmentation. Polytetrafluoroethylene (PTFE), a synthetic fluoropolymer of tetrafluoroethylene, offers one such possibility.

PTFE is a high-molecular-weight, hydrophobic, inert, thermoplastic compound of fluorocarbon. PTFE, an accidental discovery, was famously used in the Manhattan project for tubing of uranium, and was later popularized as a coating for kitchen appliances under the brand Teflon (DuPont, USA). PTFE has a Young's modulus of 0.5 GPa, a yield strength of 23 MPa, a melting point of 600 K, and a coefficient of friction of 0.05–0.10. Gore-Tex (a popularized brand name) is PTFE with incorporated micropore technology.

PTFE is a non-degradable polymer. It works, like other synthetic materials, on the premise that supporting a cuff repair mechanically, and permanently, similar to a hernia repair, would enable biologic healing. PTFE patches are characterized by their strong tensile strength, good tissue compatibility and excellent handling properties.[13] PTFE patches have been studied in both animal models and human patients for rotator cuff tear repairs. Both biomechanical and histocompatibility (tissue affinity and tissue integrity) properties of these patches have been studied.

Some concerns with the use of such non-degradable materials includes persistent infections often requiring revision operation to remove the implant, and loss of integrity in the long-term leading to degradation, inflammation and revision surgery.[13] There is a lack of long-term studies into patch augmentation modalities. A sound understanding of surgical technique is necessary.

2. Surgical technique

Although various methods of patch augmentation are used worldwide, there is little published literature on patch augmentation techniques in rotator cuff surgery, perhaps due to the novel nature of the technique. In his paper, Labbe (2006) describes one such method. The patient is placed in a lateral position and the cuff tear is addressed using standard techniques, with a lateral viewing portal. Two mattress sutures are placed in the anterior and posterior portions of the cuff and then two double-stranded suture anchors are placed into the lateral aspect of the greater tuberosity. The patch is sized using a ruled probe or similar device placed into the subacromial space. The patch is appropriately prepared, scope inserted into posterior portal and a large cannula into the lateral portal. All sutures are brought out through the cannula and the corresponding ends of each suture are held by clamps. Sutures are passed through the graft into their respective anatomical positions, using a mattress method. The graft is then grasped using a small locking grasper on its medial edge and passed through the cannula into the subacromial space. A smaller (5 mm) cannula is then passed through one of the anchor incisions into the subacromial space and the medial two sutures are retrieved through the small cannula and tied. This is then repeated for the lateral two sutures. Post-operative rehabilitation is essential.[14] We suggest the use of pre-operative MRI to help with patch sizing. There is a need to incorporate patch augmentation methods into basic shoulder courses and workshops to facilitate uptake of this novel technique.

3. Method

A search of MEDLINE (1946 – present) (search terms: "massive rotator cuff tear" AND "polytetrafluoroethylene"; "massive rotator cuff tear" AND "GORE-TEX" OR "PTFE") and EMBASE (1988 – present) (search terms: "massive rotator cuff tear" AND "polytetrafluoroethylene"; "massive rotator cuff tear" AND "GORE-TEX" OR "PTFE") was performed. The authors further searched available literature using Google Scholar (search terms: "massive rotator cuff tear/s" AND "polytetrafluoroethylene/PTFE/GORE-TEX") and the reference lists of selected articles were reviewed for additional relevant articles. Studies were included in this review if they assessed PTFE use for the treatment of massive rotator cuff tears in vivo or in vitro. A total of eleven studies (four animal and seven clinical) were found.

4. Results and discussion

4.1. Animal studies

Kimura et al (2003) reconstructed infraspinatus tendon defects of 31 beagle dog shoulders using PTFE felt grafts. Healing of tendon was achieved in 30 of the cases, with one case of infection.[15] The tensile strength of the tendons increased five fold from 60.84 N immediately after surgery to 306.51 N at 12 weeks post-operatively. The stiffness of specimens at PTFE felt-bone interface increased 14 fold from 9.61 kN/m immediately after surgery to 135.09 kN/m at 12 weeks.[15] Histological analysis of tendons showed ingrowth of fibrous tissue between the PTFE fibres, suggesting that PTFE becomes incorporated into host tissue. However, foreign body reactions were found at the margin of PTFE-bone interface between 12 and 24 weeks.[15] These results are similar to a previous study of PTFE grafts in 60 rat shoulders.[16] These studies suggest that PTFE augmentation increases tensile strength and stiffness post-operatively and becomes incorporated into host tissue.

The method for securing the patch in the host has also been studied in animals. In a biomechanical study of 2 mm PTFE patch in 12 ovine shoulder with artificially created massive rotator cuff tears, Shepherd et al (2011), found that inverted mattress tension band repairs provide significantly higher footprint contact pressures than vertical mattress suture method.[17] Tension band repairs also had significantly higher pull out strength (220 N) compared with mattress repairs (188 N).[17] Further, Ronquillo et al (2013) compared multiple mattress suture technique to weave suture technique for 44 ovine massive infraspinatus tendon tears. The found that the multiple mattress suture technique had significantly higher failure loads (327 N) compared with weave technique (265 N), however, no difference in repair stiffness, peak energy to failure, and total energy to failure were found.[18] The exact technique for patch augmentation is still evolving, and further work is needed in this field to better address the question of optimal technique.

