Innovations

Proximal Fibular Osteotomy in medial compartment Osteoarthritis Knee

Chanderpaul G[1,2], Samynathan G[1*], Jotheesvar KN[1], Chongtham Arun Kumar Singh[2]

[1]Department of Orthopedics, Trichy SRM Medical College Hospital and Research Centre Affiliated to The Tamilnadu Dr. M.G.R. Medical University, Chennai), Tiruchirapalli – 621 105, India

[2]Department of Orthopedics, Regional Institute of Medical Sciences (RIMS), Imphal – 795 004, Manipur

Abstract

Problem:*Knee osteoarthrosis is a common chronic, progressive, degenerative disease in older individuals with accompanying joint pain, stiffness and deformity. Although Conservative managements like toe-out gait modification, valgus knee braces, lateral wedge shoe insoles aim to alter abnormal loading patterns when associated with genu varum deformity the results are not promising.The objective of this study was to evaluate the functional outcome, changes in pain intensity, changes in mechanical knee alignment and radiological changes after performing Proxiaml Fibular Osteotomy.* ***Design:****The prospective hospital based study titled "Proximal fibular osteotomy in medial compartment osteoarthritis knee" was conducted in tertiary care hospital for the period of 2 years. A total of 15 patients were included in the study and all the relevant information was recorded in a proforma. The patients were followed up at 2nd, 6thand 12thmonths post-operatively. The outcome variables TFA, Joint space ratios, modified Oxford knee and visual analogue scale scores was recorded at each visit.* ***Findings:****The mean age of the study subjects was 56.1 years with the range of 50 to 65 years where the gender ratio was 1:1.5, among the male population, 33.3% werewere Drivers by their occupation. Most of the patients affected knee was right side contributing 67% and the mean BMI of our patients was 27.5 ± 3.1 belonging to the overweight category. The mean duration of symptoms in our patients was 5.5 ± 2.2 years with a range from 2 to 8 years. The mean varus angle in our patients was 8 degrees with the range of 5 to 10 degrees. Nearly 60% of our cases had varus deformity between 5 to 10 degrees, 20 % cases had varus deformity less than 5 degree and 20% had varus more than 10 degree. The mean duration of hospital stay was 8 days with the range of 5 to 11 days. Around 53% of the patients were discharged within a week and the remaining 47% were discharged at the second week post-operatively. The mean TFA measured pre-operatively in our study was 182.6±1.67. At follow ups at 2nd,6thand 12thmonths, the mean TFA were 181.1±1.72,*

179.8±1.61 and 180.07±1.53 which were statistically significant. We found that the mean medial to lateral joint space ratio preoperatively was 0.17±0.03 which was improved to 0.19±0.03, 0.20±0.04, 0.22±0.04 at follow ups of 2nd,6thand 12thmonths which were statistically significant. The mean pre-operative modified Oxford knee score was 50.5±3.8 and post-operatively improved to 58.0±3.41, 62.4±4.1, 65.7±3.5 at 2nd, 6thand 12thmonths which was statistically significant. The mean visual analogue scale score for pain was 6.8±0.9. Post-operatively at 2nd, 6thand 12th months, the mean VAS were 5.0±0.8, 3.9±0.8 and 3.5±0.7 which were statistically significant. ***Conclusion:*** *Early functional and radiological results were promising in terms of pain relief, better functional scores, improvement in tibio-femoral angle and mild opening up of medial joint space.*

Keywords: *1.Osteoarthritis knee, 2.proximal fibular osteomy*

Introduction

Knee osteoarthrosis is a common chronic, progressive, degenerative disease in older individuals with accompanying joint pain, stiffness and deformity. It has an incidence of 30% in the population elder to 60 years(Shiozaki *et al*., 1999).The disease involves mechanical, osseus, genetic and environmental factors(Ahlback, 1968). The rate of articular degeneration at weight bearing areas along with hypertrophy of articular cartilage at non-weight bearing areas of the joint which later calcify to form the osteophytes and is accompanied by increasing thickness and eburnation of the subchondral bony plate, outgrowth of osteophytes at the joint margin, stretching of the articular capsule, synovitis, weakness of muscles bridging the joint and narrowing of the joint space(Felson *et al*., 1987).

