ASEAN J. Sci. Technol. Dev., **33(2)**: 69 – 77

Wound Healing Post-mesh Repair — An Observational Study

M. N. LEBBE[1], J. KULARAJASINGHAM[2] AND R. (III) P. DIOSO[3*]

This study identified the best surgical mesh repair techniques for inguinal hernia and prevalence of wound healing post-mesh repair. The cross-sectional study design used cluster sampling for data collection. Of the 120 respondents, 48.3% preferred anterior tension-free mesh repair and 49.2% Lichtenstein mesh repair, both identified as the common surgical techniques in eastern Sri Lanka. About 82.5% of the respondents (n = 99) healed while 17% (n = 21) had recurrence of hernia after one month. Nevertheless, 2.5% of the total respondents said that the hernia repaired after one month but less than two months; and 97.5% of the interviewees stated that they recovered in less than one month regardless of the surgical mesh repair technique. Respondents aged 30–39 faced little impact on healing time with mesh repair (p = 0.4393), while those aged 40–49 probably had also longer healing time (p = 0.3947). Recovering period differed significantly (p = 0.862), on pain or discomfort, especially when bending over, coughing or lifting heavy objects.

Key words: Mesh repair; observational study; cross-sectional; wound healing; recovery room

The eastern province of Sri Lanka primarily is agriculture based and is commonly known as the "Granary of Sri Lanka" where Sri Lankans usually work (Wimalaratana 2011). Inguinal hernias are among the most common problems encountered by their farmers.

Several techniques of inguinal hernia repair have been done over the years to achieve a faster healing outcome (Amato *et al.* 2009; Kark *et al.* 1998). In Sri Lanka, surgical mesh repair such as: (1) open repairs (Anterior, Lichtenstein, Desarda, and Guamieri (which are tension-free), and Bassini and Shouldice (with tension), and (2) laparoscopic mesh repairs are usually used (Amato *et al.* 2009; Aufenacker *et al.* 2004; Vrijland *et al.* 2002; O'Dwyer *et al.* 2004). Wound healing regardless of the techniques for mesh repair varies on the types of meshes and methods (O'Dwyer *et al.* 2004; Bilsei 2012). Biological mesh types (Bilsei 2012) in *Table 1* are ideally used in Sri Lanka, however, not observed in this study.

Research Problem

There is an estimated wound healing time for post-mesh repair among adult patients with inguinal hernias. The fundamental issue of this study was based on a resolution adopted by a variety of problems such as:

1. How many days would patients need to return to their regular activities of daily living?

2. What was the best mesh repair techniques that might lead to a quick recovery?

[1] Batticaloa Teaching Hospital, Sri Lanka
[2] Batticaloa General Hospital, Sri Lanka
[3] Faculty of Nursing, Lincoln University College, Malaysia
* Corresponding author (e-mail: duke@lincoln.edu.my)

Table 1. Types of biologic meshes (Bilsei 2012).

	Description	Advantages	Drawbacks
	Human Dermis		
AlloDerm®	Aseptic proprietary process removes all cellular material, freeze-dries dermis and non-cross-linked	Long record of safety and went on terminal gas sterilization	Relatively small sizes; must be refrigerated/rehydrated and placed under tension; stretches out over time
FlexHD®	Aseptic processing. No refrigeration or rehydration needed; minimal elasticity	No refrigeration or rehydration needed	Minimal elasticity
AlloMax™	Proprietary Tutoplast processing removes all cells	Sterilized by low-dose radiation	Hydration required
	Porcine Dermis		
Permacol™	Acellular, chemically cross-linked to resist collagenase	No refrigeration or rehydration requirement	Available only in large sizes
CollaMend®	Acellular, cross-linked collagen, and elastin	Lyophilized	Requires hydration
Strattice™ and XenMatrix®	Acellular, Non-cross-linked	Available in large sheets	Long term follow up
	Porcine Intestine		
Surgisis®	Acellular, Non-cross-linked	No refrigeration requirement	Needs hydration; susceptible to collagenases
FortaGen®	Low-level cross-linking	No hydration	Unclear safety profile
	Bovine Dermis		
Veritas®	Bovine pericardium	For staple line reinforcement	Insufficient data
SurgiMend™	Fetal bovine dermis, Non-cross-linked	Long shelf life	Requires rehydration
Tutopatch®	Bovine pericardium	Small inflammatory response	Insufficient data