4.2. Clinical studies

In the earliest clinical study, Ozaki et al (1986) studied 25 patients with massive rotator cuff tears repaired using PTFE patch and found 90% to achieve satisfactory functional results with an optimal patch thickness of 3–5 mm.[16] Patch dimensions were further studied by Hirooka et al (2002) who divided their cohort of 28 patients with massive rotator cuff tears (average follow up period of 44 months post-operatively) into two groups: small patch size (less than 2 cm anteroposterior dimension; 12 shoulders) and large patch size (greater than 2 cm anteroposterior dimension; 16 shoulders). They found a significant improvement in average Japanese Orthopaedic Association (JOA) scores from 57.7 pre-operatively to 88.7 post-operatively for all patients, with no significant difference between the small and large patch size groups.[19] However, the small patch group had a significantly higher abduction strength (6.2 kg at 90° abduction) versus the large patch group (1.5 kg). Thus, smaller (less than 2 cm anteroposterior dimension) patches with thickness 3–5 mm may offer the best clinical outcomes.

In a clinical study of 30 patients with irreparable massive rotator cuff tears over a 5 year period (mean follow up of 38 months post-operatively), Kimura et al (2000) found significant improvement in pain scores (9.5 pre-operatively and 23.2 post-operatively), and mean total shoulder score (JOA score; 57 pre-operatively and 82 post-operatively).[20] There were no new osteoarthritic changes of the shoulder joint. Only one patient had a subacromial bursal infection at 6 months post-operatively. However, enlargement of the bone gutter of the greater tuberosity was seen in 30% of cases post-operatively, and the authors attribute this to biological reaction against PTFE.[20] However there was no correlation between this bone absorption and clinical outcomes. These medium term clinical results were similar to those reported earlier.[21] The bone resorption phenomenon needs to be studied in the long-term as the medium term return of tendon mechanics may be offset by repair loosening in the long-term.

Kanbe et al (2012) undertook arthroscopic repair of a massive rotator cuff tear using PTFE patch, and a second look arthroscopic surgery one year later to evaluate patch-bone and patch-tendon interface. They found a tight connection between PTFE patch and bone, and smooth attachment to cuff tissue without proliferation of inflammatory cells in the synovium.[22] Further they found improvement of American Shoulder and Elbow Surgeon scores of 24 pre-operatively to 75 post-operatively.[22] These clinical outcomes were similar to a 10 year follow up study of 5 patients with massive rotator cuff tears repaired using PTFE patch,[23] however the small sample sizes in both studies makes any conclusion difficult. Longer-term and larger clinical studies are needed.

In a Japanese study, Toshiro et al (2001) compared lattisimus dorsi transfer (14 shoulders) with PTFE felt patch (20 shoulders) for massive rotator cuff tears for mean follow up of 43.7 and 32.6 months, respectively. They found that both techniques significantly improved JOA and UCLA shoulder scores, but that average post-operative pain was lower and average post-operative strength higher in the muscle transfer group.[24] There was no significant difference in function between the two groups. PTFE combined with better pain control may allow for comparable outcomes to muscle transfer. Further work is needed to compare PTFE augmentation with other repair or augmentation techniques.

5. Conclusion

Overall, animal model studies have showed good biomechanical and biological characteristics for PTFE patches in rotator cuff surgery. However, a significant finding was the high incidence of foreign body reactions which may, in the long-term, lead to material failure. Further, tension band repair was shown to be biomechanically superior method to vertical mattress repair, and weave suture technique was biomechanically similar to multiple mattress technique. Clinical studies have confirmed the biomechanically sound principles of PTFE patches but have not allayed the fears of foreign body reactions found in animal studies, although mid-term results show low infection rates and no clinical correlations with bone

resorption phenomenon. Optimal patch dimensions have also been described. However, most clinical studies have follow up periods of less than 4 years and it is essential to assess longer-term follow ups. Additionally, clinical outcomes of patch repairs need to be compared with other commonly used techniques such as tendon grafting and other augmentation methods through randomized controlled trials.

Conflicts of interest

All authors have none to declare.