The lesions of osteoarthritis stem from degeneration of the articular cartilage and disordered repair.Biomechanical stress is the principle pathogenic mechanism but genetic factors including polymorphisms in genes encoding components of the matrix and signalling molecules may predispose to chondrocyte injury that causes matrix alteration. Chondrocytes proliferate and continuously synthesize proteoglycans but disease develops when degradation exceeds synthesis. This leads to changes in proteoglycan composition as the disease progresses.

Chondrocytes also secretes matrix metalloproteases (MMP) that degrades the type II collagen network. Cytokines and diffusible factors from chondrocytes and synovial cells such as TNF-β, Prostaglandins, and Nitric oxide are also implicated in osteoarthritis (OA) and chronic low-level inflammation contributes to disease progression.

Advance disease is characterised by chondrocyte loss and severe matrix degradation (3). Chondrocytes proliferate and form clusters in early stages of OA. Concurrently, matrix water content increases, proteoglycan concentration decreases and horizontally arranged collagen type II fibres in the superficial zone are cleaved. These processes result in fibrillation of articular cartilage and full thickness portions of cartilage are sloughed into the joint, forming loose bodies(Wu *et al*., 2004).

Exposed subchondral bone becomes the new articular surface which is burnished by friction with the opposing surface giving it the appearance of polished ivory – bone

eburnation. Underlying articular bone undergoes rebuttressing, sclerosis and develops small micro fractures creating gaps that allow the synovial fluid to be forced into the subchondral region (Sprenger and Doerzbacher, 2003).

As the loculated fluid collection increase in size, fibrous walled cysts form.Mushroom shaped bony outgrowths- osteophytes develop at the margins of the articular surface and are capped by fibrocartilage and hyaline cartilage that gradually ossify. The synovium is usually congested and becomes fibrotic (Sprenger and Doerzbacher, 2003).

Conservative management like toe-out gait modification, valgus knee braces, lateral wedge shoe insoles aim to alter abnormal loading patterns but has not shown significant results. High tibial osteotomy (HTO) and total knee arthroplasty (TKA) are the two common methods used for treating osteoarthritis. High tibial osteotomy is a relatively extensive procedure and has complications such as neurovascular injury,iatrogenic fracture and non-union(Aglietti *et al*., 2003). Though total knee arthroplasty corrects alignment, improves function and relieves pain, it is not the treatment of choice in patients of younger age and moderate osteoarthritis(Schnurr *et al*., 2013)

While comparing High tibial osteotomy and Proximal fibular osteotomy, PFO also provides excellent result in these cases(Yang *et al*., 2015; Wang *et al*., 2017). It is hypothesized that Proximal fibular osteotomy releases the taut posterolateral soft tissues and shifts the mechanical axis from medial to lateral compartment thus relieving the medial compartmental pressure and improving the pain and functional status of the affected knee(Liu *et al*., 2018).

Materials and Methods

Inclusion criteria: The patients with moderate to severe symptomatic medial compartment osteoarthritis knee medically fit for surgery during the study period not responding to adequate conservative treatment with radiological evidence of medial joint space reduction

Exclusion criteria: Secondary osteoarthritis, rheumatoid arthritis, post-traumatic osteoarthritis; those not willing to participate and give written consent; those with previous knee surgery and fractures of femur and tibia; those with Genu valgus deformity and patient unfit for surgery and anaesthesia.

Pre-OP workup: Informed written consent was taken from all the patients participating in the study.The patients after admission were thoroughly examined to evaluate their general physical condition.

