Outpatient Joint Arthroplasty—Working and Rising through the Pitfalls and Challenges

Dr Ranjana Khetarpal¹, Dr Veena Chatrath², Dr Anjan Trikha³, Dr Rajesh Malhotra⁴

¹Professor, Department of Anaesthesia, Govt medical college, Amritsar, Punjab, India.
²Professor and Head, Department of Anesthesia, Govt medical College, Amritsar, Punjab, India.
³Professor, Department of Anesthesia, AIIMS, Delhi, India.
⁴Professor and Head, Department of Orthopaedics, AIIMS, Delhi, India.

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ABSTRACT

With innovative anaesthetic techniques and minimally invasive surgical procedures outpatient joint arthroplasty (OJA) is becoming a reality and has paved the way for a cost effective and safe pathway thereby reducing the burden on health care facilities. Outpatient arthroplasty risk assessment score (OARA) with its high predictive value and specificity can reliably identify patients who can undergo OJA. Properly implemented enhanced recovery protocols (ERAS) have reduced the length of hospital stay especially relevant in times of COVID-19. These pathways have made same day discharge possible with increased patient satisfaction without compromising the quality of care and patient safety.

Both neuraxial and general anaesthesia techniques appear to be equally effective. Opioid sparing multimodal analgesia and peripheral nerve blocks like adductor canal block along with interspace between popliteal artery and capsule of posterior knee block (IPACK) and local infiltration analgesia (LIA) have made early ambulation and physiotherapy possible in the immediate post operative period thereby improving the outcome of same day arthroplasty. It is essential to have a proper system in place for follow up of patients after discharge to monitor pain control, physiotherapy and address the apprehensions of patients as well as the family.

Methodology - The literature source for this review was obtained via PubMed, Medline, google scholar, Cochrane library, embase, using the keywords, we pooled results of articles discussing the journey of transition from inpatient arthroplasty to the present scenario of outpatient arthroplasty for the last 20 years. We searched 130 articles including randomized controlled trials, systemic reviews, meta-analysis, review articles and case series. Out of these 93 articles were selected and included in this review.

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Corresponding Author: Dr Ranjana Khetarpal, Professor, Department of Anaesthesia, Govt medical college, Amritsar, Punjab, India.
INTRODUCTION:
Traditionally Total Joint Arthroplasties (TJA) were done as inpatient hospital procedures which required multiple days of hospital admission due to various factors like post-operative pain, limited joint mobility, risk of infection and urinary retention. With the worldwide rise in geriatric population and life expectancy, the number of patients requiring Total Joint Arthroplasties (TJA) of knee and hip has increased significantly. The demand for Hip and Knee Arthroplasty in foreign population of age less than 65 years has been predicted to increase by more than 50% by 2030. Young patient population is likely to utilize costly infrastructure facilities thereby imposing an economic burden and increase workload on health care delivery system. Till now, TJA was not considered as an outpatient surgery due to considerable pain leading on to impaired ambulation and increased morbidity in the immediate post-operative period.

There is a paradigm shift from inpatient Total Joint Arthroplasties (TJA) to outpatient procedures leading on to shorter hospital stays. For the last two decades, clinical pathways have been developed which incorporate multiple strategies like opioid sparing multimodal analgesia to relieve pain, post-operative nausea and vomiting (PONV), taking care of nutrition of patient and early post-operative mobilization. Recent perioperative minimally invasive surgical techniques, the use of antifibrinolytics like tranexamic acid to minimize loss of blood and avoiding the use of urinary catheters have shortened the stay of patients in hospital, after joint replacement surgeries.

Providing optimal analgesia is a vital component of enhanced recovery and discharge from hospital. By incorporating a number of analgesic strategies including peripheral nerve blocks with motor sparing, periarticular nerve blocks and injections, getting the surgery done under regional anaesthesia, avoiding the use of opioids, patient’s recovery can be enhanced.

A comprehensive and well planned opioid sparing Enhanced Recovery after Surgery (ERAS) pathway for Primary Total Joint Arthroplasties is designed to consider patients for same day discharge, optimize clinical outcomes, provide patient satisfaction and curtail the overall cost of care without compromising the standard of care.

Patient Selection Criteria:
Proper selection of patients for OJA is of paramount importance to prevent long term stay in the hospital, detrimental effects and readmissions to the hospital. Patients are included in OJA program only if they are giving consent to undergo the procedure and get discharged on same day. Pre-operative education of the patient is also very important component, and there should be a relative or caretaker with the patient, who is to be involved maximally to inspire and support the patient as soon as he comes out of operating room. Various inclusion and exclusion criterias are enlisted in Table 1 and table 2 respectively.

<table>
<thead>
<tr>
<th>INCLUSION CRITERIA</th>
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<tbody>
<tr>
<td>1. ASA Grade I or II</td>
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<tr>
<td>2. Age &lt;70 years</td>
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<td>3. Haemoglobin &gt;10g/dl</td>
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<td>4. Care giver/Assistant present at home</td>
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<td>5. Primary unilateral Total knee or Hip arthroplasty</td>
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<td>6. Absence of fracture</td>
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<td>7. Independent ambulation of patient preoperatively without any support</td>
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(Table 1)
**Relative Contraindications for outpatient Total Joint Arthroplasties (Exclusion Criteria)**

Following factors are to be kept in mind while considering the patients for TJA:

