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Joint Replacement Surgery in Parkinson's Disease

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1. Introduction

Parkinson Disease affects 4 million people worldwide and it is the second most common neurological disorder after Alzheimer disease (Huse et al. 2005). It occurs in 1% of the population over the age of 60 years (Adams et al. 1997). The annual incidence of Parkinson's disease is 20.5 per 100,000 (Rajput et al. 1984) and can result in numerous symptoms including tremor, muscular rigidity and abnormalities of gait, posture and facial expression. Despite optimal pharmacological treatment, progression of Parkinson's disease normally results in a decline in general mobility and ability to ambulate safely.

Rigidity secondary to Parkinson's Disease often aggravates joint pain from osteoarthritis (Adams et al. 1997). The outcome of joint arthroplasty in these patients is effective in relieving pain, but the overall functional results have been found to be variable (Oni et al. 1985; Vince et al. 1989; Duffy et al. 1996; Koch et al. 1997; Weber et al. 2002; Shah et al. 2005; Kryzak et al. 2009; Kryzak et al. 2010). A report from the Scottish joint registry has found an annual prevalence of Parkinson's disease of 5% to 8% in patients undergoing total hip arthroplasty (Meek et al. 2006). Optimal management of the disease before, during and after surgery is a challenge due to the neurological disturbances in Parkinson's disease including tremor, rigidity, contractures and gait abnormalities.

We will firstly provide an overview of the difficulties faced when planning surgery in patients with Parkinson's disease before discussing specific pre-, intra- and post-operative measures that should be taken. Finally we will provide an overview of the evidence available for arthroplasty in Parkinson's disease specific to the three major joints replaced – hip, knee and shoulder.

2. Parkinson's disease and surgery

Patients with Parkinson's disease usually suffer from rigidity, contractures, tremor and gait abnormalities. People with Parkinson's disease who undergo surgery have longer hospital stays and increased mortality (Pepper et al. 1999). Preoperative fasting regimes can unnecessarily result in reduced or missed administration of dopaminergic medications and subsequent serious complications (Reed et al. 1992). Patients with mild Parkinson's disease are able to tolerate the fasting period but those patients with advanced Parkinson's disease, who are under high doses of levodopa are susceptible to the condition Neuroleptic Malignant Syndrome with associated fever, confusion, raised concentration of muscle

enzymes and even death (Ueda et al. 1999). The disease itself predisposes these patients to increased risk of aspiration pneumonia and urinary tract infection compared to patients without the disease (Pepper et al. 1999).

Discharge from hospital after surgery is more difficult in those with Parkinson's disease. Patients are more likely to suffer from intra – operative and post-operative complication including falls and fractures. A longer duration of hospital stay than in patient without Parkinson's disease can be anticipated and appropriate planning is necessary (Mueller et al. 2009). Planning consists of medical and surgical optimisation and also appropriate consideration to prehabilitation, rehabilitation and convalescent requirements.

2.1 Pre – operative management

2.1.1 Pharmacologic management

Patients with Parkinson's disease require advance planning, appropriate medication and specialist neurological advice for optimisation of pharmacological management of the disease before, during and after surgery (Brennan et al. 2010). Ideally these patients are screened at the pre – assessment clinic, and advice should be sought from a neurologist or geriatrician. The neurologist can give advice about the patient treatment regimen for the period around the operation and to consider any additional measures required. Brennan and Genever have reported that oral medications should be continued until time of anaesthetic induction and that patients with Parkinson's disease are ideally placed at the start of the operating list. This facilitates greater predictability over the time of fasting and surgery.

Alternative Parkinson's drugs such as apomorphine and rotigontine can be used in the post-operative period, when post-operative ileus or delayed gastric emptying can be anticipated. Apomorphine is a potent dopamine agonist which is delivered subcutaneously, but can cause severe emesis and need the concomitant use of an anti-emetic such as domperidon. Rotigontine is delivered transdermally; it has ease of use and tolerability but may not provide adequate treatment in patients with severe Parkinson's disease (Brennan et al. 2010).

Parkinsonian medication should not be withheld prior to surgery. Although some can tolerate missed doses, there are reports of Neuroleptic Malignant Syndrome in cases where the regular dose has been omitted (Ueda et al. 1999). Mason et al have provided a detailed list of pre-anaesthetic assessments that should be carried out prior to surgery (Mason et al. 1996). This list details a number of features to look for by system and appropriate investigations (Table 1, page 511).

