

Navigation v conventional techniques for orthopaedic surgery



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Bone Cutting, Soft Tissue Balancing; Cup Implant, Leg Length Discrepancy:
Navigation vs. Conventional technique.

Introduction

In last decade, navigated implantation has become very popular and used in diverse areas of orthopaedic surgeries. This may be in total knee prosthesis, total hip arthroplasty and to restore leg discrepancies. All above surgeries require an accurate alignment of the implant, which is essential for implants long term survival. This is evident from the fact that in total knee replacement (TKR) surgeries proper bone cutting is necessary [1], total knee arthroplasty (TKA) requires correct soft tissue balancing [2], appropriate implantation of cup and stem in total hip arthroplasty (THA) [3], correcting leg discrepancies in total hip replacement (THR) [4]. Navigation system developed improves the reproducibility over conventional methods and assists surgeons with data for optimal position of implant to each individual patient. [2, 3]

It was hypothesized that navigation assisted technique would result in achieving bone cut accuracy, better soft tissue balancing, good implant of cup and stem and enhanced joint reconstruction and control in leg length discrepancy as compared to conventionally used methods.

Methods

To test positioning time and bone cut accuracy in total knee replacement (TKR).

Study involved 40 patients (23 females, 17 males) assigned randomly to TKR surgery using either conventional (n= 20, mean patient age= 67. 3 years) or Pivotal (n= 20 mean patient age= 69. 1 years) cutting blocks. Primary indication for surgical treatment was osteoarthritis (n= 36), rheumatoid arthritis (n= 3) and secondary posttraumatic gonarthrosis after tibial plateau fracture (n= 1). All cases had posterior stabilized system with standard patellar component. The surgical approach used was medial parapatellar (n= 8) or midvastus (n= 32) approach. The implants used during the process were Scorpio PS (n= 7), Scorpio Flex (n= 20), Next Gen LPS (n= 10) and LPS Flex Mobile bearing systems (n= 4) fixed to bones by pins and screws. Accurate positioning was obtained by using navigation system. Block position was finalized by surgeon using this navigation system. Statistical differences in time and cut angles were measured by Mann-Whitney test (two-tailed; SPSS for Windows, Version 11. 5). The significance level was set at $p \leq 0. 05$ for all analyses. [1]

To test soft tissue balancing in total knee arthroplasty (TKA).

The study included 120 patients [navigation assisted gap-balancing (n= 60); conventional resection technique (n= 60)], enrolled and randomized using computer-generated numbers. An inclusion criterion was substantial pain and loss of function due to osteoarthritis of knee, with any degree of genu varum deformity. An exclusion criterion was genu valgum deformity, earlier knee surgery that required removal of metallic implant, or revision of TKA. Four patients were lost to follow up and therefore excluded from study. All surgeries were done by single surgeon. Both patient groups showed no significant differences in terms of demographic characteristics, knee <https://assignbuster.com/navigation-v-conventional-techniques-for-orthopaedic-surgery/>

functions, preoperative hospital-for-special-surgery (HSS) scores and degree of preoperative deformity. Follow up period was minimum 24 months post-surgery (mean follow up = 28 months). Surgical technique was similar in all patients consisting of midline skin incision and a medial parapatellar approach. Gap measurement was done at full extension and at 90° of flexion on medial and lateral sides of knee joint and defined as medial extension gap (MEG), medial flexion gap (MFG), lateral extension gap (LEG), and lateral flexion gap (LFG). Clinical outcome assessment was measured by HSS and ranges of motion (ROM) scores at latest follow up. All patients went through pre and post-operative (3months after surgery) standing radiographic assessment of AP and lateral views of entire lower limb. Student's t-test or Mann-Whitney U tests was used for comparison of four variables in study, postoperative post-operative mechanical axes, HSS scores, and ROMs, between the two groups. The chi-square test was used for comparison of proportion of outliers (trapezoidal gaps) in symmetric gap and mechanical axis. [2]

To Test good implant of cup and stem in Total Hip Arthroplasty (THA)