The tibio-femoral angle, joint space was assessed by antero-posterior and lateral X-ray of the knee in standing position. All the patients were subjected to routine investigations like routine blood, urine examinations, serum urea, creatinine and electrolytes, blood sugar fasting and post prandial, ECG and chest X-ray. Prophylactic antibiotic in the form of parenteral third generation cephalosporins were given along with the induction of anaesthesia and was continued for 2 days post operatively.

Surgical technique

The surgery was performed with the patient in supine position under spinal or epidural anaesthesia, with a tourniquet.The tip of fibular head was marked with a skin marking pen and the appropriate downward distance measured. Skin and subcutaneous tissue were cut. The incision should be a little more than twice the length of the resected segment (Figure 1). The fibular periosteum was now exposed by separating the peroneus and soleus. The periosteum was incised in line of skin incision and a 1.5 to 2 cm piece of fibula resected with a narrow blade oscillating saw (Figure 2).

The length of fibular segment resected was 1.5 to 2 cm and the distance from fibular head was 6 to 9 cm. The idea here was to cut the two fibular cortices, converting the knee to a more balanced joint, with unicortical support on either side, allowing correction of mechanical axis. The resection was high enough to cause a mechanical axis shift, but yet not high enough to damage the lateral popliteal nerve. The size of the resected segment and its distance from fibular head depends on the patient's height and while shorter patient had a 1.5 cm segment resected 6 cm below fibular head, tall patients had a 2 cm resection, some 8 to 9 cm below (Figure 3 and 4).

Wound was washed, closed in layers (Figure 5) and a light compression bandage

Figure 1: Skin Incision over the proximal part of the fibula over the lateral aspect

Figure 2: Marking confirmed with the help of measuring scale for fibula resection

Figure 3: 1.5-2 cm piece of fibula resection done

Figure 4: Fibular piece of bone resected and confirmed with the measuring scale

Figure 5 :Final wound closure

given. The patient was mobilised as soon as tolerated, in most cases within a few days.

Post-OP protocol

Parenteral antibiotics and anti-inflammatory medications were administered regularly for the first 48 hours of surgery. The operated limb was kept elevated and active toe movement exercise was started once the patient recovered from anaesthesia. Check X-rays were taken on the 2ndor 3rdpost-operative day. Physical therapy, patient mobilization and weight bearing as tolerated were initiated within 24 to 48 hours of surgery. The skin sutures were removed on post-operative day 10.

Patients were followed up once weekly up to first 2 months, once monthly up to 6thmonth then two monthly once up to 12thmonth and thereafter three monthly once at outpatient department. Clinical and functional assessment was done during the follow up studies using the tibio-femoral angle, joint space ratio, modified Oxford knee Score and VAS score.

Results

A total of 15 patients underwent Proximal fibular osteotomy during the study period met the inclusion criteria.In our study, the peak incidence of osteoarthritis was in the age group between 51-60 years comprising of 53.3%.In this study, both male and female cases comprising of 40 and 60% with the ratio of 1:1.5.

In our study, there were 67% cases with right side predominantly and 33% cases with left side knee-affected unilaterally in all the 15 cases.Around 60% of the cases were belonging to the overweight category, 27% were obese and 13 % cases were within the normal BMI range.

In our study, 60% of cases had varus deformity between 6-10 degrees, 20% cases had less than 5 degrees and the remaining 20% cases had 11-15 degrees. Nearly 53% of the cases were discharged within a week and 47% cases discharged after a week post-operatively.In our study, 3 patients got extensor hallucis longus weakness (EHL) and 1 patient got tingling, numbness over dorsum of foot post-operatively which was gradually recovered within 4-6 months.

The mean tibio-femoral (TFA) angle measured pre-operatively was 182.6 (±1.67) degrees whereas the mean tibio-femoral angle measured post-operatively was 181.1 (±1.72) at 2ndmonth, at 6thmonth follow-up, the mean tibio-femoral angle was 179.8 (±1.61) and at 12thmonth, the mean tibio-femoral angle was 180.1 (±1.53) which was statistically significant.

