TITLE OF DISSERTATION

"AN OBSERVATIONAL STUDY ON PATELLAR RESURFACING IN TOTAL KNEE ARTHROPLASTY"

SUBMITTED BY

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ABSTRACT:

Aim: The long term complication relating to the patella following Total Knee Arthroplasty (TKA) is a major mode of failure, accounting for up to 50% of revision TKA. Controversy still exists over whether to resurface a patella in primary knee arthroplasty

Null hypothesis (H_o) = There is no difference between the patella Resurfaced and the Non-Resurfaced groups following Total Knee Replacement.

Material and Methods: We selected 106 patients who had Total Knee Arthroplasty done between March 2000 and March 2005 for this observational study. The indication for the operation was pain relief due to degenerative osteoarthritis. The procedures were performed by six different fully trained Orthopaedic consultants. All polyethylene patellar components were inserted with cement. Post-operatively on an average 5 years patients were reassessed clinically and radiologically according to the subtitles on the Modified Knee Scoring System. No scoring was given, instead a statistical analysis was done for every sub heading and the significance (p-value) found using appropriate statistical methods comparing them pre- and post-operatively. Lastly, the level of patient satisfaction was also statistically analysed.

Results: Pre-operatively, all the examined variables except preoperative range of motion have a non-significant p-value. After analysing data on an average 5 years post-operatively there was no statistically significant difference between the resurfaced and the non-resurfaced groups. In terms of pain, both groups did not show any difference in level of pain, visual analogue score, time when pain is worst and analgesia for pain relief. Whereas regarding mobility there was some improvement in both groups post-operatively however, there is no statistical difference.

Conclusion: This study shows that patella resurfaced or non-resurfaced in primary knee arthroplasty has no influence on functional outcome. Post-operatively, in both groups patient quality of life improved because of a decrease severity of pain, increased mobility and a reduction in the use of analgesia.

ABBREVIATIONS:

OA	Osteoarthritis
TKA	Total knee arthroplasty
TKR	Total knee replacement
PR	Patella resurfacing
Non PR	Non patella resurfacing
RG	Patella resurfaced group
NRG	Non patella Resurfaced Group
WR-MW Test	Wilcoxon Rank sum test - Mann Whitney U variant
VL	Vastus lateralis
VM	Vastus medialis
Fig	Figure
RA	Rheumatoid arthritis

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INTRODUCTION:

Patellar complications following Total Knee Arthroplasty (TKA) is a major mode of failure. Patella resurfacing during total knee replacement is often recommended based on higher revision rates (Lygre *et al*. 2010). The Australian Orthopaedic Association National Joint Replacement Registry conducted a study on 134799 total knee arthroplasties to compare rates of early revision between resurfacing and without resurfacing in total knee arthroplasty and the conclusion was that at 5 years cumulative percent the rate of early revision is higher in the non resurfaced group (4%) compared to the resurfaced group (3.1%) (Clements et al. 2010).

Total knee replacement with or without patella resurfacing is still a contentious issue despite three decades of successful joint replacement surgery. The benefits of TKA are excellent pain relief, improved function and durability (Dennis DA *et al*. 1992b; Insall J, Ninnazzi R, & Soudry M 1985; Swan *et al.* 2010). However, problems with the patellofemoral joint still play a major role in failure rates (Doolittle KH & Turner RH 1988). Early design of total knee replacements did not resurface the patella. However, at the time, this resulted upto a reported 50% problem with anterior knee pain (Clayton ML & Thirupathi R 1982). Subsequently total knee replacements designs were modified. This also led to the development of patella resurfacing, with the first reported patella resurfacing occurring in 1974. A polyethylene dome design for the Insall-Burstein total

condylar knee replacement (Zimmer, Warsaw, Indiana) was introduced (Insall J & Scott WN *et al* 1979). This led to design modification and patella resurfacing which became a cause for concern. In literature (Enis *et al.* 1990) showed early complications rates ranged from 4% to 50%. These complications are over or under restoration of patellar thickness, fracture, aseptic loosening, wear, component failure, patellar clunk syndrome and tendon ruptures.

(Holt & Dennis 2003b) *et al* stated that complications after patellar resurfacing can be minimized by surgical techniques such as accurate patellar resection; to maintain tangency of patellar vascularity, proper positioning of components, avoidance of soft tissue impingement and assurance of central patellar tracking (Douglas A & Dennis DA 1992).

Patellar resurfacing is not done routinely due to the numerous patellofemoral complications. While most agree to resurface the patella in patients with Rheumatoid arthritis (RA) due to the antigenic response of the roamed cartilage (Scott Rd & Reilley DT 1980) controversy still exists over whether to resurface the patella in patients with Osteoarthritis.

To address the question ‘whether or not to resurface the patella during total knee arthroplasty’ we reviewed the literatures by using the software ‘Reference Manager 10’ using the key words “total knee arthroplasty”, “Patella resurfacing”,

“patella non resurfacing”, “complications after total knee replacement”, “patellar innervation” and “patella-femoral anatomy and biomechanics”.

In medicine Randomized controlled study is the gold standard technique which provide valuable information so we accumulated data from 3 meta-analyses and 12 randomized controlled studies on patella resurfacing or non-resurfacing in total knee arthroplasty. These reports provide valuable insight towards the decision making whether patellar resurface or not to resurface in primary knee arthroplasty.

Those evidence-based randomized controlled study were well designed and it seems the results are in favor of patellar resurfacing. From meta-analyses it is concluded that there is no difference between the two groups regarding functional outcomes. It also states that overall re-operation rate and anterior knee pain is lower resurfaced group. In contrary, the result is conflicting as because unresurfaced group did not show any significant difference in functional outcome.

In 2005, (Pakos, Ntzani, & Trikalinos 2005b) *et al* studied 10 randomized controlled trial with 1-year follow-up. Anterior knee pain, relative risk of revision was the outcome criteria. Result showed in less than 5 years that there is no difference.

(Nizard et al. 2005) *et al* investigated 12 randomized trials and found out that re-operation and anterior knee pain percentage were lower in resurfaced group than non-resurfaced group.

(Parvizi et al. 2005b) *et al* analyzed data of 14 randomized trials. Re-operation, anterior knee pain, knee score and patient satisfaction determined patient's outcome. Resurfaced group showed lower percentage in pain and re-operation.

The following table 1 and 2 shows the summary of randomized controlled trials and meta-analyses respectively.

Table 1: Reviews of randomized controlled trial

Authors	**Study Design**	**Cases**	**Conclusions**
(Campbell *et al.* 2009)	Prospective, randomized	2352	With or without metal backing tibial component, patella resurfacing and mobile bearing has no effect on the rate of early complications and functional outcome.
(Smith, Wood, & Li 2008)	Prospective, randomized	159	No significant difference between resurfacing and non-resurfacing knee in mean 4 years.
(Shoji, Yoshino, & Kajino 1989)	Prospective, randomized	75 (bilat. with RA)	Pain relief and functional outcome was the same between groups.

Authors	Study Designs	Cases	Conclusions
(Burnett *et al.* 2007)	Prospective, randomized	64 (bilat. 32 patients with RA	Minimum of 10 years follow up showed no clinical difference between groups.
(Campbell *et al.* 2006)	Prospective, randomized	100	No significant difference between groups at 10 years time,
(Myles *et al.* 2006)	Prospective, randomized	50	Ranges of motion were assessed by electro goniometry 18-24 months after operation showed no difference with resurfaced patella (alpha level 0.05).
(Waters & Bentley 2003)	Prospective, randomized	474	Anterior knee pain was 25% in unresurfaced than 5% in resurfaced group in mean 5.3 years, so resurfacing recommended.
(Peng, Tay BK, & Lee BPH 2003)	Prospective, randomized	70	In mean 5.18 years, no difference in knee score, knee pain and knee function was noted.
(Mayman *et al.* 2003)	Prospective, randomized	100	Less anterior knee pain, better subjective satisfaction was documented in patella resurfaced group at 8 to 10 years post-operative period,

Authors	Study Designs	Cases	Conclusions
(Wood *et al.* 2002)	Prospective, randomized	220	12% patellla was revised in non-resurfaced and 10% patella was revised in resurfaced group in mean 4 years. Non-resurfaced group had increased anterior knee pain P=0.016.
(Barrack *et al.* 1997)	Prospective, randomized	118	Two groups did not show any significant differences in outcomes in minimum 5 years post-operative period.
(Feller, Bartlett, & Lang 1996)	Prospective, randomized	38	Better functional outcome in non-resurfaced group in average 3 years.

Table 2: Summary of meta-analysis

Authors	Study Design	Cases	Conclusions
(Parvizi *et al.* 2005a)	Meta-analysis	1519	Unresurfaced group had more anterior knee pain and less satisfaction.
(Pakos *et al.* 2005a)	Meta-analysis	1223	Reoperation due to increased anterior knee pain in unresurfaced group.