Respiratory complications are possible as a significant number of patients with Parkinson's Disease have an obstructive picture on pulmonary function testing (Neu et al. 1967). Orthostatic hypotension is a potential problem and agents that cause or contribute to peripheral vasodilatation can exacerbate this. Hypovolaemia secondary to surgical blood loss needs to be attended to as this can clearly contribute to lower blood pressure and risk of subsequent fall. Administration of medications such as tricyclic anti-depressants may also contribute to a fall in blood pressure and should be used with caution in this patient population (Nicholson et al. 2002).

2.1.2 Bone mineral density

Several studies have shown that patient with Parkinson's disease have decreased bone mineral density (BMD) and are prone to vitamin D deficiency when compared to the general

System	Assessment by history	Tests
Head and neck	Pharyngeal muscle dysfunction Dysphagia Sialorrhoea Blepharospasm	
Respiratory	Respiratory impairment from rigidity, bradykinesia or uncoordinated involuntary movement of the respiratory muscles	Chest radiograph Pulmonary function tests Arterial blood gases
Cardiovascular	Orthostatic hypotension Cardiac arrhythmias Hypertension Autonomic dysfunction	ECG
Gastrointestinal	Weight loss Poor nutrition Susceptibility to reflux	Serum albumin/transferrin Skin test allergy
Urological	Difficulty in micturition	
Endocrine	Abnormal glucose metabolism (selegiline)	Blood glucose concentration
Musculoskeletal	Muscle rigidity	
Central Nervous System	Muscle rigidity Akinesia Tremor Confusion Depression Hallucinations Speech impairment	

Table 1. Recommended assessment of the patient with Parkinson's disease(Mason et al. 1996)

population (Kao et al. 1994; Sato et al. 1997; Fink et al. 2005; Sato et al. 2005). Patients with Parkinson's disease tend to be less active than patients without the disease, and lack of sunlight absorption makes these patients more likely to be ostopenic. Rigidity and bradykinesia result in reduction in spontaneous movements, rendering the patient less mobile and active. Lack of mobilization stimulates bone calcium resorption, secondary to disuse and lack of weight bearing (Clouston et al. 1987; Gross et al. 1995; Inoue 2010). Patients with Parkinson's disease with low BMD are have twice as much the risk of fractures when compared with osteoporotic patients without the disease(Taylor et al. 2004).

Those with poor bone quality are at an increased are at increased risk of intraoperative fracture during joint arthroplasty particularly during femoral stem insertion in uncemented THA when hoop stresses are at their greatest (Hernigou et al. 2006). In an experimental *in vitro* study Thomsen et al found that patients with poor bone quality treated with uncemented THA are at higher risk of periprosthetic fracture and recommended that cemented stems should be used in this group of patients(Thomsen et al. 2008). Improving

the patient bone density or preventing continuing bone loss is therefore important before joint arthroplasty is considered in patient with PD.

All patients with Parkinson's disease referred for orthopaedic assessment for possible joint arthroplasty should be screened for osteoporosis and treated appropriately. Bisphosphonates are known to reduce osteoclastic activity and immobilization induced bone loss has been successfully treated with these agents (Yates et al. 1984; Sato et al. 2007). In a randomized control trial in patients undergoing cemented TKA, Hilding et al. showed that daily treatment with 400mg of clodronate reduced tibial component migration by 25% when compared with placebo at 6 months following surgery(Hilding et al. 2000). Friedl et al. have identified reduced migration of cementless acetabular cups in THA over 2 years following a single dose of intravenous zoledronate in patients undergoing THA for avascular necrosis(Friedl et al. 2009). However, other authors have found the effect of bisphosphonates less promising with no beneficial effect of systemic bisphosphonates seen over 2 years after hybrid THA and cementless TKA(Wilkinson et al. 2005; Hansson et al. 2009).

Patients with PD are also reported to have abnormal bone metabolism(Sato et al. 2005) resulting from reduced parathyroid hormone. Recent studies using teriparatide, a recombinant human parathyroid hormone, for the treatment of reduced BMD are showing promising results (Aspenberg et al. 2010; Ma et al. 2011; Moricke et al. 2011) but so far none of the studies are related to patients with PD.