The mean joint space ratio measured pre-operatively was 0.17±0.03. The mean joint space ratio measured at 2nd month, 6thmonth and 12thmonths were 0.19±0.03, 0.20±0.04 and 0.22±0.04 which were statistically significant (p value<0.05).The mean Oxford knee score was recorded 50.5±3.8 pre-operatively and the mean Oxford knee score recorded post-operatively at 2nd, 6thand 12th months were 58.0±3.9, 62.4±4.1, 65.7±3.5 respectively which was statistically significant.The mean VAS score was recorded 6.8±0.9 pre-operatively and the mean VAS score recorded at 2nd, 6thand 12th months were 5.0±0.8, 3.9±0.8 and 3.5±0.7 respectively which was statistically significant (Figure 6 and 7).

Figure 6: Pre-operative AP radiograph showing medial compartment OA knee- Left side

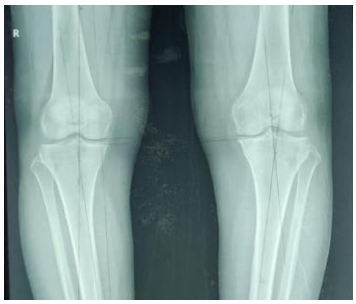
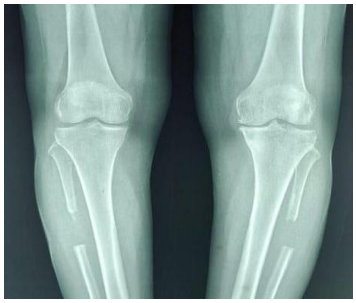


Figure 7: Post-operative AP radiograph showing resection of proximal fibular segment



Discussion

This study was conducted in a tertiary care teaching hospital in India from August 2018 to July 2020. We compared our results with the earlier studies. The following variables like age of the patient, sex, occupation, BMI, duration of symptoms, side of the knee affected were assessed. Clinical and radiological parameters like degree of varus deformity, tibio-femoral angle, joint space ratio were assessed. Functional assessment was done with Modified Oxford knee score, Visual analogue scale scores for pain. We also tried to assess the post-operative complication like oedema of limb, EHL weakness, paresthesia over the dorsum of foot and infection rate.

The mean age of presentation in our study was 56.1±5.1 years with the range of 50 to 65 years. Our patients were younger than the patients in the studies by other authors. In the study described by Yang *et al*., 2015, it was 63.5 years, Wang *et al*., 2017 with mean age of 63.96 years, Liu *et al*., 2018 with mean age of 59.45 years, Prakash, 2019 with mean age of 56.3 years, Nie i., 2018with mean age of 60.34 years.

Inthis study, the gender ratio of male and female was 1:1.5and the same gender variance was expressed invarious studies with 1:2.2, 1:2.9, 1.5.5 and 1:1.4 respectively (Yang *et al*., 2015, Wang *et al*., 2017, Liu *et al*., 2018 and Prakash, 2019.

The mean duration of symptoms in our patients was 5.5±2.2 years with a range from 2 to 8 years whereas the studies of Zou *et al*., 2017 whose patients suffered average duration of 1.5±0.4 years and Yang *et al*., 2015 with symptoms duration ranging from 1.5 to 7 years. This is because most of the patients in this study were not responding to conservative treatment for more than a year before they consented to surgical procedure.

In this study, right knee was found to be commonly involved with incidence of 67% similar to that of other studies whcih had predominant right knee involvement (Prakash, 2019; Subash *et al*., 2018).