The study involved 84 patients in two groups Navigated (42) & Nonnavigated (42), with surgeries performed by investigator. Implant position was evaluated in post-operative anteroposterior radiography 2-3months after index surgery. Pelvic radiographs were taken in standing position of patient. Operated hip joints classified on basis of preoperative radiographs in three subgroups: Group 1: preoperative leg shortening (> 5 mm); Group 2: preoperative leg length equality (± 5 mm); Group 3: preoperative lengthening of the operated leg (> 5 mm). Projected values for caput collum
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diaphysis (CCD) classified in three subgroups: $< 125^\circ$, $125^\circ - 135^\circ$, $> 135^\circ$. If any change in leg length was measured using distal line between teardrop figure and proximal corner of the lesser trochanter as an anatomical landmark. Scaling of pre and post-operative radiographs was distance between two teardrops and the head diameter of the hip replacement. Radiographic cup positions were measured for inclination with respect to teardrop line. All surgeries were done when patient was in 30° to 45° position. Any complication aroused during intraoperative and post operation was documented. General data (CCD angle, age, BMI) for both groups were compared as per Mann-Whitney U test for nonparametric values and chi-square test for distribution of operated leg, gender and indication. [3]

To Test enhanced joint reconstruction and control in leg length discrepancy

Retrospective study involved 44 patients divided in two groups A (n= 22; navigation/computer assisted THR) & B (n= 22; conventional free hand THR). Inclusion criteria involved patients with BMI < 35 who had undergone short-stemmed femoral component in the past. . Patients with hip dysplasia, limb length discrepancy (> 2 cm), or a major deformity of the femoral head or neck were excluded from study. Each patient in group A was matched in group B. This matching was done on basis of age (max difference +3 years), sex, arthritis level, preoperative diagnosis, and preoperative limb length discrepancy (max difference. + 0. 3 cm). The length of involved limbs was less than or equal to that of the contralateral limb in all cases. The two groups were also compared according to hip function and number of postoperative dislocations. The same posterolateral approach was made to the hip joint in both groups, and the same prosthesis was used in all cases. <https://assignbuster.com/navigation-v-conventional-techniques-for-orthopaedic-surgery/>

The duration of surgery was documented. Digital radiographs (*as per standardised protocol using same magnification*) were used for pre and post-operative measurements of limb length discrepancy and femoral offset. Radiographs were repeated if any mistake detected and these radiographs were assessed by independent radiologist blinded to original procedure. All episodes of hip dislocation were documented. At minimum follow-up of 3 months clinical outcome was evaluated using Harris Hip score. Statistical analysis was carried out using SPSS for Windows Release 11. 0. Differences between two groups were measured using independent Student's t-test or Mann-Whitney nonparametric test depending on the data distribution of the continuous variables. [4]

Results

Pivotal block consumed approximately half the time to adjust saw blade and perform proximal tibial and anterior and femoral resections as compared to conventional block. Statistically significant difference was observed in Pivotal and conventional blocks with respect to angular difference between instrument slots and resultant bone cuts in frontal plane. Also, Pivotal blocks eliminated angular differences $> 1^{\circ}$. [1]

The mean intraoperative gap in conventional resection technique group for MFG (medial flexion gap) was significantly greater (24 ± 3 mm) than navigation assisted (NA) gap-balancing (22 ± 3 mm) ($p = 0.028$), but other three gaps (LFG, MEG, and LEG) did not differ significantly between the two groups ($p = 0.167, 0.693, \text{ and } 0.471$, respectively). Statistical significant difference was seen in terms of kind of gaps in both groups: NA group, 88%