2.1.3 Physiotherapy

Physiotherapy has proven functional improvements in patients with PD and this needs to be considered in the planning for arthroplasty surgery (Formisano et al. 1992). Physiotherapy should not be left for the post-operative phase and emerging evidence suggests that it should play a greater role prior to surgery than we realize. Prehabilitation is fast growing to be a recognized as a potential key element in arthroplasty pathways and this has been particularly noted in patients undergoing total knee arthroplasty (Jaggers et al. 2007; Topp et al. 2009; Swank et al. 2011). Patients with PD should not be exempt from this more of preparation, and given the potential for poor mobility, loss of muscle mass and bone mineral density in this cohort, it may be even more prudent to direct these individuals for prehabilitation prior to surgery.

Nocera et al have found that knee extensor strength has a negative correlation with disease severity in PD and a positive correlation with dynamic stability (Nocera et al. 2010). Specific physical therapy programs for PD have been shown to be effective for mild to moderate disease severity(Ebersbach et al. 2010) . Allen et al in a randomized controlled trial setting have shown that a prescribed exercise program results in increased muscle strength and a reduced fear of falling in those with PD(Allen et al. 2010). While a painful degenerate joint can prohibit some prescribed exercises, gains made prior to surgery will be transcribed to potential gains made following surgery.

2.2 Intra – operative management

According to the literature, regional anaesthesia is preferred to general anaesthesia, especially in patients who require continues infusion of levodopa/carbidopa therapy during the procedure(Burton et al. 2004). Backus et al have reported a case of post-extubation laryngospasm in an un-anaesthetised patient(Backus et al. 1991). General anaesthesia has

been shown to contribute to post-operative confusion, which adversely affects patient outcomes and prolongs hospital stay (Duffy et al. 1996; Koch et al. 1997; Weber et al. 2002) Propofol which is commonly used to induce general anaesthesia may temporarily supress the tremor associated with Parkinson's disease but it has been also shown to exacerbate dyskinesia (Anderson et al. 1994; Krauss et al. 1996). Wright et al have suggested that low dose ketamine may represent an alternative sedative for use pre-operatively as it reduces dyskinesia and controls Parkinsonian tremor(Wright et al. 2009).

Of the commonly used analgesics during surgery fentanyl and morphine can both result in increased muscular rigidity (Klausner et al. 1988; Berg et al. 1999). Alfentanil has been reported to have resulted in dystonic reactions(Mets 1991)

Succinylcholine can result in hyperkalaemia and should be avoided(Muzzi et al. 1989). Non-depolarizing muscle relaxants are considered safe(Nicholson et al. 2002).

2.2.1 Peri-articular infiltration

A number of randomized control studies (Andersen et al. 2007; Toftdahl et al. 2007; Andersen et al. 2010) show the effectiveness of intra operative local infiltration analgesia (LIA) in the post - operative period. LIA has been used both during TKA and THA with equal effectiveness in pain reduction and reduction in analgesic use in the post - operative period. In a randomized, double blinded, placebo controlled study, LIA was used in hip arthroplasty (Andersen et al. 2007). Patients treated with local infiltration analgesia experienced less pain up to two weeks postoperatively and resulted in less joint stiffness and better function one week after the procedure(Andersen et al. 2007).

Multimodal anaesthetic infiltration around the hip joint has been trialled and reports to date suggest that this is an efficacious way of controlling post-operative pain whilst reducing requirements for rescue analgesia. Busch et al have shown that peri-articular infiltration of a multi-modal analgesic regime has a positive effect on subjective pain following THA and results in a reduced requirement for rescue opiate use via PCA(Busch et al. 2010). Lee et al reported similar results noting that peri-articular infiltration conferred no increased risk for the patient in the post-operative setting. Their multi-modal injection consisted of morphine, ropivacaine and methylprednisolone. Parvataneni et al reported superior control of post-operative pain using peri-articular infiltration of bupivacaine, epinephrine, methylprednisolone, cefuroxime and morphine(Parvataneni et al. 2007). Use of periarticular infiltrations such as these, particularly in hip arthroplasty can minimise subsequent use of opiate based analgesics and reduce the risk of adverse events associated with opiate usage.