The mean BMI of our patients was 27.5±3.2 which was 43 comparable to the study by Subash *et al*., 2018 who included patients only with BMI <30. High BMI with increased loading may be detrimental for articular cartilage healing.The mean varus angle in our patients was 8±2 degrees with the range of 5 to 10 degrees. Most (60%) of our cases had varus deformity between 5 to 10 degrees, 20% cases had varus deformity less than 5 degree and 20% had varus more than 10 degree. The study population of Subash *et al*., 2018 were with a varus deformity only less than 10 degree. Other studies also included knee OA with

varus deformities but the exact degree of deformity was not specified (Yang *et al*., 2015, Wang et al., 2017, Prakash, 2019; Zou *et al*., 2017).

The mean duration of hospital stay was 8 days with the range of 5 to 11 days. In this study, 53% of the patients were discharged within a week and other 47% were discharged at the second week post-operatively.The mean TFA measured pre-operatively was 182.6±1.67. At follow ups at 2^{nd}, $6^{th}$and 12^{th} months, the mean TFA were 181.1±1.72, 179.8±1.61 and 180.07±1.53 which were statistically significant. On comparison with other studies using TFA as a measure for correction of mechanical alignment foundthe mean TFA improved from 182.7±2.0 pre-operatively to 179.4±1.8 (Yang *et al*., 2015). A study found that TFA improved significantly from 183.4±2.5 pre-operatively to 168.9±1.3 post-operatively (Zou*et al*., 2017). Another study found that mean TFA improved from 182±1.8 to 179±1.9 (Subash *et al*., 2018).

The mean medial to lateral joint space ratio pre-operatively was 0.17±0.03 which improved to 0.19±0.03, 0.20±0.04, 0.22±0.04 at follow up of 2^{nd},$6^{th}$and 12^{th}months which were statistically significant (p value <0.05). The results of Wang *et al*., 2017 described that the joint space ratio improved significantly from 0.40±0.28 to 0.58±0.30 at 12 month follow up. Another study showed that the mean medial joint space change was from 1.3±0.8 to 4.2±2.7 at final follow up of 24 months (Subash *et al*., 2018). Similarly there was a corresponding reduction in lateral joint space from 7.6±1.2 to 5.4±1.3 which were statistically significant who analysed only the width of lateral joint space and found that the lateral joint space was decreased from 12.2±1.1 preoperatively to 6.9±0.7 at final follow up of 24 months which was again statistically significant (Yang et al., 2015).

In this study, the mean pre-operative knee score was 50.46±3.8 and post-operatively improved to 58.0±3.9, 62.4±4.1, 65.7±3.5 at 2^{nd}, $6^{th}$and 12^{th}months which was statistically significant with p-value <0.05. Comparing to other studies, the mean functional knee score was 54.4 pre-operatively which was increased to 77.0 post-operatively (p-value <0.05) and the mean score was 52.2 pre-operatively which was increased to 79.0 post-operatively (p-value <0.05) which was statistically significant (Prakash, 2019; Subash et al., 2018).

All the patients in this study had pain as a major clinical symptom which was not responding to conservative treatment. Pain due to OA knee contributes to functional impairment, impairment of mobility reduced quality of life in elderly population. The mean visual analogue scale for pain in this study was 6.8±0.9. Post-operatively at 2^{nd}, 6^{th} and 12^{th} months, the mean VAS were improved to 5.0±0.8, 3.9±0.8 and 3.5±0.7 which were statistically significant with the p-value of <0.05.

The mean VAS was comparable to other studies with VAS of 7, 8.02, 6.7, 5.64, 4.6 and 6.9 respectively while analyzing pre-operatively; while analysing post-operative observations, the results of the similar studies with VAS of 2, 2.74, 2.2, 0.27, 0.5 and 2.1 respectively which were statistically significant (Yang *et al*., 2015, Wang *et al*., 2017 Prakash, 2019; Nie *et al*., 2018; Zou*et al*., 2017; Subash *et al*., 2018).