<table>
<thead>
<tr>
<th>S.no</th>
<th>FACTOR</th>
<th>REMARKS</th>
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<tbody>
<tr>
<td>1</td>
<td>ASA Physical Status</td>
<td>More than 2 as these patients are at high risk of readmission after TJA.</td>
</tr>
<tr>
<td>2</td>
<td>Advanced Age</td>
<td>Age more than 70 years is a risk for complications and readmissions.</td>
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<tr>
<td>3</td>
<td>Chronic Liver disease/ Cirrhosis</td>
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<tr>
<td>4</td>
<td>Thrombocytopenia</td>
<td>&lt;75,000 is challenging.</td>
</tr>
<tr>
<td>5</td>
<td>BMI &gt;35kg/m²</td>
<td>Associated with postoperative complications, increased post-operative time and intraoperative blood loss.</td>
</tr>
<tr>
<td>6</td>
<td>Diabetes Mellitus</td>
<td>HbA1c &gt;8% is associated with worse outcomes.</td>
</tr>
<tr>
<td>7</td>
<td>Coronary Artery Disease</td>
<td>Patients with cardio pulmonary issues must be stable without angioplasty or coronary artery bypass grafting in the last 6 months.</td>
</tr>
<tr>
<td>8</td>
<td>COPD, Pulmonary fibrosis, carcinoma, pulmonary embolism</td>
<td>Increased risk of pulmonary complications.</td>
</tr>
<tr>
<td>9</td>
<td>Parkinson’s disease, CVA and peripheral neurological disorders</td>
<td>Increased risk for falls.</td>
</tr>
<tr>
<td>10</td>
<td>Chronic Opioid use / Substance Abuse</td>
<td>Chronic opioid consumption prior to TJA results in worse post-operative outcomes and long stays in the hospital, due to opioid induced hyperalgesia and increased demand for pain medications.</td>
</tr>
<tr>
<td>11</td>
<td>Smoking</td>
<td>Leads on to impaired wound healing, increased risk of periprosthetic infections and post-operative pulmonary complications.</td>
</tr>
<tr>
<td>12</td>
<td>Anaemia</td>
<td>Increased risk of infection and delayed discharge. Male patients with Hb &lt;12g/dL and females with Hb &lt;11g/dL should be excluded.</td>
</tr>
<tr>
<td>13</td>
<td>Coagulation disorders</td>
<td>Management of anticoagulants.</td>
</tr>
<tr>
<td>14</td>
<td>Chronic pain syndromes for example - Fibromyalgias</td>
<td></td>
</tr>
</tbody>
</table>
15. Atrial fibrillation, congestive heart failure, peripheral vascular disease

16. Severe Renal insufficiency, End stage renal disease
   - Serum creatinine more than 2mg/dL have a high risk for post-operative complications

17. Poor Social Support System
   - Inability to participate in pre-operative counseling due to lack of mental-capacity, lack of means of transportation and living at more than 1 hour distance from hospital

18. Obstructive Sleep Apnea

19. HIV/AIDS

20. Family history of Malignant Hyperthermia

21. History of falls

22. Unable to walk without walker pre-operatively

23. Bilateral Surgery and Revision Surgery is also contraindication.

Risk assessment gives the surgery and anaesthesia team, exact and current information about the patient’s risk of having complications in the perioperative period and feasibility of OJA. A joint coordinator or a case manager should be allocated to all the patients, who ensures that patients and surgeons requirements are being catered to. He must assess the home environment of the patient to make sure that the home care giver is proficient enough to attend to the needs of the patient in the first 2-3 days post-operatively. The use of information technology/software program can be helpful in this. He is also actively involved in counseling and rehabilitation to ensure that the patient is in the best possible preoperative condition.

OARA score assesses presence, severity and extent of optimization of medical conditions in 9 comorbidity areas.

<table>
<thead>
<tr>
<th>CO MORBIDITIES</th>
<th>POINTS</th>
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<tbody>
<tr>
<td>1. CARDIAC</td>
<td>385</td>
</tr>
<tr>
<td>2. HAEMATOLOGIC</td>
<td>325</td>
</tr>
<tr>
<td>3. PULMONARY</td>
<td>250</td>
</tr>
<tr>
<td>4. RENAL/UROLOGY</td>
<td>220</td>
</tr>
<tr>
<td>5. NEUROLOGICAL/PSYCHOLOGICAL</td>
<td>185</td>
</tr>
<tr>
<td>6. GASTROINTESTINAL</td>
<td>185</td>
</tr>
<tr>
<td>7. GENERAL MEDICINE</td>
<td>180</td>
</tr>
<tr>
<td>8. ENDOCRINE</td>
<td>165</td>
</tr>
<tr>
<td>9. INFECTIOUS DISEASE</td>
<td>65</td>
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</table>

A study was conducted by Mary Ziembe Davis and Peter Caccavallo in 2018 on 2051 patients undergoing primary TJA by a single surgeon to predict the optimal value of the outpatient Arthroplasty Risk...
Assessment Score (OARA) in relation to ASA grading for same day discharge and to identify the optimal OARA score for safe selection of patients. This study found that OARA scores of 0-79 could accurately identify the patients fulfilling the criteria to undergo outpatient arthroplasty without any risk. This study had high specificity and positive predictive value.

In a study conducted by Scott Lovald and Kevin Ong. regarding selection of patients in outpatient knee arthroplasty (TKA) in 2014, it was observed that patients with higher Charlson Index, old age, history of congestive cardiac failure, patients not given femoral nerve block had a higher risk of rehospitalization, infection, wound complications and death. Charlson Index quantifies the presence of comorbid conditions in to a composite score and has been proven to be a well-founded method to estimate the mortality risk from comorbid diseases.