Authors	Study Designs	Cases	Conclusions
(Nizard *et al.* 2005)	Meta-analysis	1490	International Knee Society function score, Hospital for Special Surgery Score were used to evaluate outcome of anterior knee pain, stair climbing and patient satisfaction. No differences were found between the two groups. Unresurfaced group underwent re-operation due to more anterior knee pain.

The Swedish Knee Arthroplasty Registry database showed that one variable such as patellar resurfacing in total knee arthroplasty made a difference in terms of patient satisfaction. From their report on 27372 knees operated on between 1981 an 1995, (Bourne & Burnett 2004) analysed patient satisfaction between osteoarthritis and rheumatoid arthritis groups. The results were in osteoarthritis group 19% of 7567 nonresurfaced knees were unsatisfied or uncertain compared to 15% 4731 resurfaced knees and in rheumatoid arthritis group 15% of 1813 unresurfaced knees were unsatisfied or uncertain compared to 12% of 1208 resurfaced knees. There are also non-randomized studies in the literature which showed equivalent clinical results irrespective of patellar resurfacing or non resurfacing at the index surgery.

AIM OF THE STUDY:

Patella resurfacing or unresurfacing is still a debatable question. Some surgeons always resurface the patella, some never use a patellar implant, and some only do it in selected cases depending on patient factors, implant design factors, surgical techniques and material properties.

From the literature, different studies have used different scoring system to analyse the overall results. There is no study in the literature to our knowledge that has statistically analysed the individual variables of those scoring systems independently in both groups, the patella resurfaced (PR) and the non patella resurfaced (non-PR) pre- and post-operatively. Hence this observational study was undertaken to see what difference it makes between the two groups when the constituents of the American Knee Society Scoring (KSS) were analysed statistically pre- and post-operatively in both the groups and therefore help to recommend which is the better technique.

This study will expand on the patellofemoral anatomy, nerve supply around the patella and biomechanics of the patellofemoral joint and the importance of these factors in decision making for the surgeons which will help them to perform a successful total knee arthroplasty. It is proven that altered biomechanics of patella can be a cause of anterior knee pain after primary arthroplasty.

PATELLO-FEMORAL ANATOMY:

The patella is the largest sesamoid bone, which is embedded in the tendon of quadriceps femoris, anterior to the knee joint. Morphologically, it is a flat triangular distally and curved proximally. The patella has two surfaces, three borders and an apex. Its articular surface is the thickest in the body and can measure up to 4 to 5 mm in its central portion. Posteriorly the vertical ridge divides the patella into lateral and medial facets. The medial facet can vary anatomically. It is divided into the medial facet proper and a seventh “odd” facet. The odd facet is purely cartilaginous and is felt to develop secondary to forces generated between the lateral aspect of the medial femoral condyle and the medial facet (Ficat P 1977). The odd facet comes into contact with the trochlear portion of the medial femoral condyle in deep knee flexion. The medial facet is flat to slightly convex while the lateral facet is concave as well as larger than the medial facet (Wriberg G 1941). Facet hypoplasia and anatomic variations in the patella have been implicated in the etiology of patellar instability. Wriberg (Ficat P 1977; Wriberg G 1941) have classified different patellar morphologies based on radiographic shape and angle created by the medial and lateral facets respectively, and their relationship to patellar stability. Ficat *et al*. described that the normal angle created by the medial and lateral facets as between 120 and 140 degree, with angles greater than 140 degree being potentially unstable.

The medial and lateral femoral condyles or facets have a convex shape and the intercondylar notch distally. The articular cartilage of the lateral facet is thicker,

the lateral facet is larger and projects more cephalad and anteriorly than the medial facet (Fulkerson JP & Hungerford DS 1990). The normal sulcus angle formed by the medial lateral femoral facets is 142 degree, as determined by Brattstrom (Brattstorm H 1964). Underdeveloped condyles and/or sulcus angles of more than 150 degree can also lead to patellofemoral instability (DeJour H *et al*. 1990).

The patella derives its primary blood supply from the medial and lateral superior and inferior geniculate arteries in addition to contributions from the supreme geniculate artery and the medial and anterior tibial recurrent arteries. For technical purposes, it is important to remember that the superior lateral geniculate artery is located between the lateral retinaculum and the synovium at the superolateral pole of the patella **(Figure 1).** Patellofemoral joint stability is provided by the bony architecture of the medial and lateral facets of the patella as well as those of the femur, in addition to the static and dynamic stabilizers about the knee. Static restraints include the lateral peri-patellar retinaculum, which is composed of two major components. Connecting the lateral patella to the illiotibial band, the superficial oblique retinaculum is the less significant component, whereas the deep transverse retinaculum is more extensive and substantial. Within its substance is the lateral patellofemoral ligament, the patellotibial band, and the illiopatellar bands. The static restraints on the medial side of the patella include the patellofemoral and patellotibial ligaments as well as a capsular condensation. In addition, the patellar tendon, acting as a restraint in

the frontal plane, limits excess patellar displacement proximally to less than 10 mm (Fulkerson JP & Hungerford DS 1990). The four major components of the quadriceps muscle act as the dynamic stabilizers of the patellofemoral joint. These components include the rectus femoris and vastus intermedialis tendons as well as the vastus medialis and the anatomically disntinct vastus medialis obliqus, which originates from the adductor tubercle and inserts on the medial patella at a 55 degree angle, serving as a primary dynamic stabilizer against lateral translation of the patella (Lieb FJ & Perry J 1968). Finally, a portion of the distal aspect of the vastus lateralis muscle inserts onto the lateral patella obliquely, thus providing dynamic stabilization against medial displacement of the patella (Hallisey MJ, Doherty N, & Bennett WF *et al* 1987).

(Holt & Dennis 2003a) *et al. 2003* described post-operative complications can be reduced by protecting extraosseous and intraosseous patellar blood supply. Care must be taken to retain the patellar fat pad and preserve the superolateral geniculate artery. (Dennis DA et al. 1992a)proposed components with large central fixation peg can damage intraosseous blood supply.

Surgical approach towards patellar resurfacing is an important factor for clinical results. Satisfactory outcome can be achieved by maintaining symmetric facet thickness, proper positioning of all components, central patellar tracking and avoiding soft tissue interference around prosthesis.

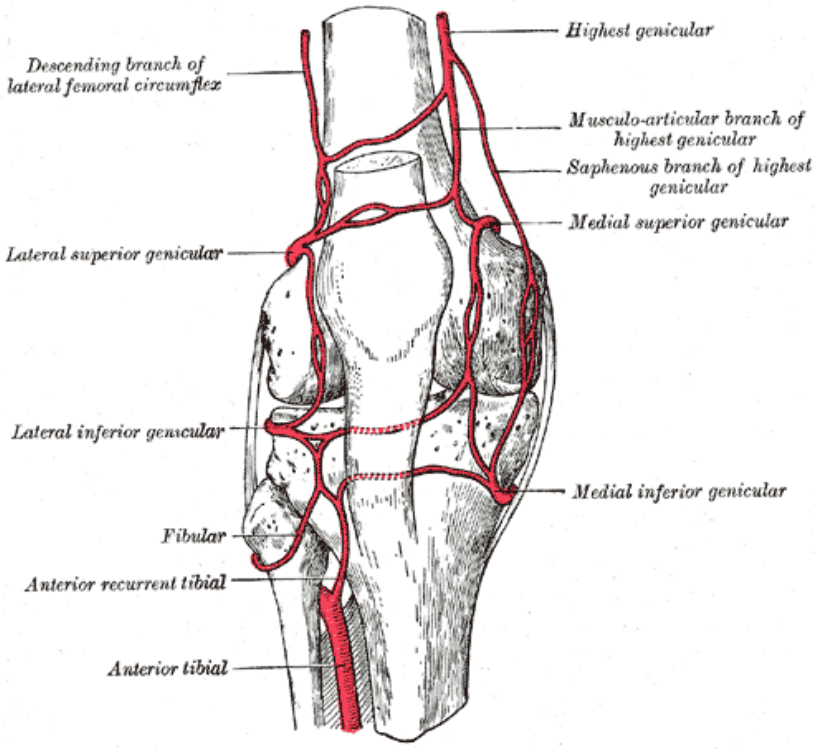


Figure 1: Arteries of the knee (Gray's Anatomy).