Recent studies show that periarticular infiltration at the end of TKA has several advantages over other approaches. In a randomized controlled study by Venditoli et al 42 patients who underwent TKA were randomized either to receive an intraoperative infiltration with ropivacaine followed by an infusion of ropivacaine through 16 gauge catheter on the first post-operative day or control group. Narcotic consumption was less in the first 40 hours post op with improved pain scores during rest and exercise for the first forty eight hours and fewer nausea symptoms during the first five post-operative days than the control group(Vendittoli et al. 2006). It is well known that morphine exerts its analgesic effect by binding to opioid receptors in the central nervous system and peripherally (Stein et al. 1989). In a double blinded, randomized clinical trial Tanaka et al. have shown that patient who were administered intra-articular morphine and bupivacaine had reduced pain scores, a much smaller requirement of systemic analgesia, longer duration between the operation

and the first requirement of systemic analgesia and improvement in the range of motion of the knee joint at time of discharge(Tanaka et al. 2001). Andersen et al. have used a combination intraoperative infiltration of ropivacaine ketorolac and epinephrine combined with and intra-articular infusion of ropivacaine and ketorolac for the first 48 hours post operatively. They found out that peri and intra-articular analgesia with multi modal drugs provided superior pain relief and reduced opioid consumption compared with continuous epidural infusion with ropivacaine combined with intravenous ketorolac(Andersen et al. 2010). These protocols can be used in patients with Parkinson's disease to help reduce the use of opioids in the post-operative period and reducing the risk of multi drug interaction and side effects. Further studies are required, to assess the effectiveness of these protocols in patients with Parkinson's disease.

2.3 Post – operative management

2.3.1 Analgesic management

In joint arthroplasty, pain control after the procedure is one of the major elements in early mobilizations. Most patients are managed with opioid analgesics for the first 24 hours after surgery including the use of patient controlled analgesia (PCA). Opioid analgesics are well known to cause confusion especially in elderly patients.

This type of analgesics effect patients' mental state and can exacerbate Parkinsonian symptoms through the dopaminergic pathway (Chudler et al. 1995; Burton et al. 2004). Opioid analgesic has also been shown to increase the length of stay in hospital in a nationwide study done in Denmark(Husted et al. 2010).

Multimodal analgesia with non-steroidal anti-inflammatory drugs in patients with adequate renal function is reported to be as effective as opioid analgesia with fewer side effects (O'Hara et al. 1997; Post et al. 2010). When using multimodal analgesia, it is especially important to take early advice from the patient's neurologist for potential adverse interaction between the type of analgesic protocol used and the neurological medication regime.

2.3.2 Respiratory function

Post-operative nursing care and rehabilitation are an important factor in patients with Parkinson's disease because these patients are at high risk of for falls and fractures (Melton et al. 2006; Camicioli et al. 2010). Close attention to the respiratory status in this patient cohort following surgery is mandatory. As eluded to earlier, Parkinson's Disease is associated with an obstructive respiratory pattern. This is likely due to the incoordination of the upper airway seen in extra-pyramidal disorders(Vincken et al. 1984). Musculature around the larynx is likely to be affected by the neuromuscular abnormalities in Parkinson's disease. Patients are therefore prone to atelectasis, retained secretions and respiratory tract infections(Easdown et al. 1995). It has been noted that aspiration pneumonia is a not infrequent cause of death(Hughes et al. 1993). Pulmonary physiotherapy and early commencement of ambulation are essential components to help minimise the risk of these complications.

2.3.3 Physiotherapy

Patients with Parkinson's disease require more intensive monitoring than patients without the disease in order to prevent complications such as pressure sores. Earlier mobilization

and physiotherapy regimes improve motor function, respiratory function and may help in preventing muscle contractures (Gobbi et al. 2009; Dereli et al. 2010). The Royal Dutch Society for Physical Therapy (KNGF) has published evidenced based clinical practice guidelines in order to be able to deliver optimal care to patients with PD. These guidelines have been also adopted by the Association of Physiotherapist in Parkinson's disease Europe(Keus et al. 2007). The two treatment strategies recommended in these guidelines are cognitive movement strategies and cueing strategies. These guidelines also emphasize on training joint mobility and training strength which are essential in both the pre- and post-operative period. Hurwitz et al. showed that an exercise program focused on improving joint mobility, in combination with improving mobility and self-care also improved memory(Hurwitz 1989). In a randomized control trail, Schenkman et al. showed that an exercise program focused at improving joint mobility and coordinated moving incorporated in activities of daily living (ADL) improves functional axial rotation and reach(Schenkman et al. 1998). Exercise programs which are, focused on improving muscle strength, may also improve muscle strength in patients with PD (Toole et al. 2000; Hirsch et al. 2003).
Again, in the post-operative phase it is important to remain cognizant of the potential pharmacological interactions that may precipitate orthostatic hypotension and lead to a reduced mobility or increased risk of falling.