Injury to the common peroneal nerve can occur if bone levers are inadvertently placed which could have resulted in the post-operative paresthesia over dorsum of foot in one (6.6%) of the cases included in this study. Similar complications were encountered by Yang *et al*., 2015 who reported 4 (3.6%) of their cases with paresthesia over foot and 2 (1.8%) cases with

confirmed superficial peroneal nerve palsy and Subash *et al*., 2018 in 3 (10%) of their cases. The paresthesia recovered uneventfully without any intervention during the follow up at 4-6 months which showed that the injury to the nerve could be due to neuropraxia. A study reported with one (2.5%) case with neurovascular injury. In this study also faced 3 (20%) case with EHL weakness in which could have been due to traction injury of the common peroneal nerve itself (Zou *et al*., 2017). Adequate precautions were taken by making our incision 6cms below fibular head, osteotomy 8cms below fibular head and not using bone levers for retraction in future cases to prevent injury to common peroneal nerve or its fanning of branches. A study identified that common peroneal nerve (CPN) courses superficial to the lateral surface of the fibula and approximately 2cms distal to fibular head passes into the fibular tunnel and as they wrap around the fibular neck demonstrated broad fanning of fibers with three major divisions including anterior recurrent, superficial and deep branches (Baruah *et al*., 2018).

Conclusion

Knee osteoarthritis is one of the leading causes of morbidity among elderly patients. If associated with genu varum deformity the results of conservative treatment are not promising. Even though high tibial osteotomy (HTO) and unicompartmental knee arthroplasty (UKA) could correct genu varum deformity and prevent disease progression, they are associated with serious complications. Total knee arthroplasty (TKA) was considered too radical surgery for early OA knee. Proximal fibular osteotomy was a reliable surgery for early OA knee with genu varum deformity provided that deformity less than 15 degrees. The beneficial effect of PFO was mainly because of release of taut posterolateral softtissue structures attached to fibular head and also correction of non-uniform loading on the tibial weight bearing articular surface. Proximal fibular osteotomy was a simple quick surgery which could be performed within 30-40 mins with minimal blood loss of approximately 30-50 ml. Early ambulation with full-weight bearing was allowed in the post-operative period which was an added advantage. Early functional and radiological results were promising in terms of pain relief, better functional scores, improvement in tibio-femoral angle and mild opening up of medial joint space.

The hypothesis proposed in this study showed that PFO improved pain and functional status of the patient by shifting the mechanical axis from medial to lateral compartment and relieving medial compartmental pressure.

References

1. *Aglietti, P., Buzzi, R., Vena, L.M., Baldini, A., Mondaini, A (2003). A high tibial valgus osteotomy for medial gonarthrosis: a 10- to 21- year study. J Knee Surg 16(1):21-26 (www.pubmed.ncbi.nlm.nih.gov/12568262).*

2. *Ahlback, S (1968). Osteoarthrosis of the knee: a radiographic investigation. Acta Radiol Diagn 277(3):7-72 (www.pubmed.ncbi.nlm.nih.gov/5706059).*

3. *Baldini, T., Roberts, J., Hao, J., Hunt, K., Dayton, M., Hogan, C (2018). Medial compartment decompression by proximal fibular osteotomy: a biomechanical cadaver study. Orthoped 41(4):496-501 (www.pubmed.ncbi.nlm.nih.gov/29708573).*

4. *Baruah, R.K., Harikrishnan, S.V., Baruah, J.P (2018). Safe corridor for fibular transfixation wire in relation to common peroneal nerve: a cadaveric analysis. J Clin Orthop Traumatol 10(2):432-438 (www.pubmed.ncbi.nlm.nih.gov/30828221).*

5. *Felson, D.T., Naimark, A., Anderson, J., Kazis, L., Castelli, W., Meenan, R.F (1987). The prevalence of knee osteoarthritis in the elderly: the Framingham osteoarthritis study. Arthr Rheum 30(8):914-918 (www.pubmed.ncbi.nlm.nih.gov/36327320).*