NERVE SUPPLY:

Pain mechanism of patella is still unclear. Anterior knee pain is probably due to structural disorders of knee joint. (Maralcan et al. 2005) explored anatomical and clinical study of patellar innervation. He described that knee pain occurs due to afferent innervation of knee. Superomedial and superolateral edge of patella is innervated by two nerves, fibular branch ascends towards patellar tendon and fat pad. Terminal branches of medial femoral cutaneous supply anterior part of knee region. Medial and lateral retinacular structures are supplied by medial and lateral retinacular nerves. (Swan, Stoney, Lim, Dowsey, & Choong 2010) *et al* 2010 proposed anterior knee pain in most cases may be due to neural

inflammation and altered propioception. **Figure 2** shows how medial and lateral patellar nerve supply anterior patellofemoral joint.

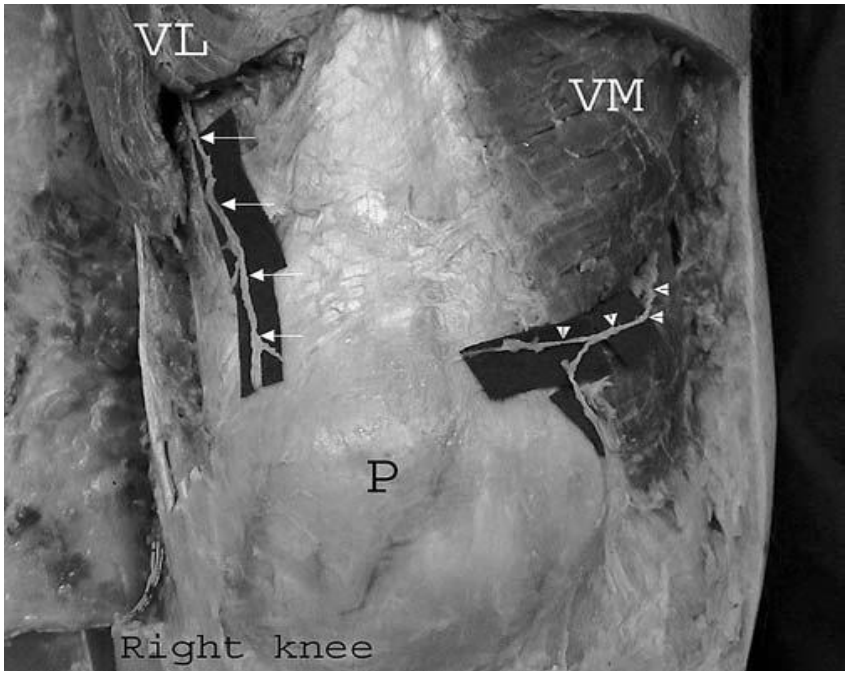


Figure 2: Ant. view of the patellofemoral joint and patellar nerves. VL, VM and P denotes Vastus Lateralis, Vastus Medialis and Patella respectively. Medial patellar nerve (arrowheads) and Lateral patellar nerve (arrows) [from Original Article by Maralcan G *et al* published in Surg Radiol Anat (2005) 27: 331-335]

BIOMECHANICS - PATELLA AND PATELLOFEMORAL JOINT:

The quadriceps muscles act primarily to extend the knee. The patella plays a major role in facilitating the function of the quadriceps muscles by increasing the distance of the quadriceps tendon from the centre of rotation of the knee – i.e., increasing the moment arm. This gives the quadriceps tendon a biomechanical advantage, increasing quadriceps force by 33 to 50 percent (Kaufer H 1979). Furthermore, the patella provides protection for the knee joint and femoral

condyles as well as functioning to guide the quadriceps tendon within the trochlear groove. Thick hyaline cartilage of the patella allows the extensor mechanism to glide smoothly, thus protecting the quadriceps tendon form shear forces that could potentially cause excessive wear on the quadriceps tendon. Under normal circumstances, the articular surface of the patella is subjected to significant forces. Using a mathematical model, Reilly and Martens (Reilly D & Martens N 1972) determined that the patellofemoral joint's reactive forces was approximately half body weight during normal walking, and these forces increase to greater than three times body weight with stair climbing. Others have demonstrated that placing a weight around the ankle during knee extension results in significantly greater patellofemoral joint reactive forces, especially in the middle arcs of knee motion (Huberti HH & Hayes WC 1984; Hungerford DS & Barry M 1979).

With the knee in full extension, the patella does not come into contact with the trochlea. In a knee with normal patellar tendon length, the patella does not come into contact with the trochlea until the knee has been flexed to 10 degree. The distal patella is the first portion to come into contact with the trochlea; as knee flexion is increased, the area of contact moves proximally along the patella. Initially the lateral facet is the first to make contact; gliding along the lateral trochlea at approximately 20 degree of flexion the medial facet and medial trochlea begin to articulate, but this does not necessarily occur in some knees until the knee has been flexed to 30 or 40 degree. The odd facet does not come

into contact until the knee has been flexed to 135 degree **(Figure 3**). Once the knee has been flexed to 90 degree, the quadriceps tendon begins to contact the trochlea thus sharing the compressive load. Furthermore, the patellofemoral contact area increases with increasing knee flexion as this contact area moves proximally along the patella (Hungerford DS & Barry M 1979).

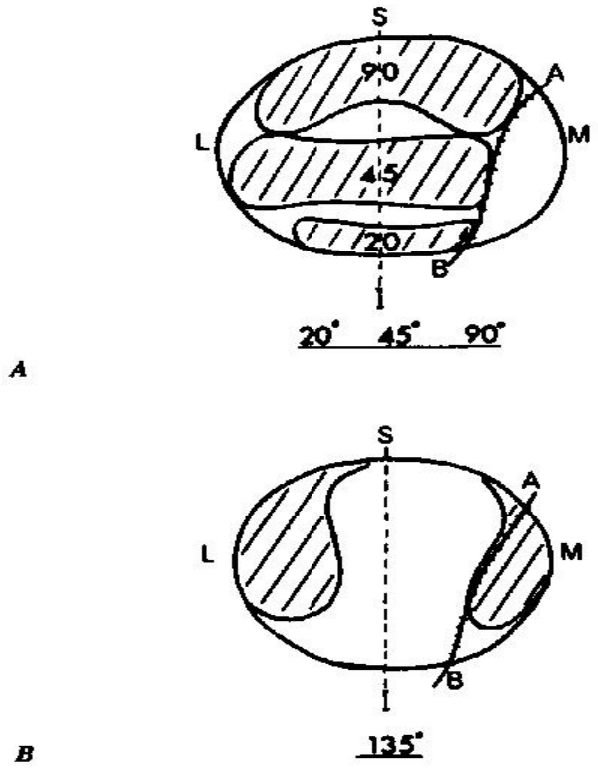


Figure 3: Experimentally determined areas (cross hatched) of patellar contact with femur through varying degrees of knee flexion. A. Areas in contact at 20, 45 and 90 degrees; B. Both areas in contact at 135 degrees.

(Smith, Lloyd, & Wood 2006) *et al* 2006 did kinematic and kinetic gait analysis 12-18 months after total knee replacement and interpretated that there were no clinically relevant differences after total knee replacement with or without patella resurfacing.

MATERIALS AND METHODS:

Null Hypothesis (H_o) = There is no significant difference between the two groups patella resurfaced and patella non-resurfaced in primary knee arthroplasty.

Power Calculation: To achieve a medium effect size of 0.56 or above with 80% power at a 5% significance level we need 30 patients in each group i.e.; 60 patient in total, where α error = 5%, power = 1-β = 80%, β error = 20%. It was agreed to study more than 30 patients in each group to account for the possibility of patients dropping out of the study or lost to follow-up.

Methods: A total of 106 concurrent patients were taken for this observational study those who had Kinemax Knee prosthesis in between 2000 to 2005. These patients were followed up for an average of 5 years (from 4 to 6 years). The main indication for surgery was pain due to degenerative changes within the joint after an adequate trial of non-operative therapy. Patients who had previous knee injury, any disability, any knee infection and significant other underlying medical illnesses that limited the ability to walk were not included in this study which may influence post-operative functional outcome.

For the purpose of study all the patients were provided with an explanation before being questioned and reassured that all information will be confidential.

Rotational alignment of femoral component is critical in knee arthroplasty (Insall J *et al.* 1976) so all procedures were performed with a medial parapatellar

technique which included external rotation of the femoral component and lateralization of patellar component. Lateralization and medialization were defined as placement of the lateral or medial edge of the cut surface of the bone respectively. The femur rotates internally in valgus knee so anteroposterior cuts and the femoral components are in external rotation. Varus and valgus deformity was corrected by using extramedullary rod to restore functional mechanical axis. Every component was inserted with cement and patellar components were all-polyethylene (non-metal-backed). The patients who had good articular surface of patella but osteophytes caused problem with movement of patella over knee joint. In those cases resurfacing was not performed, and so-called patelloplasty was carried out, including removal of osteophytes and smoothening of fibrillated cartilage. The decision was made for patellar components to be revised or not taken from traditional indications for patellar resurfacing and non-resurfacing (table 3).