(53 knees) -rectangular gaps and 12% (7knees)-trapezoidal gaps. Whereas in conventional group 75% (42 knees) -rectangular gaps and 25% (14knees) had trapezoidal gaps. Greater difference in medial gap difference (MGD; MFG-MEG) outliers in conventional group (23%) than NA group (5%) ($p = 0.025$). No difference was noticed in average postoperative mechanical axis of lower limb between NA and conventional group ($1\text{á}\mu' \pm 2\text{á}\mu'$ vs. $1\text{á}\mu' \pm 3\text{á}\mu'$; $p = 0.558$). Greater number of outliers were seen in mechanical axis ($> 183\text{á}\mu'$ or $< 177\text{á}\mu'$) for conventional group [27% (16knees)] ($p = 0.012$) than that of NA group [8% (5knees)]. The median HSS scores in the NA and conventional groups were 89 (range 64–98) and 87 (range 60–100), respectively ($p = 0.738$) and mean ROMs were $123\text{á}\mu'$ (range $105\text{á}\mu'$ – $145\text{á}\mu'$) and $122\text{á}\mu'$ (range $100\text{á}\mu'$ – $150\text{á}\mu'$) respectively ($p = 0.835$). In all patients there was no correlation between preoperative deformity and postoperative restoration of mechanical alignment ($p = 0.083$, $p = 0.347$). [2]

Statistical difference was noted in patient's age at time THA, with p value slightly below 0.05. Significant difference was seen during radiologic analysis of cup position {Non-navigated: 53° , SD 8.1; Navigated: 44° , SD 5.6, $p < 0.001$ }. Radiologic inclination was reduced by average of 8° by navigation method, whereas radiologic ante version {Non-navigated: 7° , SD 4.6; Navigated: 12° , SD 5.3, $p < 0.001$ } increased by 6° . The number of cup positions in safe zone as defined by radiographic inclination/ante version of $45^\circ/15^\circ \pm 10^\circ$ also relatively improved by navigation method (38 of 42, 90%, $p < 0.001$) as compared to non-navigation method (21 of 42, 50%). No significant difference was seen in post-operative values of change of limb

length of operated hip (Matt Whitney U test $P= 0.7$) in either methods [Non-navigated: mean leg lengthening 9.2 mm, SD 6.2 mm; Navigated: mean leg lengthening 8.5 mm; SD 5.4]. Also, post-operative leg length difference to non-operated hip was 6.2 mm (SD 9.0) for non-navigated and 4.4 mm (SD 6.4) for navigated. As per preoperative classification of pre-existing leg length difference, slight decrease of intraoperative leg lengthening in navigated technique was noted (± 5 mm: Non-navigated: +10.7mm; Navigated: +7.6mm). Increased leg length for smaller CCD angles ($<125^\circ$) was observed (Non-navigated: +8.0mm; Navigated: +10.8mm), whereas this was not seen in CCD angles of 125° - 135° and $> 135^\circ$. No implant related or navigation technology related complications and no joint dislocations in both groups were noted. [3]

There was no statistically significant difference in patient demographics. In both groups preoperative limb length discrepancy, no significant differences were noted. (0.9 cm navigation/computer assisted THR vs. 1.1cm free hand/conventional THR). Mean surgical time was 102.6 min, comparatively longer in navigation/computer assisted THR than free hand/conventional THR (87.7 min) Statistically significant difference was seen in mean postoperative leg length discrepancy of 0.4 cm in navigation/computer assisted THR to that of 0.8 cm (free hand/conventional THR). There were no cases of postoperative cases with leg length discrepancy > 1.0 cm & > 2.0 cm for navigation/computer assisted THR. However, in 9% cases (2patients) postoperative cases with leg length discrepancy > 1.0 cm was noted and 3patients (13.6%) had postoperative over lengthening mean of 0.4 cm in Free hand/conventional THR group. Recreation of femoral offset better in

navigation/computer assisted THR than free hand/conventional THR group. Preoperative and postoperative femoral offset difference less in navigation/computer assisted THR than free hand/conventional THR, which was statistically significant. No statistically significant differences in Harris Hip Score in both groups. [4]

Discussion

The comparison of patient groups in navigated and non-navigated techniques may be a possible method for obtaining useful information regarding various orthopaedic surgeries. In our studies long term survival of prosthesis can be improved by accurate positioning of implant. This can save time and improve accuracy of the procedure.