REFERENCES

1. Yamaguchi K, Ditsios K, Middleton WD, Hildebolt CF, Galatz LM, Teefey SA. The demographic and morphological features of rotator cuff disease. A comparison of asymptomatic and symptomatic shoulders. *J Bone Joint Surg Am*. 2006 Aug;88(8):1699–1704.
2. Bigliani LU, Cordasco FA, McIlveen SJ, Musso ES. Operative treatment of failed repairs of the rotator cuff. *J Bone Joint Surg Am*. 1992 Dec;74(10):1505–1515.
3. DeFranco MJ, Bershadsky B, Ciccone J, Yum J-K, Iannotti JP. Functional outcome of arthroscopic rotator cuff repairs: a correlation of anatomic and clinical results. *J Should Elb Surg Am Should Elb Surg Al*. 2007 Dec;16(6):759–765.
4. Cummins CA, Murrell GAC. Mode of failure for rotator cuff repair with suture anchors identified at revision surgery. *J Should Elb Surg Am Should Elb Surg Al*. 2003 Apr;12(2):128–133.
5. Christian Gerber SHW. Treatment options for massive rotator cuff tears. 2011;20:S20–S29.
6. Neri BR, Chan KW, Kwon YW. Management of massive and irreparable rotator cuff tears. *J Should Elb Surg Am Should Elb Surg Al*. 2009 Oct;18(5):808–818.
7. Longo UG, Lamberti A, Rizzello G, Maffulli N, Denaro V. Synthetic augmentation in massive rotator cuff tears. *Med Sport Sci*. 2012;57:168–177.
8. Badhe SP, Lawrence TM, Smith FD, Lunn PG. An assessment of porcine dermal xenograft as an augmentation graft in the treatment of extensive rotator cuff tears. *J Should Elb Surg Am Should Elb Surg Al*. 2008 Feb;17(1 suppl):35S–39S.
9. Metcalf MH, Savoie III FH, Kellum B. Surgical technique for xenograft (SIS) augmentation of rotator-cuff repairs. *Oper Tech Orthop*. 2002;12(3):204–208.
10. Encalada-Diaz I, Cole BJ, Macgillivray JD, et al. Rotator cuff repair augmentation using a novel polycarbonate polyurethane patch: preliminary results at 12 months' follow-up. *J Should Elb Surg Am Should Elb Surg Al*. 2011 Jul;20(5):788–794.
11. Ricchetti ET, Aurora A, Iannotti JP, Derwin KA. Scaffold devices for rotator cuff repair. *J Should Elb Surg Am Should Elb Surg Al*. 2012 Feb;21(2):251–265.
12. Derwin KA, Badylak SF, Steinmann SP, Iannotti JP. Extracellular matrix scaffold devices for rotator cuff repair. *J Should Elb Surg Am Should Elb Surg Al*. 2010 Apr;19(3):467–476.
13. Hakimi O, Mouthuy P-A, Carr A. Synthetic and degradable patches: an emerging solution for rotator cuff repair. *Int J Exp Pathol*. 2013 Aug;94(4):287–292.
14. Labbé MR. Arthroscopic technique for patch augmentation of rotator cuff repairs. *Arthrosc J Arthrosc Relat Surg*. 2006 Oct;22(10):1136.e1–1136.e6.
15. Kimura A, Aoki M, Fukushima S, Ishii S, Yamakoshi K. Reconstruction of a defect of the rotator cuff with polytetrafluoroethylene felt graft recovery of tensile strength and histocompatibility in an animal model. *J Bone Joint Surg Br*. 2003 Mar 1;85-B(2):282–287.
16. Ozaki J, Fujimoto S, Masuhara K, Tamai S, Yoshimoto S. Reconstruction of chronic massive rotator cuff tears with synthetic materials. *Clin Orthop Relat Res*. 1986 Jan;202:173–183.
17. Shepherd HM, Lam PH, Murrell GAC. Biomechanics of synthetic patch rotator cuff repairs. *Tech Should Elb Surg*. 2011 Dec;12(4):94–100.
18. Ronquillo JC, Lam P, Murrell GAC. Arthroscopic ePTFE patch repair for irreparable rotator cuff tears. *Tech Should Elb Surg*. 2013 Jun;14(2):29–32.
19. Hirooka A, Yoneda M, Wakaitani S, et al. Augmentation with a Gore-Tex patch for repair of large rotator cuff tears that cannot be sutured. *J Orthop Sci Off J Jpn Orthop Assoc*. 2002;7(4):451–456.
20. Kimura A, Okamura K, Fukushima S, Ishii S, Aoki M. Clinical results of rotator cuff reconstruction with PTFE felt augmentation for irreparable massive rotator cuff tears. *Should Jt*. 2000;24:485–488.
21. Ozaki J, Okamura K, Kadono T, Tatsumi H. Reconstruction of chronic massive rotator cuff tears with synthetic materials: indications and limits of this procedure. *Should Jt*. 1995;19:417–420.
22. Kanbe K, Chiba J, Nakamura A. Histological evaluation after arthroscopic reconstruction of the shoulder using a polytetrafluoroethylene patch for massive rotator cuff tears. *Eur J Orthop Surg Traumatol Orthop Traumatol*. 2012 Dec 5:S183–S187.
23. Shepherd H, Murrell GAC. Use of synthetic patches as tendon substitutes in knotless arthroscopic repairs of massive rotator cuff tears. *Tech Should Elb Surg*. 2012 Mar;13(1):32–35.
24. Toshiro T, Kenji O, Akihiko K, Keiko K, Toshihiko Y, Mitsuhiro A. A latissimus dorsi Transfer versus a teflon (PTFE) felt patch procedure for reconstruction of massive rotator cuff tears. *Should Jt*. 2001;25(2):309–313.

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