Table 3: Indications for patella resurfacing and non-resurfacing

Indications for resurfacing	**Indications for non-resurfacing**
Pre-operative anterior knee pain	Size of patella
Patellar malalignment	Good patellar cartilage
Old age	Congruent patellar tracking
Inflammatory arthropathy	Younger age
History of patellar sublaxation or dislocation	Patella baja/alta
Patellar articular cartilage loss	Good patient compliance
High-grade chondromalacia	Vascular compromise

All patients were managed with the same peri-operative regimen. Post-operatively, all patients were followed up on a time period. Patients were assessed clinically and radiologically according to the subtitles on the Modified Knee Scoring System. Patients from both groups were compared against each subheading. A statistical analysis was done instead of giving a score. By doing a non parametric test the p-value was calculated for every subheading. Depending on pain relief and general function post-operatively patient satisfaction was evaluated using the question i.e. how satisfied are you after knee replacement and the choices given were satisfied, unsatisfied and undecided.

RESULTS:

One hundred and ten patients were included in this study. Eleven patients had bilateral total knee replacements making a total of one hundred and twenty one knees. A total of 11 patients had bilateral knee replacements, 95 patients reached with five years follow up, making a total of 106 knees. Seven patients were excluded because they did not come for follow up after two years due to unavoidable circumstances. Lastly, 3 patients had post-operative infection and 5 patients were deceased due to their underlying pre-existing medical conditions. Therefore a total of 106 knees were followed up for an average of five years.

Statistical Analysis: Thirty nine percent (39%) of total patient (106) underwent patellar resurfacing and sixty seven percent (67%) among total number of patient

did not have resurfacing as part of total knee arthroplasty procedure. Pre-operative knee scores are discussed below under different subheadings:

Pre-op Level of pain p=0.85 (WR-MW Test)	**Resurfaced**	**Non-Resurfaced**
None	0	0
Mild-no relation with activity	0	0
Mild on stairs	0	0
Mild on any motion	2(5%)	0
Moderate-occasional	7(18%)	5(8%)
Moderate-continuous	6(15%)	31(46%)
severe	24(62%)	31(46%)

Pre-op Visual analogue score p=0.54 (WR-MW Test)	**Resurfaced**	**Non-Resurfaced**
Zero	0	0
One	0	0
Two	0	0
Three	0	0
Four	0	1(2%)
Five	2(5%)	0
Six	2(5%)	1(2%)
Seven	7(18%)	19(28%)
Eight	26(67%)	36(54%)
Nine	2(5%)	10(14%)
Ten	0	0

Pre-op Time when pain is worst p=0.18 (WR-MW Test)	**Resurfaced**	**Non-Resurfaced**
All the time	5(13%)	12(18%)
Sitting down	3(8%)	8(12%)
Stairs	3(8%)	4(6%)
Walking	22(56%)	39(58%)
Walking uphill	6(15%)	4(6%)

Pre-op Analgesia for pain p=0.63 (WR-MW Test)	**Resurfaced**	**Non-Resurfaced**
Never	1(3%)	2(3%)
Occasionally	5(13%)	10(15%)
One to three times/day	9(23%)	17(25%)
More than three times/day	24(61%)	38(57%)

Pre-op Ability in stairs p=0.57 (WR-MW Test)	**Resurfaced**	**Non-Resurfaced**
Normal up and down	2(5%)	4(6%)
Normal up, down with rails	2(5%)	3(5%)
Up and down with rails	33(85%)	53(79%)
Unable	2(5%)	7(10%)

Pre-op Walking aids use p=0.99 (WR-MW Test)	**Resurfaced**	**Non-Resurfaced**
None	10(26%)	18(27%)
One stick	26(66%)	43(64%)
Two sticks	3(8%)	4(6%)
Crutches or frame	0	2(3%)
Unable to walk	0	0

Pre-op Walking distance p=0.79 (WR-MW Test)	**Resurfaced**	**Non-Resurfaced**
Unlimited	0	0
Upto 1 mile/half an hour	0	1(2%)
Upto half a mile	1(2%)	5(7%)
Upto a quarter mile	33(85%)	47(70%)
House bound	5(13%)	14(21%)
Unable	0	0

Pre-op Range of motion p=0.55 (WR-MW Test)	**Resurfaced**	**Non-Resurfaced**
70-79 degrees	3(8%)	4(6%)
80-89 degrees	4(10%)	2(3%)
90-99 degrees	18(46%)	27(40%)
100-109 degrees	10(26%)	16(24%)
More than 110 degrees	4(10%)	18(27%)

Pre-op AP instability p=0.45 (WR-MW Test)	**Resurfaced**	**Non-Resurfaced**
Normal (<5mm)	39(100%)	66(99%)
5 to 10mm	0	1(1%)
>10mm	0	0

Pre-op ML instability p=0.45 (WR-MW Test)	**Resurfaced**	**Non-Resurfaced**
Normal (<5mm)	39(100%)	66(99%)
5 to 10mm	0	1(1%)
>10mm	0	0

Pre-op Alignment p=0.22 (WR-MW Test)	**Resurfaced**	**Non-Resurfaced**
Normal	23(59%)	30(45%)
Varus	12(31%)	30(45%)
Valgus	4(10%)	7(10%)

The null hypothesis for the above mentioned tests is 'there is no difference between resurfaced and non resurfaced group in pre-operative scores (H_o = resurfaced = non- resurfaced)'. By using simple interactive statistical analysis we found that all the subheadings have non-significant p-value.

Post-operative results are discussed below similarly by using Wilcox rank sum test-Mann Whitney U variant because the distribution was non-normal.

Post-op Level of pain p=0.85 (WR-MW Test)	**Resurfaced**	**Non-Resurfaced**
None	25(64%)	44(66%)
Mild-no relation with activity	4(10%)	10(15%)
Mild on stairs	2(5%)	0
Mild on any motion	2(5%)	2(3%)
Moderate-occasional	2(5%)	3(4%)
Moderate-continuous	3(8%)	6(9%)
severe	1(3%)	2(3%)

Post-op Visual analogue score p=0.93 (WR-MW Test)	**Resurfaced**	**Non-Resurfaced**
Zero	25(64%)	43(64%)
One	0	2(3%)
Two	2(5%)	3(4%)
Three	4(10%)	5(8%)
Four	0	2(3%)
Five	3(8%)	6(9%)
Six	2(5%)	0
Seven	2(5%)	1(2%)
Eight	0	3(4%)
Nine	1(3%)	2(4%)
Ten	0	0

Post-op Time when pain is worst p=0.93 (WR-MW Test)	**Resurfaced**	**Non-Resurfaced**
Not applicable	27(69%)	45(67%)
All the time	1(3%)	7(10%)
Sitting down	1(3%)	0
Stairs	4(10%)	5(8%)
Walking	6(15%)	9(13%)
Walking uphill	0	1(2%)

Post-op Analgesia for pain p=0.66 (WR-MW Test)	**Resurfaced**	**Non-Resurfaced**
Never	24(62%)	40(60%)
Occasionally	6(15%)	5(7%)
One to three times/day	5(13%)	14(21%)
More than three times/day	4(10%)	8(12%)

Post-op Ability in stairs p=0.67 (WR-MW Test)	**Resurfaced**	**Non-Resurfaced**
Normal up and down	12(31%)	20(30%)
Normal up, down with rails	0	2(3%)
Up and down with rails	24(61%)	43(64%)
Unable	3(8%)	2(3%)

Post-op Walking aids use p=0.57 (WR-MW Test)	**Resurfaced**	**Non-Resurfaced**
None	18(46%)	25(37%)
One stick	15(38%)	33(49%)
Two sticks	3(8%)	5(8%)
Crutches or frame	2(5%)	4(6%)
Unable to walk	1(3%)	0

Post-op Walking distance p=0.43 (WR-MW Test)	**Resurfaced**	**Non-Resurfaced**
Unlimited	10(26%)	23(34%)
Upto 1 mile/half an hour	6(15%)	8(12%)
Upto half a mile	6(15%)	7(11%)
Upto a quarter mile	10(26%)	22(33%)
House bound	5(13%)	6(9%)
Unable	2(5%)	1(1%)

Post-op Range of motion p=0.29 (WR-MW Test)	**Resurfaced**	**Non-Resurfaced**
70-79 degrees	0	2(3%)
80-89 degrees	2(5%)	3(5%)
90-99 degrees	22(56%)	27(40%)
100-109 degrees	12(31%)	28(42%)
More than 110 degrees	3(8%)	7(11%)

Post-op AP instability	Resurfaced	Non-Resurfaced
Normal (<5mm)	39(100%)	67(100%)
5 to 10mm	0	0
>10mm	0	0

Post-op ML instability	Resurfaced	Non-Resurfaced
Normal (<5mm)	39(100%)	67(100%)
5 to 10mm	0	0
>10mm	0	0