Aims

On account of these issues, it was hoped that:

1. Identify the best surgical mesh repair techniques for inguinal hernias; and

2. Identify prevalences of wound healing post-mesh repair.

Variables

The cause variable was the surgical mesh repair procedure among patients with an inguinal hernia while the effect variable was the healing time. The variables would then answer the question: Was there a significant evidence of faster wound healing time for post -mesh repair among adult patients with an inguinal hernia?

Hypothesis

It was however hypothesized that there is an important technique of surgical mesh repair leading to a faster wound healing time among patients with an inguinal hernia admitted to government hospitals in the eastern province of Sri Lanka.

LITERATURE REVIEW

Search strategy

Review of literature of the publications relating to the fast wound healing of inguinal hernia post mesh repair among adult patients came from the published reports of the Ministry of Health, Sri Lanka, the published annual reports of the Central Bank, the documents of the Department of Census and Statistics Sri Lanka, the Sri Lankan government publications, the documents of the World Medical Association, the published annual reports of the World Health Organization, the documents from the Sri Lankan eastern provincial council, Google Scholars, Biomed Central, and Proquest. A total number of 22 000 kinds of literature were found; however, only five studies would be used in this review.

Few studies most relevant were:

1. Randomized Clinical Trial of Non-mesh versus Mesh Repair of Primary Inguinal Hernia, by W. W. Vrijland *et al.* 2002

2. Randomized Clinical Trial Assessing Impact of a Lightweight or Heavyweight Mesh on Chronic Pain after Inguinal Hernia Repair, by P. J. O'Dwyer *et al.* 2005

3. Reoperation after Recurrent Groin Hernia Repair, by Haapaniemi *et al.* 2001

4. The Role of Antibiotic Prophylaxis in Prevention of Wound Infection after Lichtenstein Open Mesh Repair of Primary Inguinal Hernia: A Multicenter Double-blind Randomized Controlled Trial, by Aufenacker *et al.* 2004

5. Three Thousand One Hundred Seventy-five Primary Inguinal Hernia Repairs: Advantages of Ambulatory Open Mesh Repair Using Local Anesthesia, by Allan *et al.* 1998

Critical Appraisal

Three hundred patients were studied by Vrijland *et al*. (2002) between September 1993 and January 1996. Based on all patients scheduled for repair of a unilateral primary inguinal hernia were randomized to non-mesh or mesh repair. The patients were followed up at one week and 1, 6, 12, 18, 24 and 36 months. Clinical outcome, such as quality of the mesh, its weight and stiffness and isotropy were analyzed. The results were to compare mesh and non-mesh suture repair of primary inguinal hernias on quality of mesh in a multi-center randomized trial in general hospitals. The result of the study of Vrijland *et al.* (2002), says that 300 patients healed after a 3-year recurrence rate: 1% for non-mesh repair (n = 143) and 7% for mesh repair (n = 146) (p = 0·009). Mesh repair with quality meshes was superior to non-mesh repair.