In studies conducted previously, predictive value of OARA was found to be better than ASA grading and Charlson index for same day discharge or discharge a day after surgery. ASA grading doesn’t give ample information for safe selection of patients for OJA. Key factors responsible for successful outcome of an outpatient total joint arthroplasty are given in Table 3.

### (Table 3) Discharge Criteria

**DISCHARGE CRITERIA**

Same day discharge after TJA requires the active role of patients in recovery process. A family member or a close relative should be present to take care of the patient in the immediate post-operative period. (Table 4)

<table>
<thead>
<tr>
<th>SAME DAY OUTPATIENT DISCHARGE CRITERIA</th>
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<tbody>
<tr>
<td>1. Tolerates oral fluids and solid food</td>
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<tr>
<td>2. Lack of nausea and vomiting</td>
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<td>3. Voiding without difficulty</td>
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<tr>
<td>4. Haemodynamically stable during mobilization after surgery</td>
</tr>
<tr>
<td>5. Adequate pain control with oral medication</td>
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<tr>
<td>6. Patient can safely ambulate, transfer from bed to standing and toilet</td>
</tr>
<tr>
<td>7. Clearance from surgery, anaesthesia and physical therapy teams</td>
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</table>

*(Table 4) Total Joint Replacement Surgeries in Times of COVID-19 Pandemic*

As the whole world is passing through the phase of COVID 19 pandemic, it has hastened the trend towards more outpatient surgeries at various hospitals all over the world. One of the unavoidable consequences of the pandemic is patients who were previously anxious about going back home on the same day of surgery, now want to be discharged on the same day to recover in their own familiar environment and to minimize the risk of exposure to virus in hospital premises.

The operating room can prove to be a risky environment during the current pandemic particularly if the surgery is done under general anaesthesia and endotracheal intubation, as intubation is an aerosol generating procedure. Surgical patients with co-morbidities if found COVID-19 positive
preoperatively will need extended hospital stay thereby increasing the chances of virus transmission. Patients should be well informed about the high risk of virus transmission, the long incubation period, the variable nature of disease from mild to severe. A PCR positive patient should be postponed for atleast 7 weeks for elective arthroplasty and further delay is advised for patients with ongoing symptoms for >7 weeks from diagnosis. Postponing hip and knee arthroplasty is associated with increased anxiety, disability, deterioration of functions and reduced benefits derived from surgery and delayed return to activities of daily life (ADL) with a risk of pain medication abuse. Osteoarthritis leads to absenteeism from work and request from the patients for temporary unemployment benefits thereby burdening the public welfare system.

Spinal anaesthesia is safer than general anaesthesia (GA) for all patients whether RT-PCR positive or negative as compared to general anaesthesia, because GA requires direct airway manipulation and endotracheal intubation which can easily transmit SARS-Cov-2.

ASA guidelines suggest safety measures to limit aerosolization of droplet particles by giving special attention to surface and equipment cleaning, avoiding high flow devices, using video laryngoscope and close suction cannulas.

The International Consensus group and the AAHKS (American Association of Hip and Knee Surgeons) Research Committee have made the following changes to be adapted post-operatively during the pandemic:

1. Minimise the length of hospital stay by following enhanced recovery protocols.
2. Use of telemedicine for post-operative round and follow up.
3. Early discharge of patients to their respective homes and advised to do self-directed therapy.
4. Hospital visits are advised only to those patients who have issues with healing of wounds, stiffness and suspicion of fracture.
5. Wearable sensor technology that aids in patient monitoring thereby playing an important role in patient management.

### Cemented versus Non-cemented Arthroplasty

Till date there is still a controversy whether to use cemented implants or uncemented prosthesis in patients with TJA on an outpatient basis. Cemented implants are cheap as compared to uncemented implants. However, during the last 10 years there has been a universal trend towards uncemented implants in THR. Uncemented implants were introduced to cope up with the complications associated with the cemented THR mainly in young population.

A review published by Zhang et al reported better long term survival with cemented fixation than cement less fixation in older patients undergoing primary total hip arthroplasty, while cementless fixation lasted for a longer duration in young patients.

In a comparative study done in patients in age groups 50-80 years in 2018, the functional outcome of cemented and uncemented total hip replacement at 2 year follow up, it was found that 88% of patients in cemented group and 84% patients in uncemented group showed promising results in terms of functional (Pain score or Harris hip score HHS) outcome.

Cementless prosthesis is a fascinating option in younger population, who are actually the candidates for out patient arthroplasties because of its potential for biological fixation and improvement in survivorship. Personal preference, experience and expertise of orthopaedician, infrastructure of medical care facility, characteristics of patients including chronological age, availability and cost of prosthesis are important factors which play a role in the choice to be made and long term outcome with a certain type of fixation.

Cost is definitely a concern with uncemented THR in developing countries like India however now invariably most of the institutions are performing uncemented THR in more than 95% of cases especially so in outpatient joint arthroplasties.

### Anaesthesia and Arthroplasty

Innovative and novel anaesthetic techniques, improved and minimally invasive surgical procedures have paved the way for early mobilization and physical therapy in the immediate postoperative period so as to make discharge on the same day feasible. Choice of anaesthetic technique goes a long
way to affect surgical outcome and discharge readiness. 