Post-op Alignment p=0.84 (WR-MW Test)	Resurfaced	Non-Resurfaced
Normal	36(92%)	61(91%)
Varus	0	1(1%)
Valgus	3(8%)	5(8%)

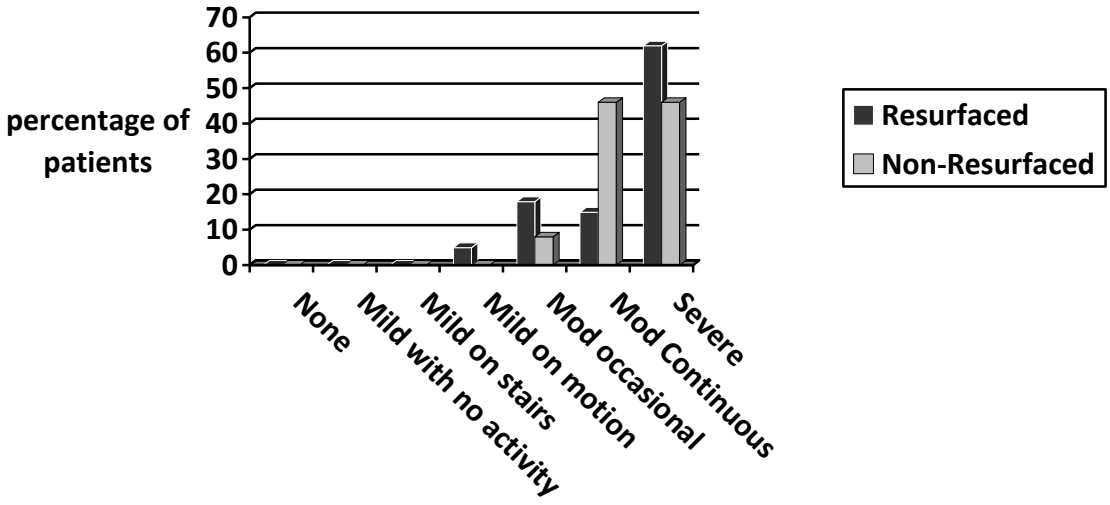
So, there is no significant difference post-operatively between two Resurfaced and Non-Resurfaced groups.

GRAPHICAL REPRESENTATION OF RESULTS:

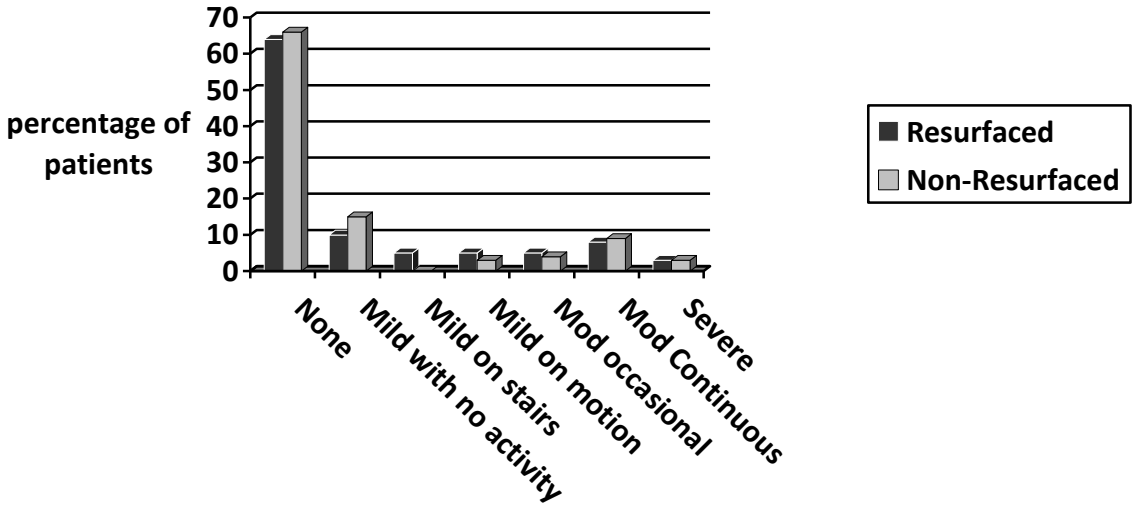
Pre-operative and post-operative results are discussed below:

Graph 1: Level of pain

Pre-operative p=0.85



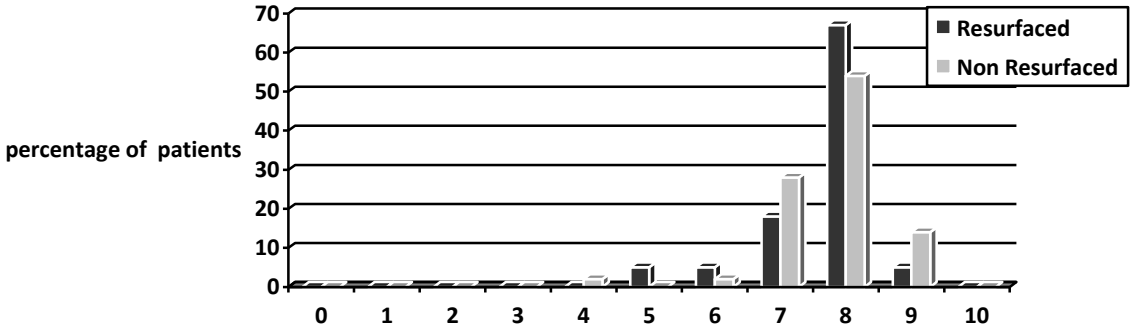
Post-operative p=0.85



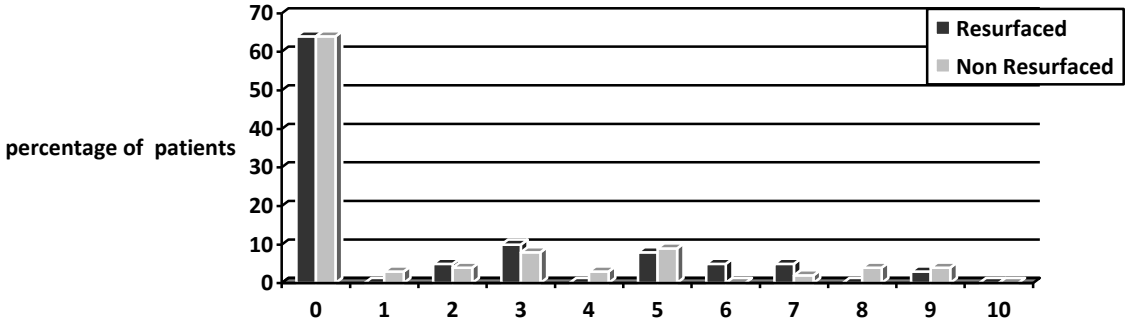
Pre-operatively, 62% patients (Resurfaced group) were in severe pain whereas 46% patients (Non Resurfaced group) were in moderate pain. Post-operatively, most of the patients moved to the no pain category. Statistically there was no significance p=0.85 in both groups.

Graph 2: Visual analogue score

Pre-operative p=0.54



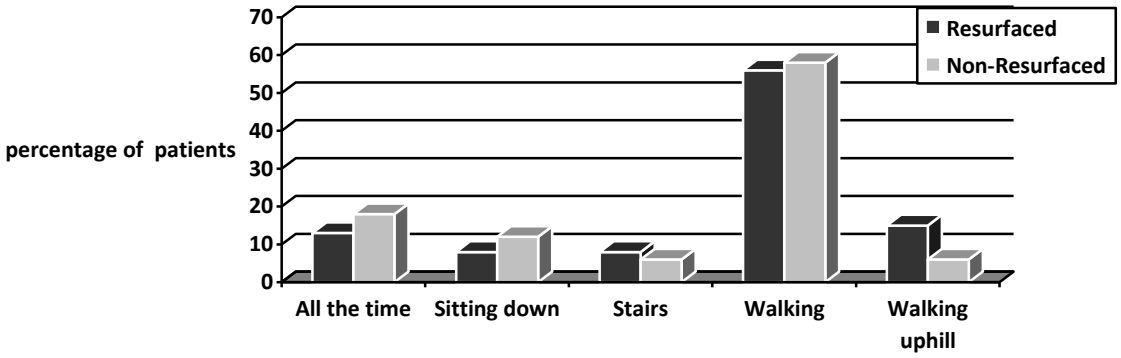
Post-operative p=0.93



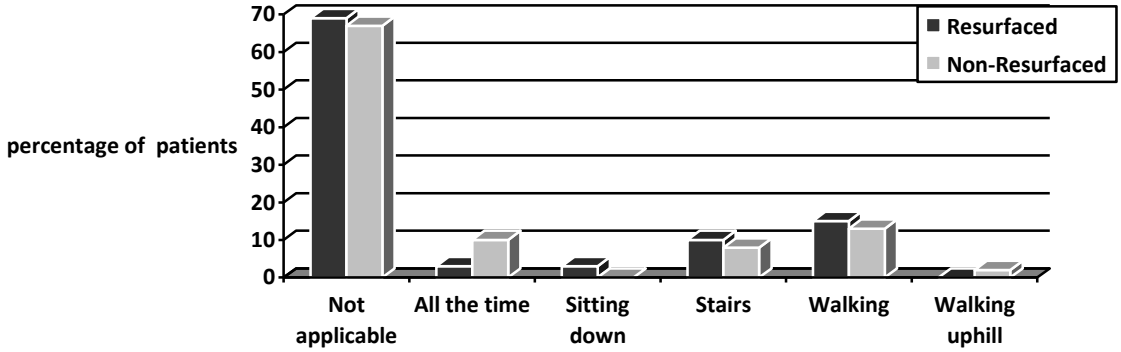
In this category, 67% patient from Resurfaced group had pain level of eight and 54% in Non-Resurfaced group pre-operatively. Post-operatively there were no patients at level zero. Statistically there was no significant difference pre-operatively (p=0.54) and post-operatively (p=0.93).