3. Parkinson's disease and arthroplasty

There is limited literature focusing on joint arthroplasty in patients with Parkinson's disease and so far there are only 17 studies. Seven studies dealt with fractures of the femoral neck treated with hemi-arthroplasty(Rothermel and Garcia 1972; Coughlin and Templeton 1980; Eventov, Moreno et al. 1983; Staeheli, Frassica et al. 1988; Turcotte, Godin et al. 1990; Clubb, Clubb et al. 2006; Kryzak, Sperling et al. 2010), 6 studies dealt with total knee arthroplasty in Parkinson's disease(Oni and Mackenney 1985; Vince, Insall et al. 1989; Fast, Mendelsohn et al. 1994; Duffy and Trousdale 1996; Erceg and Maricevic 2000; Shah, Hornyak et al. 2005), 2 studies dealt with total hip arthroplasty(Weber, Cabanela et al. 2002; Meek, Allan et al. 2006) and 2 dealt with total shoulder arthroplasty. In this section we will provide an overview of the evidence available for arthroplasty in PD specific to the three major joints replaced – hip, knee and shoulder.

3.1 Hip

3.1.1 Hemiarthroplasty for femoral neck fractures

The 7 studies (Rothermel et al. 1972; Coughlin et al. 1980; Eventov et al. 1983; Staeheli et al. 1988; Turcotte et al. 1990; Clubb et al. 2006; Kryzak et al. 2010), that discussed the outcome of hemi-arthroplasty in Parkinson's disease are not strictly applicable since the procedure is usually undertaken as an emergency or semi-elective procedure, but some inferences can be taken in terms of rates of dislocation and post-operative complications(Table.2. Page 516). However, it must be remembered that the biomechanics of a hemiarthroplasty are different to those in THA.
Turcotte, et al(Turcotte et al. 1990) reported that out of 41 patients undergoing 47 hemi-arthroplasty for a Garden III – IV fracture , five subsequently dislocated and four of these within the first month of surgery. Four patients had wound infections, one subsidence of the stem, one acetabular protrusion, one femoral shaft fracture, three decubitus ulcers on the operated limb and one patient died within the first 6 months. Four patients never walked

Study authors	Study type	Arthroplasty (type + numbers)	Mean age (yrs, range)	Length of follow up (yrs)	Implant type/surgical technique	Outcome
Weber et al	retrospective	THR(107)	72 (57 - 87)	7.1 (2 - 21)	94 acetabular cups and 103 femoral stems were cemented, 13 acetabular cups and 4 stems were uncemented	93% pain free, 6% dislocations, 3% aseptic loosening, 26% post oprative medical complication rate
Meek et al	retrospective	THR(2394)	N/A	N/A	N/A	0.46 annual dislocation rate
Kryzak et al	retrospective	Hemi hip		0.5 - 6 years	posterior approach, various types of endo prosthesis	6 month mortality 75%, 37% dislocation, 8.3% deep wound infection
Clubb et al	Literature review	Hemi hip	N/A	N/A	N/A	N/A
Eventov et al	retrospective	Hemi hip (62)	74 (61 - 90)	N/A	34 patients had a hemiarthroplasty using the posterolateral approach, 11 underwent plate and nail fixation , the rest were treated non operativly	31% mortality at 3 months, pneumonia most frequent cause of dead, complications highest in the operated group.
Rothermel et al	retrospective	Hemi hip (16)	63.5	N/A	7 treated with hemiarthroplasty, 3 McLaughlin nail, plate and screws, 1 miltiple pins 2 nail and plate and 2 on traction	12.5% flexion contractures,
Coughlin et al	retrospective	Hemi hip (13)	78	0.5 - 6 years	posterior approach, various types of endo prosthesis	6 month mortality 75%, 37% dislocation, 8.3% deep wound infection
Staeheli et al	retrospective	Hemi hip (50)	74.3 (47 - 92)	7.3 years	50% anterolateral approach, 40% posterior approach and 10 % trans trochanteric approach, various prosthesis used	2% dislocation, 20% mortality at 6 months, pneumonia was the most frequent cause of dead
Turcotte et al	retrospective	Hemi hip (47)	74 (51 - 89)	N/A	posterior approach	8.5% wound infection, 11% dislocated, , 2.1% subsidence, 2.1% protrusio acetabuli, 2.1% femoral shaft fracture, 6.4% decubitus ulcers, 15% mortality at 6 months