On the other hand, O'Dwyer *et al.* (2005) conducted a study aimed to compare the pain of any severity at 12 months after inguinal hernia repair with a partially absorbable lightweight (LW) mesh group or with a non-absorbable heavy weight (HW) mesh group. They used 321 patients, 162 in the LW group and 159 in the HW group and patients were assessed for pain at 1, 3 and 12 months by questionnaire, and were examined clinically at 12 months. O'Dwyer *et al.* (2005) found after 12 months, significantly fewer patients in the LW group than in the HW group had the healing time of 39.5% versus 51.6% (difference — 12·1 (95% confidence interval — 23·1 to 1·0)%; p=0·033). The recurrence of inguinal hernia rate was higher in the LW group (5.6% versus 0.4%; p=0·037). Five of 8 recurrences in LW group were associated with a single participating center. Finally, O'Dwyer *et al.* (2005) has taken a decision that the "use of LW mesh was associated with less chronic pain but an increase in hernia healing time post-mesh hernia repair. The latter may be related to technical factors associated with fixation of such meshes rather than any inherent defect in the mesh".

Re-operation after recurrent groin hernia repair was the study done by Haapaniemi *et al.* (2001) analyzing re-operation rates for recurrent and primary groin hernia repair documented in the Swedish Hernia Registration from 1996 to 1998. Postoperative complications and direct hernia were associated with its burst strength which increased relative risk for re-operation. Actuarial analysis adjusted for patients' death was used for calculating the cumulative incidence of re-operation. Haapaniemi *et al.* (2001) found that from 1996 to 1998, 17 985 groin hernia operations were recorded in the Swedish Hernia Registration, 15% for a recurrent hernia and 85% for a primary hernia. At 24 months the risk for having a re-operation was 4.6% after recurrent hernia repair and 1.7% after primary hernia repair. The relative risk for re-operation was significantly lower for laparoscopic methods and anterior tension-free repair because of the significant burst strength of the meshes.

The study of Aufenacker *et al.* (2004) aimed to determine whether the use of prophylactic antibiotics are effective in the prevention of postoperative wound infection after Lichtenstein open mesh inguinal hernia repair. Patients with primary inguinal hernia scheduled for Lichtenstein repair were randomized to a preoperative single dose of 1.5 g intravenous cephalosporin or a placebo. Patients with recurrent hernias, immunosuppressive diseases, or allergies for the given antibiotic were excluded. Aufenacker *et al.* (2004) found that 1008 patients analyzed had infections (1.6%) in the antibiotic prophylaxis and the placebo group (p = 0.82). There were deep infections (1.8%) in the antibiotic prophylaxis group and the placebo group (p = 0.57). Statistical analysis showed an absolute risk reduction of 0.19% (95% confidence interval, −1.78% to 1.40%) and a number needed to treat of 520 for the total number of infections. For deep infections, the absolute risk reduction is 0.20% (95% confidence interval, −0.87% to 0.48%) with a number needed to treat of 508. Aufenacker *et al.* (2004) concluded that a low percentage of wound infection after Lichtenstein open mesh inguinal (primary) hernia repair was found, and there was no difference between the antibiotic prophylaxis or placebo group. The result showed that, in Lichtenstein inguinal major hernia repair, antibiotic prophylaxis is not indicated in low-risk patients but rather the tensile strength and compliance of the mesh.

Finally, Allan *et al.* (1998) a imed to study the "Controversy existing over the relative advantages of open mesh repair compared with open stitching methods and the laparoscopic approach." Allan *et al.* (1998) examined 2906 consecutive unselected adult patients who underwent 3175 primary inguinal hernia repairs using polypropylene mesh, analyzing its elasticity on an ambulatory basis. The age range was 15–92 years. The study specifically investigated the postoperative course about pain, complicati ons, and time of return to work. Allan *et al.* (1998) found that there were neither shrinkages nor deformations with strains

from the meshes and no cases of unhealed wounds post-mesh repair. The incidence of deep infection was 0.3%. However, n o cases of testicular atrophy occurred. There was a gradual decrease in time of return to work over four successive 1-year periods. Manual workers returned to work in 15 days (median) in the first year, reducing to 9 days in the fourth year. The overall median time of performance to work across the whole group was nine days. There were eight recurrences with an 18-month to 5-year follow-up. Allan *et al.* (1998) conclude d from this study that "open mesh repair under local anesthesia is an effective day case technique, particularly in the elderly and medically unfit. The economic benefits are enhanced by low morbidity, early return to normal activities and low recurrence rates".