**ENHANCED RECOVERY AFTER SURGERY (ERAS)**

Short hospital stay protocols utilize the ERAS pathways and lead to early recovery as well as patient satisfaction and improved experience to make them feel confident enough to go back home the same day. ERAS focuses on wellbeing as well as satisfaction of patients and reducing complication rate. It requires comprehensive and coordinated management by a multidisciplinary team. ERAS includes preoperative, intraoperative and postoperative care with the focus to decrease the complication rate, shorten length of stay in hospital thereby increasing bed capacity and decreasing economic burden of health care. (Table 4)

Postoperatively patients are followed up regularly for one year. Reasons for failures, increased length of stay in hospital and readmissions are recorded.

### ERAS- A COORDINATED TEAM EFFORT
Orthogeriatrician, Orthopaedician, Anaesthesiologist, Nursing sister, Physiotherapist

#### PREOPERATIVE
- Assess home care facility and identify caretaker at home
- Patient education and presurgery counselling
- Avoid sedatives, Dexamethasone to prevent PONV, identify POCD risk factors, Hb correction, nutritional status (liberal fasting 6 hrs solids and 2 hrs for clear liquids), quit smoking
- Preemptive oral analgesics*, IV antibiotics, IV Tranexamic acid, DVT prophylaxis, carbohydrate load before surgery

#### INTRAOPERATIVE
- Neuraxial anaesthesia preferably spinal
- Fluids to prevent dehydration, maintain normothermia, maintain normovolemia
- Opioid sparing multimodal analgesia
- Peripheral nerve blocks- Adductor canal, IPACK, LIA
- Judicious blood transfusion, blood conservation**

#### POSTOPERATIVE
- Early post procedure ambulation and PT, DVT prophylaxis
- Early removal of tubes and drains
- Opioid sparing multimodal analgesia, Proton pump inhibitors
- Early transition to oral pain medications
- Early allowance of food intake
- Discharge on the day of surgery
- Follow up for 1 year

*Preemptive oral analgesics- Acetaaminophen, Celecoxib, Pregabalin, Gabapentinoids  **Blood conservation strategies- preop Hb correction, IV tranexamic acid, Addition of adrenaline to LA cushion under knee for 3 hrs postoperatively

(4) **ERAS PROTOCOL**

ERAS protocol was used for THA and TKA in a study conducted in Canada by Pascal Andre Vendittoli et al in which complications according to Clavien- Dindo scale, duration of stay and cost of hospital care were compared between prospective cohort of 2 groups.

One group consisting of 120 short stay ERAS and another control group of 150 patients undergoing THA/TKA. It concluded that ERAS short protocol lead to better outcome of patients by cutting down the rate of untoward events like pain, PONV,
constipation, dizziness, hypotension, edema, headache and urinary retention by 50% and achieved decreased cost and LOS in hospital to <24hrs. It was also concluded that combined epidural/sedation technique with local infiltration anaesthesia (LIA) was used and patients were able to stand/walk 2-3 hrs after surgery thus making outpatient arthroplasty a feasible option. Outpatient surgery should not be a primary objective. Vehmeijer et al suggested that reducing duration of stay in hospital should not be the goal in itself but should rather be the outcome of successfully executed recovery protocol on the basis of notion “first better than faster”. Increased rate of complications, readmissions, resurgery or post discharge expenditure while achieving decreased LOS is a wasted exercise. Moreover, not all the centers have already established fast track recovery protocols in place and this may question the feasibility of outpatient surgeries in these places or even if carried out could lead to readmissions and increased morbidity which in turn could lead to augmented utilization of post discharge care facilities with increased cost and safety issues. Optimization of infrastructure to decrease the post procedure sequela is obligatory for the success of this protocol.

**CHOICE OF ANAESTHESIA**

Anaesthetic technique goes a long way to affect surgical outcome and discharge readiness. Various anaesthetic techniques include, General anaesthesia(GA), Neuraxial anaesthesia(NA), target controlled infusion(TCI), total intravenous anaesthesia(TIVA), local infiltration analgesia(LIA) and peripheral nerve blocks(PNB)

**GENERAL ANAESTHESIA (GA) VERSUS NEURAXIAL ANAESTHESIA (NA)**

Both the modalities have been used for outpatient arthroplasty procedures. There are conflicting data on outcomes in terms of mortality and morbidity depending upon the type of anaesthesia used.

In a large observational study by Memtsooudis carried out on more than 5 lakh patients, major morbidity and fatality were found to be remarkably reduced in patients being administered neuraxial anaesthesia or a combination of NA and GA for total hip or knee arthroplasty. However combination of GA and neuraxial anaesthesia is rarely required during these procedures. Spinal anaesthesia gained popularity because of marketing of short acting local anaesthetics and refinement of regional anaesthesia techniques.

Large National database studies have proven improved outcome, reduced mortality and morbidity with spinal anaesthesia. Way back in 1980s, it was proven that SA reduces intraoperative fibrinolysis during TJA. Also rate of blood transfusion is less under spinal. This is especially relevant in setting of outpatient joint replacement as bleeding and blood transfusions both are likely to hinder the same day discharge.

The systematic review by Raut S et al concluded the neuraxial anaesthesia techniques to be superior to GA for patient outcomes following total hip/knee arthroplasty. Also they confirmed that neuraxial techniques did not result in increased duration of surgery but decreased LOS in hospital and also associated with improved perioperative outcomes. Neuraxial procedures do not take more time to perform and in fact may reduce the duration of surgical procedures (up to 11 mins or less). Also they are better and safer in elderly and sick patients with comorbidities. Ehan et al in 2015 also reported decreased LOS, decreased cost and increased overall survival (5yr to 14yr ) in follow-up period in patients receiving neuraxial anaesthesia, various other studies also reported lesser use of narcotics, improved hydration, faster ambulation and decreased rate of re-admission.