Graph 3: Time when pain is worst

Pre-operative p=0.18



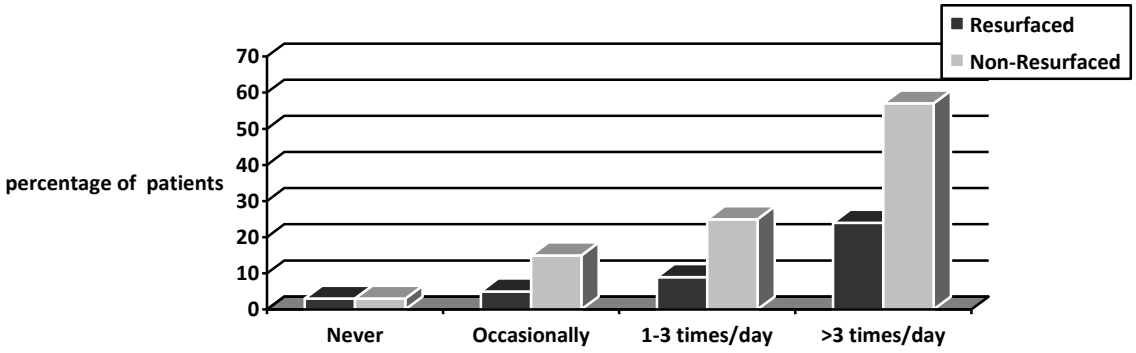
Post-operative p=0.93



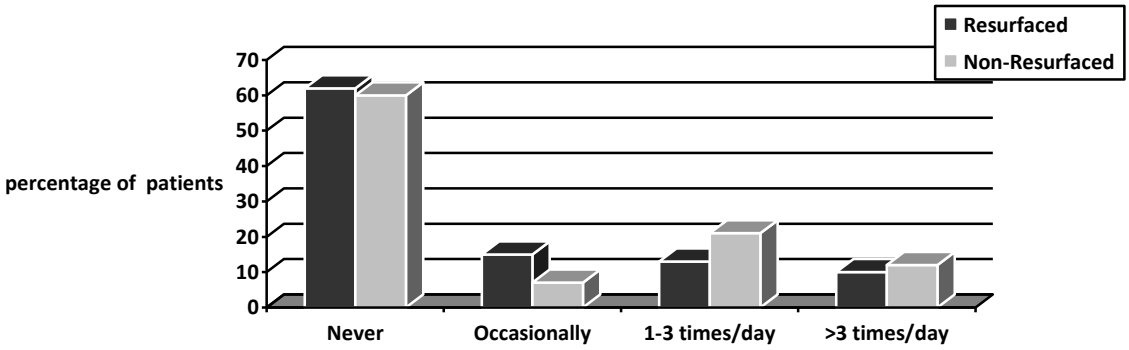
Both Resurfaced and Non-resurfaced groups showed no significant difference pre- and post-operatively. Pre-operatively, 56% and 58% patients had pain while walking in Resurfaced and Non-Resurfaced groups respectively. Post-operatively, majority patients had no pain 69% and 67% in Resurfaced and Non-resurfaced groups.

Graph 4: Analgesia for pain

Pre-operative p=0.63



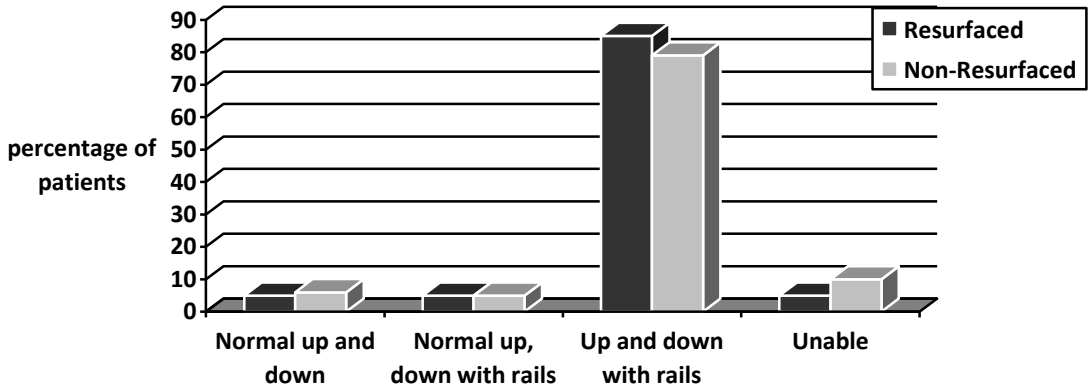
Post-operative p=0.66



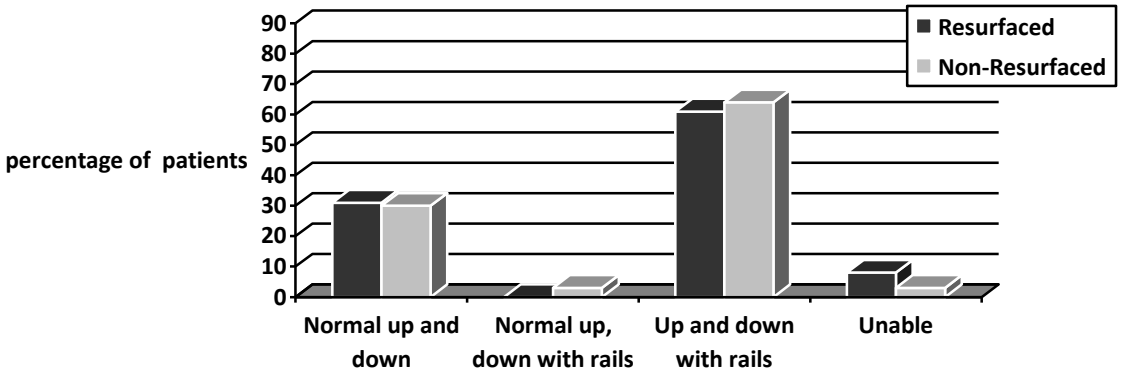
Pre-operatively, 61% in Resurfaced group and 57% in Non-Resurfaced group were taking analgesia more than 3 times a day. Post-operatively, 62% and 60% patients were not taking any analgesia in Resurfaced and Non-resurfaced group respectively. More than 10% in both groups were still taking analgesia more than 3 times per day due to other arthritic problems. In this category, there was no significant difference between the two groups.