Analysis

The literature reviewed will help design the method of this research (Hopkins 2008). It was also examined that there were varieties of terms that needed to be observed and variables that affected the healing time. Moreover, surgical methods of mesh repairs are based on the physical characteristics of the meshes (Bilsei 2012). Surgical techniques are still considered. However, these methods would fail if the quality of the meshes was not considered (*Table 2*).

METHODOLOGY

Design

A quantitative cross-sectional study design was used in this research. This was because two hospitals were selected to cross analyze the data collected from the samples.

Sampling Technique

Cluster random sampling used 120 populations; at 20% estimated prevalence and precision of 5% margin of error at 95% confidence interval. The sample size was calculated using this formula:

$$n = \frac{Z^2.P(1 - P)}{d}$$

where, n = population; Z = confidence P = prevalence, and d = precision.

Data Collection

The questionnaires were issued directly to 120 inguinal hernia patients who were admitted to two government hospitals.

The questionnaire was in the form of a constructed survey based on the Likert five-point scale (Strongly Agree, Agree, Neutral, Disagree and Strongly Disagree). According to Hopkins (2008), validity as an indicator of research measures the questionnaires set. According to Johns (1999), questionnaires must have greater validity if they consider the ease of its use.

Data Analysis

The results from the data analysis included an analysis of response rate, demographic characteristics of respondents, about their disease, symptom of disease and healing time after surgery. The analysis was further divided into sections: (1) exposure to surgical mesh repair of an inguinal hernia; and (2) evidence of wound healing regardless of the surgical technique.

The descriptive data results used central tendencies such as:

- Mean and standard deviation;
- Anova test; and
- Probability findings.

Ethics

The approval started with the ethical committee of Lincoln University College, Research Management. The Sri Lankan Ministry of Health also approved the use of the government hospitals for data collection. Lastly, letters from the two government hospitals selected were sought.

Table 2. Prevalence of healing post mesh-repair.

Anterior tension-free	48.3%
Lichtenstein tension-free	49.2%
Bassini tension	17.0%
Laparoscopic	0.0%

Table 3. Prevalence of the time of recovery.

Time	N	%
Less than one month	117	97.5%
Less than two months	3	2.5%
Total	120	100.0%

Tables 2 and *3* shows that the vast majority of the respondents regardless of age group, healed post-mesh repair ($p<0.05$).

However, on *Table 4* ages 30–39 faced low impact with mesh repair ($p = 0.4393$), while ages 40–49 were also probable to have longer healing time ($p = 0.3947$). These age brackets (30–49 years old) were facing pain or discomfort in their groin, especially when bending over, coughing or lifting.

Table 5 on the other hand, identifies the number of respondents admitted for a re-occurrence of the hernia thus subject for second mesh repair. A 6.7% ($n = 8$) previously had hernia repair ≥1 year while 93.3% ($n = 112$) only had one-time experience of mesh repair.

Table 4. Mesh repair healing time by age group.

	N	Mean	Std. deviation	Probability
20–29	24	1.00	0.000	0.0000
30–39	58	1.02	0.131	0.4393
40–49	28	1.07	0.262	0.3947
50–59	8	1.00	0.000	0.0000
60–69	2	1.00	0.000	0.0000
Total	120			

Table 5. Previously with hernia repair.

Response	N	%
≥1 year	8	6.7%
One time experience	112	93.3%
Total	120	100.0%

Table 6 shows the symptoms of post-mesh repair. The μ within the range of ≥1 to ≤ 2.5 indicates that all the symptoms had no impact on the healing time of post-mesh repair. Recovering period among symptoms differed significantly using F-test (s = 0.862), on pain or discomfort, especially when bending over, coughing or lifting symptom. The F-test significant value (4115) = 0.719, for the rest of the symptoms except serious mesh repair pain was not statistically significant at 0.05. Serious mesh repair pain ($p<0.05$) did influence the longer recovery period for post-mesh repair. Other symptoms such as irregular bowel ($p = 0.3736$), blood in stool ($p = 0.3567$), black tiny stool ($p = 0.2392$), and pain on exertion ($p = 0.3579$) were not significant. Age bracket 30–39 years old ($p = 0.4393$) and 40–49 ($p = 0.3947$) had more problems with recovery as compared with the other age brackets since they were facing pain or discomfort in their groin, especially when bending over, coughing or lifting.