Klima, 2008 showed pivotal blocks used during surgery improved bone cuts and reduced time for positioning and adjustment by nearly 50%. In addition, navigation technique used allowed initial positioning to be achieved in 5-10 seconds. Also, navigation system indicated that all patients were within 3° in frontal plane angular bone cut deviations of ideal mechanical axis.

Conventional blocks used were found to be associated with some degree of motion during insertion of pins, but this was not the case with pivotal blocks. [1]

Lee. et al, 2010 showed, soft tissue balance can be achieved by having equal extension and flexion gaps after bone cutting and no inclination between medial and lateral bony surfaces. Any error in bone cutting can affect overall postoperative mechanical alignment and quickening of wear process. In study it was found that use of navigation guided gap balancing technique <https://assignbuster.com/navigation-v-conventional-techniques-for-orthopaedic-surgery/>

improved in creating accuracy of rectangular space between bones as compared to conventional measured resection technique. Only 12% (7 of 60 patients) in navigation TKAs had outliers of > 3mm either medially or laterally in extension gap or 90° flexion were seen as compared to conventional TKAs (25%) [14 of 56 patients]. As compared to earlier studies, this study had outliers of the medial and lateral compartments together. There was no significant gap differences (FGD, EGD, and LGD) in both navigation assisted and conventional groups, in spite of that navigation guided technique proved to be more reliable in attaining equal joint gaps as there were small proportion of outliers in that group. Significant difference was seen in medial gap difference (MGD) in two groups. There were limited outliers in MGD observed and moreover navigation technique can be easily reproduced as compared to conventional technique, so this prevents unnecessary any over release of medial soft tissue during TKA. In addition, navigation system helped surgeon in correcting any kind of deformed alignment. Clinical outcomes were similar to both groups even though navigation group showed more accurate gap balancing than conventional group. This can be attributed to the fact that relatively small amount of asymmetry in soft tissue balancing in conventional group. Also, both groups had relatively short term follow up and inaccurate scoring system. The study had several limitations: during gap measurement patella was in laterally everted position, which is not anatomically correct. Ligament balancing was not taken in consideration. Gap measurements was done by surgeon who performed operation in the study, this may have led to bias. [2]

In a study by Mainard, 2008 showed that comparing navigated and non-navigated techniques can lead to information about benefits and any improvement required for position of implant. In this study, there was a clear and significant improvement of acetabular cup positioning by use of THA navigation. In both methods average total limb lengthening of operated joint was below 10mm (9.2 mm Non-navigated, 8.5 mm Navigated), i. e. below clinical relevance value and comparable to other studies (mean lengthening 7mm). Mean post-operative limb discrepancy is close to 5 mm (6.2mm Non-Navigated; 4.4mm Navigated) comparable to 3.9 mm in other study with patient pool of 420. This study however had several limitations: retrospective in nature; Measurements of implant position are less accurate than CT based measurements; Radiologic and ante-version taken in standing positions with anteroposterior radiographs (not to exceed deviation of 5 mm compared with CT); Limb length data of un-operated hip joint is small (+ 1.3 mm-navigated; -1.3mm - nonnavigated); Cup position measurements unimproved as patients radiograph is not in standing position; No change in leg lengthening data using navigated or non-navigated technique. [3]

In a study by Confalonieri, et al, 2008 showed that to resurface hip arthroplasty short stem prostheses is an attractive alternative option with same selected indications. In this study 22 patients in each group were match paired using same modular short stemmed femoral component. Strict criteria were adhered to achieve the match. At minimum follow up of 3 months after surgical intervention results showed computer navigation provided better results in correction of limb length discrepancy and restoring original offset. However, there were few limitations associated with the

study: Retrospective; patients were not randomized; short follow up; small number of cases in each group (hence, no clinical difference detected and findings for improvement in dislocation risk). [4]

Conclusion

From above studies it can be concluded that given correct indications navigation guided technique is a minimally invasive surgical option and is significantly better than conventionally used technique in orthopaedic surgeries which proves our original hypothesis. Though it might take a little longer time but can give better and improved results in bone cutting, soft tissue balancing, acetabular implant and correction of limb length discrepancy and restoring original offset depending on patient anatomy. Further research in this area is still directed.

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