Endotracheal intubation, mechanical ventilation, and anaesthetic drugs including neuromuscular blocking agents are avoided. By using NA incidence of thromboembolic events, pulmonary complications, acute respiratory failure, cost and postoperative pain is lesser. Spinal anaesthesia decreases the incidence of post-op nausea vomiting(PONV) compared to GA as shown in retrospective analysis of 3922 patients undergoing THA under GA/SA, also confirmed in another metanalysis. Neuraxial and peripheral nerve blocks (PNB) are also associated with significantly less inpatient falls.

Early ambulation is very vital for same day discharge but residual motor blockade, spinal induced hypotension, dizziness or numbness of lower leg may hinder the same. To overcome these issues various
short acting local anaesthetics are used. So, use of short acting LA drugs for spinal like lidocaine, chlorprocaine, mepivacaine is mandatory to avoid residual motor blockade and orthostasis. Studies have shown mepivacaine to be superior to bupivacaine due to faster returning sensory and motor function, frequency of occurrence of urinary retention, time to micturition , time taken to discharge , improved recovery profile, pain control making it suitable for OJA and did not show significant transient neurological symptoms (TNS) and also superior in terms of same day discharge (SDD)\textsuperscript{46}. Articaine is also superior to bupivacaine/prilocaine in outpatient settings\textsuperscript{47,48}.

- Lignocaine is a short acting LA agent with rapid onset of action. A study was done on 50 patients in USA, who were given single shot spinal anaesthesia with 2\% isobaric lignocaine in addition to propofol sedation in OJA . The study concluded that isobaric lignocaine is safe and effective with all patients sent home on the same day of surgery without any case of TNS. Motor blockade lasted for 2.89 hrs and time from post anaesthesia care unit to full return of motor function was 0.58 hrs\textsuperscript{49}. This is contrary to Cochrane review by Zaric et al\textsuperscript{50} on 1479 patient which concluded that lignocaine was associated with higher risk of TNS as compared to bupivacaine, levobupivacaine , ropivacaine ,chlorprocaine , procaine, mepivacaine and prilocaine regardless of baricity.

- Depending on surgeon’s experience and expertise, chlorprocaine is recommended for procedures anticipated to last for 30min or less. Lignocaine and mepivacaine can have effect lasting for variable time depending upon the dosage used. Prilocaine resulted in faster recovery as compared to bupivacaine. A study was conducted to analyse the effectiveness and side effects of bupivacaine vs lidocaine in 50 out patients undergoing knee arthroscopy . Unilateral spinal anaesthesia was given to both the groups . The study came to the conclusion that spinal anaesthesia with lidocaine was better for fast track anaesthesia with shorter time to ambulate and in term of home readiness\textsuperscript{51}.

- Addition of adjuvants like intrathecal morphine is best avoided to prevent nausea/vomiting and pruritis

In spite of consensus for spinal anaesthesia in outpatient TJR, one must not forget the absolute necessity to initiate physiotherapy (PT) as early as possible in postoperative period

**EPIDURAL ANAESTHESIA AND COMBINED SPINAL EPIDURAL ANAESTHESIA**

Lumbar epidural anaesthesia with 2\% xylocaine (10-15cc) along with propofol sedation can also be given but epidural catheter should be removed in the operation theatre itself. Epidural anaesthesia is avoided because of delayed onset, chances of epidural abscess, epidural hematoma, hypotension and urinary retention, and for the same reasons combined spinal epidural anaesthesia is avoided as in-situ epidural catheter will hinder the ambulation of patient. But no technique is 100\% reliable and without failure with incidence of failure in neuraxial anaesthesia being 1\% – 17\% reported in some studies. Causes could be many including failed lumbar puncture, incorrect dose or baricity, anatomical abnormalities, or loss of injectable etc.\textsuperscript{52} besides patients not giving consent or anticoagulation issues which are common in elderly age groups. Since the use of short acting local anaesthetic is desirable to avoid residual motor blockade, surgeon’s efficiency and competence is needed to finish off the procedure in stipulated time period. Urinary retention is an issue with spinal and is a reason precluding same day discharge.

**GENERAL ANAESTHESIA**

Though ERAS pathways and peripheral nerve blocks (PNBs) strongly favor spinal over GA, along with local infiltration, but modern general anaesthesia techniques like TIVA and target controlled infusions targeted to depth of anaesthesia also have a place in outpatient TJA. Multimodal analgesia along with PNB also serves to fill some of the gaps between GA vs. SA. General anaesthesia has an advantage in these regards. Stambough et al reported in his rapid recovery cohort that 96\% patients receiving GA could be subjected to physiotherapy (PT) within 2 hrs postoperatively and could be discharged on 1\(^{st}\) postoperative day\textsuperscript{53}. Faster ambulation and better
overall recovery with TIVA as compared to SA after TJA was reported by Harstem et al. Many patients do not want to remain awake during surgery and desired to receive GA. Newer and safer pharmacological intravenous and inhalational agents, target controlled infusions, supraglottic devices and modern ventilation equipment makes GA a feasible alternative option for outpatient arthroplasty. With thromboprophylaxis having instituted routinely for the orthopaedic surgeries gap between GA and SA in terms of decreased DVT with spinal is also narrower now. GA may protect against myocardial infarction as compared to neuraxial.