CONCLUSION

Of the 120 respondents, 82.5% (n = 99) healed while 17% (n = 21) had recurrence of hernia. There was no significant technique of surgical mesh repair leading to a faster wound healing time among patients with an inguinal hernia admitted to government hospitals in the eastern province of Sri Lanka. However, 48.3% preferred anterior tension-free and 49.2% said that Lichtenstein tension-free mesh repair healed faster. Nevertheless, 2.5% of the total respondents said that a hernia healed after one month but <2 months; and 97.5% respondents stated that they recovered in less than one month regardless of the surgical mesh repair techniques they had.

RECOMMENDATION

Prophylactic antibiotics could be used with the high rate of wound infection post-surgical mesh repair irrespective of the technique (Praveen & Rohaizak 2009). Local anesthesia is a suitable and economical option for extensive repairs and should be popularized in day-case settings (Simons *et al.* 2009). Mesh repairs are superior to "non-mesh" tissue-suture repairs in Sri Lanka. Lichtenstein repair and endoscopic/laparoscopic techniques have similar efficacy (Akinci *et al.* 2010; Khajanchee *et al.* 2004; McCormack *et al.* 2005) however, only tension-free (Lichtenstein) is the preferred technique of Sri Lankans. Standard polypropylene mesh was still the choice, whereas the use of partially absorbable lightweight meshes seemed to have some advantages.

According to the data analysis, mesh repair of inguinal hernias was superior to non-mesh repair and showed comparable results regarding postoperative complications, pain, and quality of life. However, quality of meshes (*Table 7*) could also affect healing time and was therefore recommended to surgeons for further research.

Table 6. Symptoms of post-mesh repair.

Symptoms	Results		
	Mean μ	Standard deviation ó	Probability
Bowels are irregular	1.23	0.719	0.3736
Blood in stool	1.31	0.868	0.3567
Black tiny stool	1.38	0.536	0.2392
Pain on exertion	1.13	0.357	0.3579
Serious mesh repair pain	1.00	0.000	0.0000

Table 7. Quality of meshes for further research.

Cause variables	Effect variables
Weight	Measurement of the "heaviness" or "heft" delays healing time (O'Dwyer *et al.* 2005; Vrijland *et al.* 2002)
Shrinkage	Dimensional decrease in length or width delays healing time (Allan *et al.* 1998)
Strain	Deformation of a material in response to an applied force delays healing time (Allan *et al.* 1998)
Tensile strength	Maximum stress subject to its load that can withstand stretching without tearing or breaking speeds up healing time (Aufenacker *et al.* 2004)
Burst strength	The maximum uniformly distributed pressure applied at right angle to its surface that will withstand under standardized conditional pressure speeds up healing time (Haapaniemi *et al.* 2001)
Elasticity	Changes its shape and size under the action of opposing forces, but recovers its original configuration when the forces are removed, increases healing time (Allan *et al.* 1998)
Stiffness	Ratio of steadily increasing or decreasing force acting on a deformable elastic material to the resulting displacement or deformation speeds up healing time (Vrijland *et al.* 2002)
Compliance	Displacement or deformation of a material as the result of application of a unit force affects healing time (Aufenacker *et al.* 2004)
Isotropy	When a material do not exhibit differences in properties based on the direction of the applied load, affects healing time (Vrijland *et al.* 2002)

Date of submission: December 2016
Date of acceptance: February 2017

REFERENCES

Akinci, M, Ergül, Z, Kulah, B, Yilmaz, KB, & Kulacoglu, H 2010, 'Risk factors related with unfavorable outcomes in groin hernia repairs', *Hernia*, vol. 14, pp. 489–493.