Graph 5: Ability in stairs

Pre-operative p=0.57



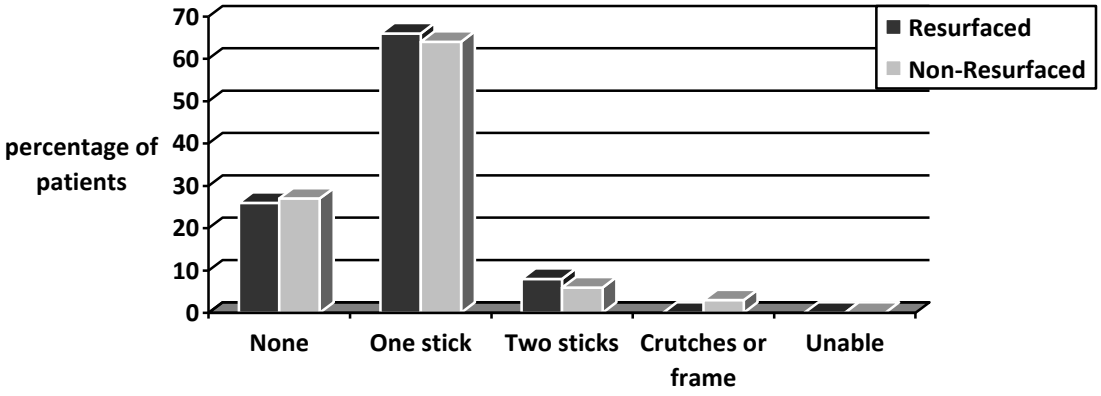
Post-operative p=0.67



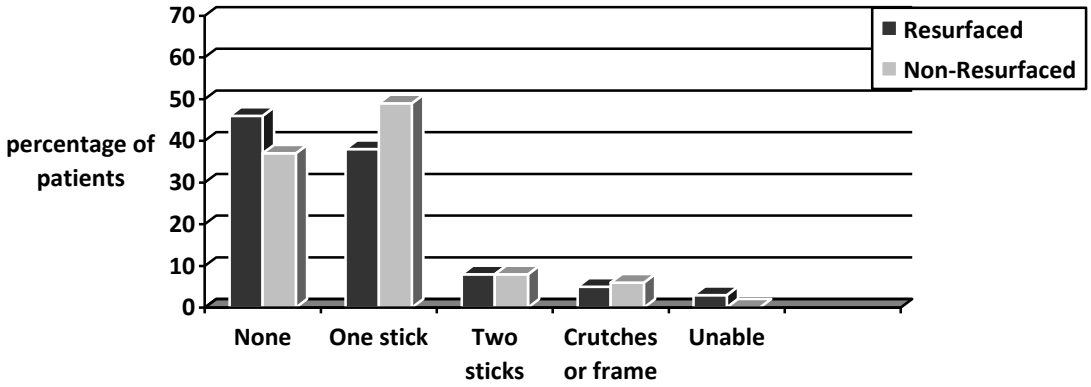
Pre-operatively, 5% patients from Resurfaced group and 6% patients from Non-resurfaced group were able to walk normally. Post-operatively, ability in stairs with rails for going up and coming down was 61% in Resurfaced and 64% in Non-Resurfaced groups. So, ideally in post-operative period the value falls into (61-5)=56% and (64-6)=58% in Resurfaced and Non-Resurfaced groups. Statistically, there was no significant difference.

Graph 6: Walking aids

Pre-operative p=0.99



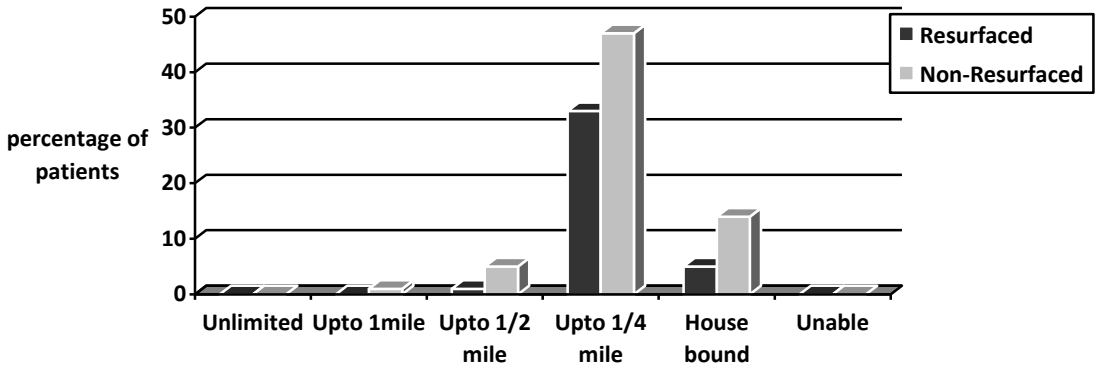
Post-operative p=0.57



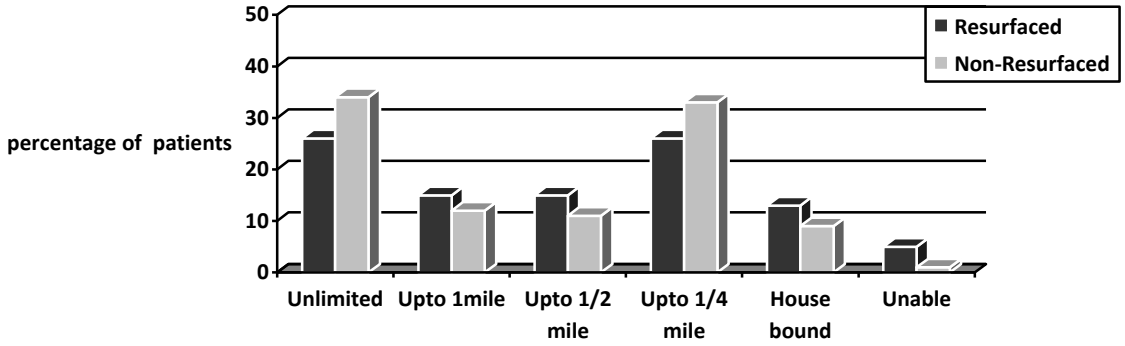
In Resurfaced group, patients using one stick to walk dropped from 66% to 38% pre-operatively and in Non-Resurfaced group, it was from 64% to 49%. Patients who were not using any walking aids showed improvement in both groups. In Resurfaced group it was (46-26)=20% and in Non-Resurfaced group it was (37-27)=10% post-operatively. Again, there was no significant difference statistically.

Graph 7: Walking distance

Pre-operative p=0.79



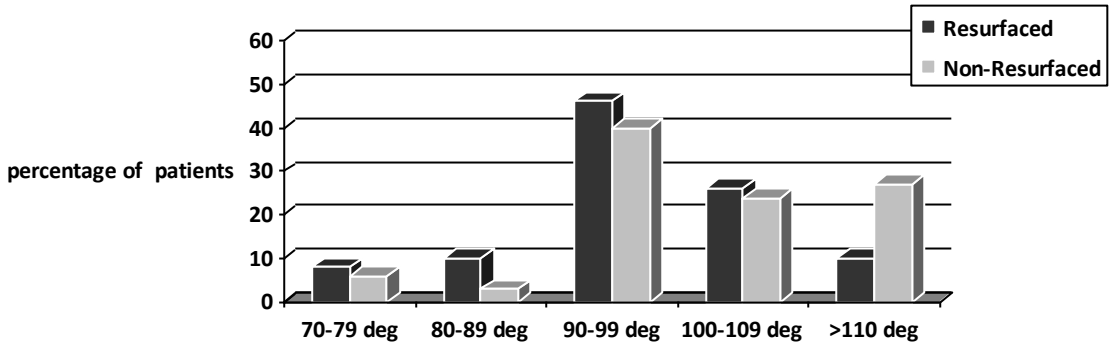
Post-operative p=0.43



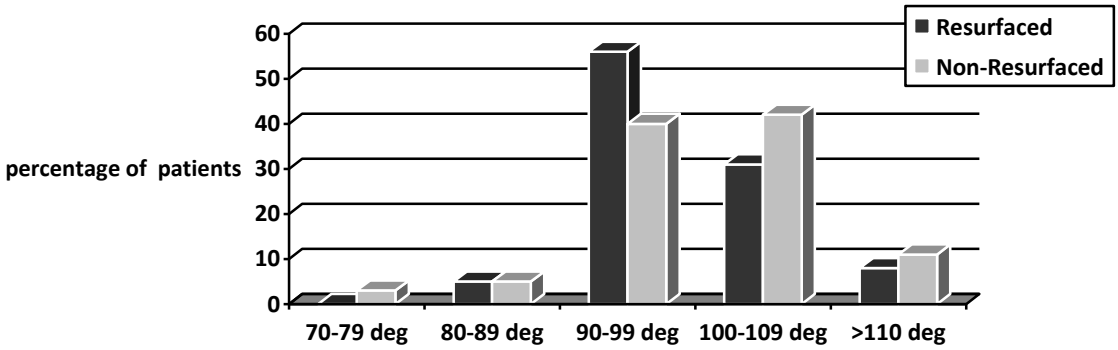
Here pre-operatively, 85% and 70% patients were able to walk quarter of a mile in Resurfaced and Non-Resurfaced groups. Post-operatively the same groups showed 26% and 33% respectively. Thirteen percent of patients in Resurfaced group and 9% in Non-Resurfaced group were house bound post-operatively in comparison to 13% in Resurfaced group and 21% in Non-resurfaced group. Statistically there was no significance between the groups.