But GA per se can cause perioperative complication and prolonged hospitalization. It can result in cognitive dysfunction in postoperative period up to 7 days GA is also associated with risk of airway instrumentation and greater likelihood of pulmonary and hemodynamic compromise, increased risk of postoperative ventilation, stroke and cardiac events based on anaesthetic and analgesic management, postoperative cognitive function is affected with GA, chances of postoperative delirium is increased leading to delayed discharge and issues of postoperative motor weakness. There was no difference in cognitive dysfunction beyond 7 days as reported by Steinmetz et al. Wong et al reported that using EEG monitoring intraoperatively while giving GA resulted in faster time to orientation in recovery room. Optimizing depth of anaesthesia and intraoperative cerebral monitoring is beneficial along with opioid sparing analgesic techniques.

More important than anaesthetic techniques, proper patient selection is a must. Also with modern ERAS pathway, multimodal analgesic techniques, local infiltration anaesthesia by surgeons, adductor canal block it has been possible to effectively managed pain after TJA. Individual and institutional protocols play a big role in deciding the mode of anaesthesia. Both GA and spinal anaesthesia can facilitate same day discharge if fast track recovery pathways along with opioid sparing multimodal analgesic techniques are incorporated based on individual and institutional infrastructure, protocols, skills and resources but patient selection is the most vital aspect of this.

TARGET CONTROLLED INFUSION AND TOTAL INTRAVENOUS ANAESTHESIA IN OJA

SAB can be combined with propofol target controlled infusion. Target controlled infusion for delivering propofol/midazolam with or without spinal anaesthesia is a newer milestone for outpatient arthroplasty to reduce patient’s anxiety and accepting the idea of staying awake during surgery. Such anxiety during procedures is known to be associated with adverse surgical outcomes and increased intensity of postoperative pain. Though other additives like visual distraction, patient education and music have also been effectively tried. Injection propofol is given by anaesthesiologists using computer assisted TCI taking advantage of rapid onset and sedative effect of propofol. Propofol has an edge over the midazolam in terms of early awakening, less postoperative confusion and delirium and also an option of conversion to GA easily and when needed. Infusion rate by TCI device is adjusted over time to attain desired plasma/effect site drug concentration. But it may be associated with the inaccurate drug dosing, or errors related to wrong selection of TCI device or human error. Under/over sedation may result due to improper judgment of patient’s anxiety level which has been taken care of by patient maintained propofol sedation (PMPS). This system is controlled by patient by using a handheld button and has been shown to give favorable results in terms of patient anxiety level, sedation level and recovery time. An anaesthetist override button is included in PMPS interface to enable the anaesthetist to intervene and take control in case of any medical issue. This deactivates the patient button and enable anaesthetist to take charge of situation and increase or decrease the target effect site propofol concentration.

In a study done at Houston by Dereck M Klavans patient undergoing hip/knee arthroplasty were divided into 2 groups namely traditional protocol group(TPG) and updated protocol group. TPG had standard anaesthesia protocol consisting of combination of GA and long acting neuraxial anaesthesia and UPG received combination of TIVA and short acting spinal anaesthesia — propofol i/v bolus plus continuous i/v infusions with fentanyl/remifentanil along with short
acting spinal anaesthesia. Perioperative variables like surgery time, estimated blood loss, length of time spent in PACU were significantly lower in UPG. The study concluded that TIVA used in conjunction with short acting non opioid spinal anaesthetics facilitated earlier postoperative mobilization in a safe manner and lead to decreased length of stay in hospital. Also incidence of complication and readmission to hospital was lower in UPG. No urinary catheterization was done in UPG.

**MULTIMODAL ANALGESIA AND PNBs**

Multimodal analgesia is an important aspect of fast recovery pathways in which many drugs having different mechanism of action are combined to provide quality analgesia, result in fewer complications and have opioid sparing effect. Multimodal analgesia targets pain transmission signals from peripheral nociceptors to central nervous system (CNS) by using cocktail of oral analgesics, RA and or infiltration techniques to get opioid sparing analgesia. Dexmedetomidine, alpha2 agonist dexamethasone, acetaminophen, non-steroidal anti inflammatory drugs (NSAIDs), gabapentine are used. Dexmedetomidine , is used as adjuvant in peripheral nerve blocks, prolongs duration and improves postoperative pain scores.

Multimodal analgesia leads to better outcomes after TJA as inadequate analgesia leads to increased length of stay in hospital, patient dissatisfaction and delayed discharge from the hospital, thereby taking away goal of outpatient TJA. Opioid sparing analgesia also contributes to decreased incidence of PONV, which is again a very important reason for delayed discharge. Multimodal analgesia consists of preemptive analgesia started before the pain actually gets severe in the form of gabapentinoids, pregabalin COX-2 inhibitors, celecoxib, acetaminophen, NSAIDs non selective cyclooxygenase (COX-1) and COX-2 specific inhibitors. Long term use of NSAIDs has disadvantages in the form of GI effects like peptic ulcer and compromise renal functions but short term use in perioperative period is not of much concern. Ibuprofen and COX-2 inhibitors carry lower risk of GI bleed compared to ketorolac. Acetaminophen is safe and highly recommended. **Local anaesthetics are important component of multimodal analgesia. They block the sodium channels and can be given intravenously, intra articularly , topically and as neuraxial and PNBs. Dexamethasone- long acting, potent antiemetic and perineural adjuvant is used to prolong duration of anaesthesia.**

**LOCAL INFILTRATION ANALGESIA (LIA)**

Intra articular injections are simple and unlikely to affect motor function. It is administered by surgeon in tissues around and within knee/ hip joint before he places component during THR/TKR. Anatomical structures targeted are posterior capsule, synovium over distal femur, suprapatellar pouch, medial and lateral retinaculum and subcutaneous structures. For THA, injections are given in periosteum of femur neck, hip capsule, trochanteric bursa, superficial tissue overlying iliotibial fascia. LA provides effective analgesia alone or along with other RA techniques including adductor canal block and IPACK. Injectate for periarticular infiltration includes long acting LA like bupivacaine, liposomal bupivacaine, ropivacaine with adjuncts like ketorolac, methylprednisolone, epinephrine, morphine and large volume of 80-120ml is given, Duration of analgesia is around 8-12 hrs.