Allan, EK, Kurzer, MN & Belsham, PA 1998, Three thousand one hundred seventy-five primary inguinal hernia repairs: advantages of ambulatory open mesh repair using local anesthesia', *Journal of the American College of Surgeons*, vol. 186, no. 4, pp. 447–455.

Amato, B, Moja, L, Panico, S, Persico, G, Rispoli, C, Rocco, N, *et al.* 2009, Shouldice technique versus other open techniques for inguinal hernia repair,' *Cochrane Database Syst. Rev.*, vol. 4, CD001543.

Aufenacker, TJ, van Geldere, D, van Mesdag, T, Bossers, AN, Dekker, B, Scheijde, E, van Nieuwenhuizen, R, Hiemstra, E, Maduro, JH, Juttmann, Jan-Willem, Hofstede, D, van Der Linden, Cunera TM, Gouma, DJ, Simons & MP 2004, 'The role of antibiotic prophylaxis in prevention of

wound infection after lichtenstein open mesh repair of primary inguinal hernia: a multicenter double-blind randomized controlled trial', *Annals of Surgery*, vol. 240, no. 6, pp. 955–961.

Bilsei, Y 2012, 'The search for ideal hernia repairs; mesh materials and types', *International Journal of Surgery*, vol. 10, no. 6, pp. 317–321.

Haapaniemi, S, Gunnarsson, U, Nordin, P & Nilsson, E 2001, 'Reoperation after recurrent groin hernia repair', *Annals of Surgery*, vol. 234, no. 1, pp. 122–126.

Hopkins, W 2008, 'Quantitative research design', *Sport Science*, vol. 4, no. 1.

Khajanchee, YS, Kenyon, TA, Hansen, PD & Swanström, LL 2004, 'Economic evaluation of laparoscopic and open inguinal herniorrhaphies: the effect of cost-containment measures and internal hospital policy decisions on costs and charges', *Hernia*, vol. 8, pp. 196–202.

McCormack, K, Wake, B, Perez, J, Fraser, C, Cook, J, McIntosh, E, *et al.* 'Laparoscopic surgery for inguinal hernia repair: systematic review of effectiveness and economic evaluation', *Health Technol. Assess.*, vol. 9, no. 14, pp. 1–203.

O'Dwyer, PJ, Kingsnorth, AN, Molloy, RG, Small, PK, Lammers, B & Horeyseck, G, 2005, 'Randomized clinical trial assessing impact of a lightweight or heavyweight mesh on chronic pain after inguinal hernia repair', *British Journal of Surgery*, vol. 92, no. 2, pp. 166–170.

Praveen, S & Rohaizak, M 2009, 'Local antibiotics are equivalent to intravenous antibiotics in the prevention of superficial wound infection in inguinal hernioplasty', *Asian J. Surg.*, vol. 32, pp. 59–63.

Simons, MP, Aufenacker, T, Bay-Nielsen M, Bouillot, JL, Campanelli, G & Conze, J, *et al.* 2009, 'European Hernia Society guidelines on the treatment of inguinal hernia in adult patients', *Hernia*, vol. 13, pp. 343–403.

Vrijland, WW, van den Tol, MP, Luijendijk, RW, Hop, WCJ, Busschbach, JJV, de Lange, DCD, van Geldere, D, Rottier, AB, Vegt, PA, IJzermans, JNM & Jeekel, J 2002, 'Randomized clinical trial of non-mesh versus mesh repair of primary inguinal hernia', *British Journal of Surgery*, vol. 89, no. 3, pp. 293–297.

Wimalaratana, W 2011, *Agriculture and rural development in Sri Lanka*, Department of Resource Centre, Colombo, Univ. Colombo Pub.