6. *Liu, B., Chen, W., Zhang, Q., Yan, X., Zhang, F., Dong, T (2018). Proximal fibular osteotomy to treat medial compartment knee osteoarthritis: preoperational factors for short-term prognosis. PLoS ONE 13(5):1387-1389 (www.pubmed.ncbi.nlm.nih.gov/29795669).*

7. *Nie, Y., Huang, Z.Y., Xu, B., Shen, B., Kraus, V.B., Pei, F (2018). Evidence and mechanism by which upper partial fibulectomy improves knee biomechanics and decreases knee pain of osteoarthritis. J Orthop Res 36(8):2099-2108 (www.pubmed.ncbi.nlm.nih.gov/29424452).*

8. *Prakash, L (2019). Proximal fibular osteotomy in medial compartment arthritis of the knee with varus deformity. EC Orthoped 10(5):315-321 (www.pubmed.ncbi.nlm.nih.gov/32952909).*

9. *Qin, D., Chen, W., Wang, J., Lv, H., Ma, W., Dong, T (2018). Mechanism and influencing factors of proximal fibular osteotomy for treatment of medial compartment knee osteoarthritis. J Int Med Res 46(8):3114-3123 (www.pubmed.ncbi.nlm.nih.gov/29848141).*

10. *Schnurr, C., Jarrous, M., Gudden, I., Eysel, P., Konig, D.P (2013). Pre-operative arthritis severity as a predictor for total knee arthroplasty patients satisfaction. Int Orthop 37(7):1257-1261 (www.pubmed.ncbi.nlm.nih.gov/23525526).*

11. *Shiozaki, H., Koga, Y., Omori, G., Yamamoto, G., Takashashi, H.E (1999). Epidemiology of osteoarthritis of the knee in a rural Japanese population. The Knee6(3):183-188 (www.thekneejournal.com/article/S0968-0160(99)00011-3).*

12. *Sprenger, T.R., Doerzbacher, J.F (2003). Tibial osteotomy for the treatment of varusgonarthrosis: survival and failure analysis to twenty-two years. J Bone Joint Surg Am 85(3):469-474 (www.pubmed.ncbi.nlm.nih.gov/12637433).*

13. *Subash, Y., Naidu, G.K (2018). The role of proximal fibular osteotomy in the management of medial compartment osteoarthritis of the knee. Int J Orthop Sci 4(3):369-372 (www.orthopaper.com).*

14. *Utomo, D.N., Mahyudin, F., Wijaya, A.M., Widhiyanto, L (2018). Proximal fibula osteotomy as an alternative to TKA and HTO in late stage varus type of knee osteoarthritis. J Orthop 15(3):858-861 (www.pubmed.ncbi.nlm.nih.gov/30147277).*

15. *Wang, X., Wei, L., Lv, Z., Zhao, B., Duan, Z., Wu, W (2017). Proximal fibular osteotomy: a new surgery for pain relief and improvement of joint function in patients with knee osteoarthritis. J Int Med Res 45(1):282-289 (www.pubmed.ncbi.nlm.nih.gov/28222626).*

16. *Wu, L.D., Hahne, H.J., Hassenpug, T (2004). A long-term follow-up study of high tibial osteotomy for medial compartment osteoarthrosis. Chin J Traumatol7(6):348-353 (www.pubmed.ncbi.nlm.nih.gov/15566691).*

17. *Yang, Z.Y., Chen, W., Li, C.X., Wang, J., Shao, D.C., Hou, Z.Y (2015). Medial compartment decompression by fibular osteotomy to treat medial compartment knee osteoarthritis.Orthoped38(12):1110-1114(www.pubmed.ncbi.nlm.nih.gov/26652332).*

18. *Zou, G., Lan, W., Zeng, Y., Xie, J., Chen, S., Qiu, Y (2017). Early clinical effect of proximal fibular osteotomy on knee osteoarthritis. Biomed Res 28(21):9291-9294 (www.biomedres.info).*

Corresponding Author and Email: Dr. G. Samynathan, ***gsnathan30@gmail.com***