**ADDUCTOR CANAL BLOCK(ACB)** - Femoral nerve block(FNB) has been in use since long but now replaced with ACB as FNB leads to quadriceps weakness thereby delaying ambulation. ACB does not compromise quadriceps motor function. Vaso adductor membrane (VAM), which overlies roof of adductor canal, serves as confirmatory landmark to identify adductor canal sonographically. LA is injected deep to VAM and near superficial femoral artery. Nerve to vastus medialis can be blocked separately. Subsartorial femoral nerve block can also be given but not frequently used. Single injection technique for ACB is better as continuous catheter placed in adductor canal can get in the way with surgical preparation site without any added analgesic benefit when compared to single injection technique. IPACK- Interspace between popliteal artery and capsule of posterior knee block- aims to target the articular branches of sciatic nerve innervating post knee joint. LA is given between popliteal artery and
proximal femoral condyles under ultrasound guidance. This block manages to preserve functions of tibial and common peroneal nerve. Combination of IPACK, ACB and LIA provide comprehensive analgesic coverage of knee joint and achieves balance between analgesia and function\(^{64}\).

Selective tibial nerve block involves blocking tibial nerve as it separates from common peroneal nerve in popliteal fossa. It restricts the plantar flexion and inversion of foot though dorsiflexion and eversion are preserved and facilitate the ambulation and rehabilitation after TKA.

![Stimulated needle path, needle tip position and local anaesthetic initial distribution (blue area) to anaesthetize the saphenous nerve at the level of the thigh, FA- Femoral artery, FV- Femoral vein (The image is reproduced with permission from NYSORA)]

**CRYOTHERAPY**

Postoperative period after TKA is marked by pain, bleeding, edema and decreased range of motion. Cryotherapy is an effective, convenient, low cost strategy to relieve pain by decreasing edema, nerve conduction velocity, cellular metabolism, local blood flow and reduces vascular spasm\(^{67}\). Cryotherapy has evolved from something as simple as ice packs to latest innovative gadgets like electronically monitored cold fluid or circulation. Therapy is still controversial and is in evolving stage. There is only a transient reduction in intra articular temperature\(^{68}\). Paradoxical increase in local tissue edema has been reported due to prolonged cooling \(^{69}\). Kullenberg et al reported satisfactory analgesia and good patient satisfaction score in cryotherapy patient vs. epidural anaesthesia in a study conducted on 86 patients\(^{70}\). 50% reduction in analgesic usage was reported by Morse\(^{71}\) and Albrecht\(^{72}\) et al. A study conducted by Ni et al\(^{73}\) reported improved pain relief on 2\(^{nd}\) postoperative day but not on 1\(^{st}\) and 3\(^{rd}\) day.

No improvement in pain and analgesic requirement was found In a meta-analysis by Adre et al of 11 prospective RCT on cryotherapy after TKA \(^{74}\). Significant reduction in blood loss has been reported in a cohort study by Levy and Marmon\(^{75}\) and also endorsed by Ni et al \(^{73}\). Morse\(^{71}\) also deduced that continuous flow cold therapy significantly reduced blood loss following TKA. Kullenberg\(^{70}\) et al reported an improved range of movement in their study on 86 patients. Use of cryopneumatic devices has drawn attention of researchers now. Better outcomes have been reported by Morse et al\(^{71}\) with their usage. Variations in the type of device used, types of frequency or duration used limit reaching a firm conclusion.

**BARRIERS TO SAME DAY DISCHARGE:**

A retrospective study was published in April 2020 to analyse the factors responsible for failure of same day discharge following OJA\(^{46}\). This study was done on 525 patients undergoing uni compartmental knee arthroplasty and TJA from year 2013 and 2019. In 110
patients (21%) it was not feasible to discharge patients on the same day. Out of these deranged motor and sensory functions were responsible for (N=36 of 110) unsuccessful same day discharge in 33% patients and this was most commonly observed in patients with TKA (11%) compared to uni compartmental arthroplasty (3.2%) and THA (1.1%).

In addition to these other reasons cited were female gender, dizziness and orthostatic hypotension observed in patients who underwent TKA (4%), THA (8.9%) and uni compartmental knee arthroplasty (0%). Blood loss during surgery, significant post-operative pain, patients having higher pre-operative VAS Score, PONV occurring in patients with GA and early wound discharge were other factors responsible for failure of same day discharge.

In other studies, foot drop (2 of 33 patients [6.1%]) and bilateral leg weakness (2 of 33 patients [6.1%]) were found to be the reasons for failure to discharge.

In a study done on implementation of ERAS protocols in a cohort of 120 patients undergoing THA or TKA, by Pascal-Andre Vendittoli et al in 2019, it was not possible to discharge 4 patients of THA and 3 patients of TKA, on the same day of surgery. The main reasons were giddiness (n=2), retention of urine (n=1), excessive discharge from wound (n=1) and postural hypotension in 4 patients.