Graph 8: Range of motion

Pre-operative p=0.55



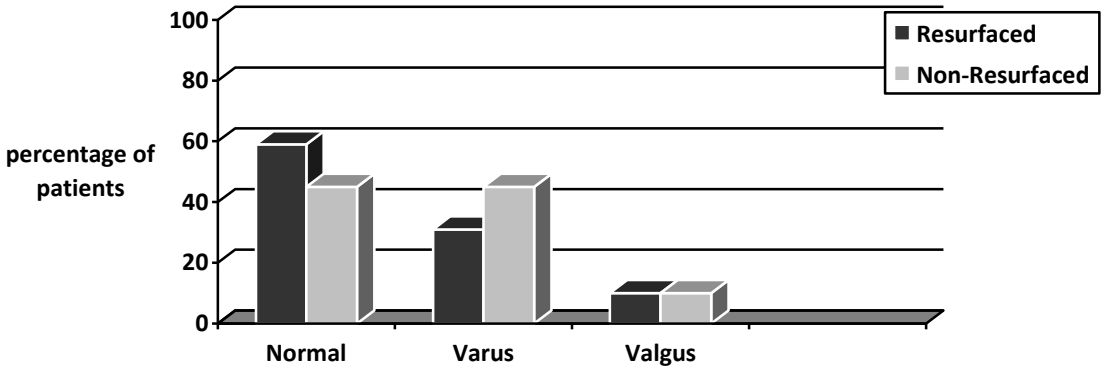
Post-operative p=0.29



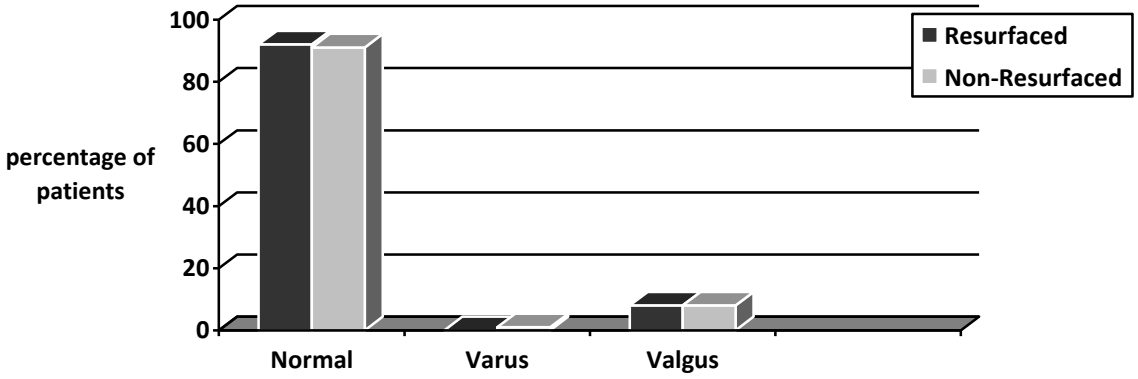
Statistically there was a significant difference between two groups pre-operative p=0.55 and post-operative p=0.29. Pre-operatively in both groups had a range of motion greater than or equal to 90 degrees 82% (46+26+10) in resurfaced group and 81% (40+24+27) in Non-Resurfaced group. Post-operatively, it was gone up to 95% (56+31+8) and 93% (40+42+11) in Resurfaced and Non-resurfaced group respectively.

Graph 9: Alignment

Pre-operative p=0.22



Post-operative P=0.84



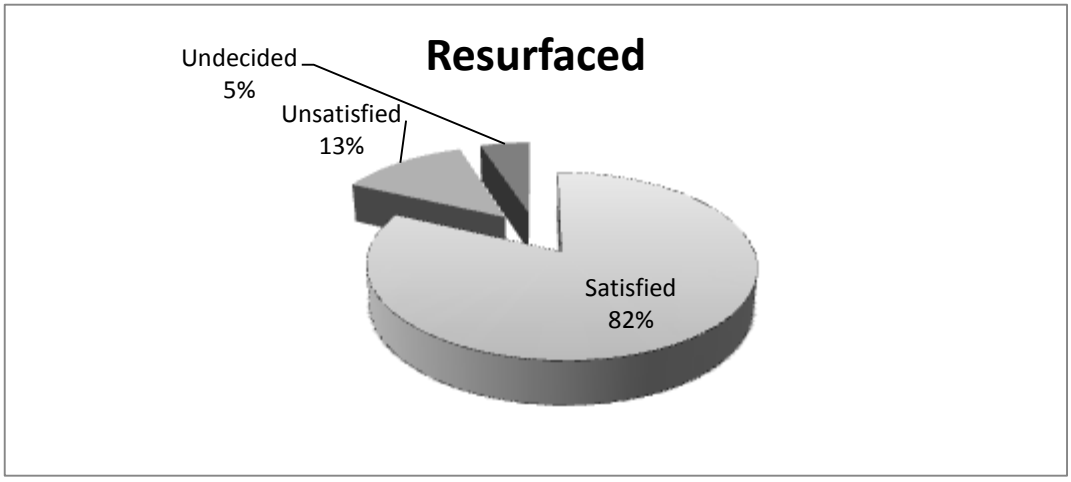
The alignment measured against the mechanical axis in both AP and ML planes. Post-operatively, there were no Antero posterior and Medio lateral instability. Pre-operatively (p=0.22) and post-operatively (p=0.84) there was no significance between the two groups.

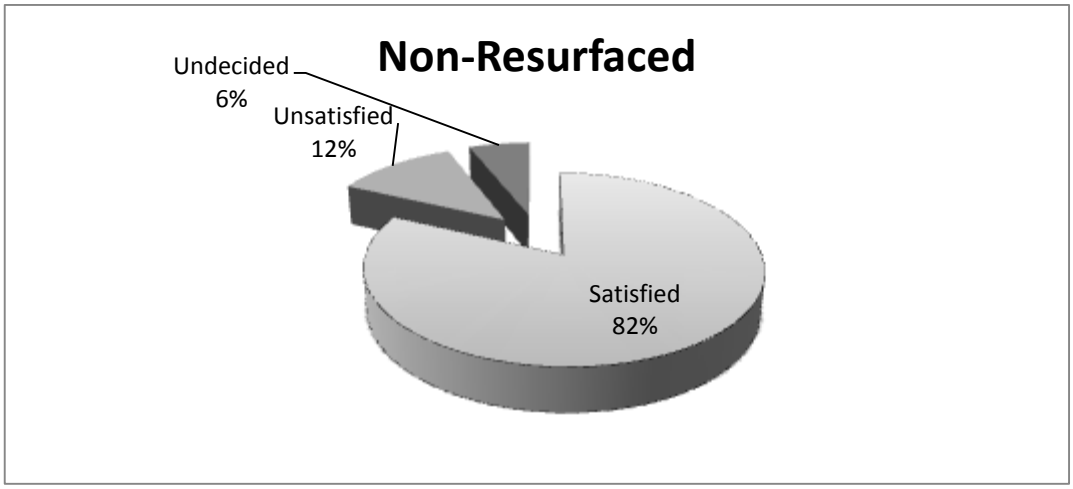
DISCUSSION:

Total knee replacement is an established surgical procedure. With the increase of survival rates of knee arthroplasty, patellar complications are also increasing such as anterior knee pain, impingement, and secondary damage to patellar articular surface. In contrary, patients who had patellar resurfacing can lead to reduce survival rate because of wear, loosening of the implant, fractures, osteonecrosis of the patella, increase of chance of infections and sublaxation of patella. Literature suggests complications after resurfacing the patella in total knee replacement depend on four main categories; these are patient factors, design factors, surgical techniques and material properties (Smith, Wood, & Li 2008).

In this observational study, 106 patients underwent total knee replacement with or without patella resurfacing. The main indication was pain relief due to osteoarthritis. Operation was done by fully trained specialist orthopaedic surgeon. Thirty nine patients had patella resurfaced and 67 patients did not have patella resurfaced. Patella resurfaces and not to resurface decision were justified in the best interest of patients by the Orthopaedic surgeons. All patients were evaluated under different subheadings of Modified knee Scoring System. Different categories were analyzed statistically and calculated p-value. We did not find any differences statistically in pain, mobility and alignment. Previously published literature suggests that patella resurfacing reduce the anterior knee pain (Waters & Bentley 2003), we found that post-operatively, 64% from resurfaced and 66% from non resurfaced groups moved into ‘no pain’ grade. In terms of stair climbing,

both groups showed no significant difference. Lastly to find out the clinical outcome in patients' perspective, patient satisfaction questionnaire was analyzed. From the patient satisfaction questionnaire it was clear that 82% patients were satisfied irrespective of whether the patella was resurfaced or non-resurfaced. Only 5-6% patient population was doubtful and 12-13% patient were unsatisfied.





There was no significant difference in patient satisfaction between the two groups P=0.04.

CONCLUSION:

Based on this observational study the result is almost same regardless of whether patella had been resurfaced or not. This result may be specific to some extent as because of the use of same prosthesis and the surgical techniques were used. However, there can be no definite conclusion because of many confounding factors such as component designs, surgeon experience and surgical techniques.

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