Readmissions after surgery:

Gromov et al did a study on complications and readmissions following OJA. This study compared early readmissions resuting in overnight stay in hospital and complications between the outpatient arthroplasty group and another group treated as per (standard) fast track protocol. Readmissions were reported on postop day 2 and day 48 in outpatient and day 4 and day 58 in control groups. 6% and 4% readmissions were reported within 90 days in outpatients and inpatient group respectively. Falls leading to periprosthetic fractures were cited as main reason for readmission in outpatient group but such incidents were reported in control group also during admission as well as after discharge. No readmissions happened within first 2 days of surgery. So it was concluded that such readmissions could not have been avoided by longer stay in hospital. Both groups had spontaneous urination before getting discharged from hospital but readmissions occurred on post op day 2 and 7 in outpatient cohort. But readmissions were unavoidable even if patient had longer stay in hospital. So early discharge on day of surgery did not contribute to readmissions. Lower rates of readmission also are attributable to the fact that relatively healthier patients are selected for outpatient arthroplasties.

Lovecch et al reported 2.4% readmission in outpatient group vs. 2% in inpatient group; Kolisek et al reported no readmission in 64 patients with outpatient TKA, also endorsed by other studies.

Many factors are there for discrepancy in rates of readmissions found in different studies depending on variation in patient cohorts, definition of re-admission, methods of follow up of patients, criteria of outpatient surgeries.

Incidence of thromboembolic events as such is low with Fast Track recovery pathways due to early mobilization.

In a study done by Cassard et al in 2018, it was concluded that if patients are selected appropriately, outpatient knee arthroplasty per se does not lead to increased rate of readmission. Outpatients group had lower rate of readmission (3.3%) while inpatient group reported 4.9%. Most common reasons for readmission in outpatient group were fever not related to surgery and knee pain while in inpatient group reasons were mainly medical in the form of fever, respiratory complications, deep vein thrombosis, anaemia, cardiac complications, surgical complications like pain in postoperative period, patella-femoral dislocation etc.. None of the patient in inpatient or outpatient group had an untoward event which needed revision surgery in first 1 month. Outpatient group in fact reported very high satisfaction rate with 80% patients being very satisfied, 20% satisfied and none of the patients were dissatisfied. Overall complication rate of 7.5% was reported in patient group and 8.2% in outpatient group. Outpatient arthroplasty did not have a higher complication rate producing comparable functional outcome and associated with better patient satisfaction as endorsed by other studies.
Springer et al. in their study reported higher incidence of 30 day readmission in outpatient group (12%) compared to 6% in inpatient group. In a study done by Venditoli et al, it was reported that implementation of outpatient protocol resulted in decreased length of stay in hospital, better patient care and decreased health care cost. Rate of adverse events was also reduced by 50% compared to inpatient group.

In a study to evaluate safety and effectiveness of OJA by occurrence of untoward events, emergency visits and readmissions were noted by Richards et al in 90 days. Within 90 days post operatively, 8.82% patient in outpatient group and 10.29% patient in inpatient group reported adverse event. No serious adverse event was noted in either group.

A study by Saleh et al. reported nonspecific medical symptoms in 24.8% patient, minor GIT problems in 10.5% for return to emergency department (ED) after TJA. Surgical causes were edema and pain in 35% patients, wound complications (12%), hip dislocations in 7.3%. Out of these half of wound related complications and 40% of hip dislocations were treated in ED without readmission.

Minimally invasive technique for TKA was used by Berger et al. who reported that outpatient TKA was safe without any cases of short term readmission or complication attributable to early discharge.

Berend et al. studied 1230 OJA cases over two years and reported patient satisfaction rates of 98%-100%. Same day discharge was achieved in 98% patient and no readmission for pain control was reported. Overall readmission rate of 2% was reported.

With the increasing number of arthroplasties, challenges lie ahead regarding staffing levels, long waiting times, access to healthcare services and limited number of beds available besides economic burden. Proper patient selection for outpatient arthroplasty is very important. Counseling of patients preoperatively and explaining them the likely course of events in and out of hospital, complications, anaesthetic and analgesic requirements in perioperative and post-operative period and also addressing their concerns and unrealistic expectations is vital to the success of OJA. Too much of information load in too short time can cause the patients to lose track or miss/fail to register important information. There are organizational barriers like execution and adherence to discharge criteria and factors at patient end like bleeding issues, persistent pain and nausea, lack of enthusiasm, stimulus and absence of caretaker at home. Lack of adequate counseling related to analgesics can hinder mobilization post-surgery. Change in organizational practices, novel information, and communication skills and collaborative mechanisms can address these issues.

We should, however, not be over enthusiastic and be mindful to “walk before the run” and not land up with complications, readmissions or revision surgeries. Future guidelines point towards achieving comprehensive understanding and insight into improving outpatient ERAS and control unsavory and unpleasant perioperative inflammatory responses, pain, orthostatic intolerance and cognitive dysfunction. Proper patient selection is a key to the success of OJA. Identification of patients at risk of complications precluding the early discharge and the optimization of their pathophysiology before surgery can facilitate the success of OJA.

CONCLUSION

The fact is OJA is finally here and is likely to stay in future too. From anaesthesiologist point of view the type of anaesthesia, PNB, and medication as part of multimodal analgesia to be included in protocol depends on skills of anaesthesiologist, resources and infrastructure of each institution. But ultimately anaesthesiologist have to meet head on with the challenge of providing safe, high quality anaesthesia to alleviate post-operative pain while preserving function, all in a budget friendly manner. In health care system facing challenges to maintain financial viability, OJA paves way for the health care cost to be reduced in a substantial manner.

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