Table 2. Summary of the studies in patient with Parkinson's disease undergoing THR or Hemiarthroplasty.

again despite being ambulatory prior to surgery. Overall mortality in these patients was 15%(Turcotte et al. 1990) mainly due to increased medical complications.
Other studies had better outcomes with Staeheli et al(Staeheli et al. 1988) reporting only one dislocation out of a series of 49 patients undergoing hemi-arthroplasty for femoral neck fracture, while Eventov et al have reported a 3% dislocation rate (Eventov et al. 1983).
Some studies have reported mortality rates as high 47% within the first 6 months after hemi-arthroplasty of the hip(Coughlin et al. 1980). As in other studies the high mortality rate was mainly due to increased medical complications including myocardial infarction, urosepsis and pneumonia (Staeheli et al. 1988; Turcotte et al. 1990). Aggressive physiotherapy and early mobilization was advised for patients with Parkinson's disease undergoing hemi-arthroplasty(Coughlin et al. 1980; Eventov et al. 1983; Staeheli et al. 1988; Turcotte et al. 1990). Some of these studies have also advised that patients with Parkinson's disease should be treated with internal fixation of the fracture and that hemi-arthroplasty may be contraindicated (Coughlin et al. 1980; Turcotte et al. 1990).

3.1.2 Total hip arthroplasty

Total Hip Arthroplasty (THA) is usually performed in patients with osteoarthritis (OA) (Fig.1. Page 518 & Fig.2. Page 519) to relieve pain and improve joint function. In a review of total hip arthroplasty (THA) in patient with neurological conditions , Queally et al found only two studies in the literature which report the results of THA in patients with Parkinson's disease(Queally et al. 2009). These studies reported lower rates of dislocation than those noted in reported cohorts of hemiarthroplasty in the trauma setting. Meek et al have reported only two dislocations in 1467 patients with Parkinson's disease who underwent THA between 1996 and 2004 as reported in the Scottish National Arthroplasty Registry(Meek et al. 2006). They also found an annual incidence of Parkinson's disease 5% to 8% in patients undergoing THA (Meek et al. 2006).
Weber et al reported a high rate of post-operative complications (26%) in 98 patients with Parkinson's disease after THA at mean follow up at 7.1 years(Weber et al. 2002). An anterolateral approach was used in 56 patients, trans-trochanteric in 36, postero-lateral in 12, and direct lateral in three patients. No dislocations or wound infections were noted. They did note that THA provided a high level of long lasting pain relief and initial improvement in ambulation. Functional decline in the individuals was related to the neurological disease and was not joint specific. There were 6 dislocations in the revision THA group, which included 1 from the trans-trochanteric approach, 1 from the direct lateral and 4 from the anterolateral approach. The low rate of dislocation seen in these 2 studies is mostly related to both advancement in medical management of Parkinson's disease developed in recent years and the wider choice of biomaterials such as constrained liners and larger femoral heads which improve stability at the hip joint. These 2 studies are summarised in Table. 2 (page 516).
General decline in mobility in Parkinson's disease can lead to weakness in abductor muscle function. Application of biomechanical principles suggests that increasing the offset can optimize abductor function by lengthening the abductor lever arm. Contractures may develop in any individual after hip arthroplasty, limiting functional gains. This potential case is probably more likely in PD due to the lower mobility and associated problems with rigidity. Bhave et al have found that administration of botulinum toxin to the contracted muscle groups can help alleviate this problem. Injection to a variety of muscle group including the adductors, abductors and hip flexors resulted in lasting improvement in range of movement for 20 months or more(Bhave et al. 2009).

Fig. 1. Anteroposterior radiograph of the pelvis showing, right hip osteoarthritis with a triad of joint space narrowing, subchondral cysts and osteophyte formation.

3.2 Knee

3.2.1 Knee Arthroplasty

Total Knee Arthroplasty (TKA) has been condemned for patients with Parkinson's disease by Oni et al in 1985 when they reported 3 cases of TKA complicated by a persistent flexion contracture of the hamstrings induced by the operation itself(Oni et al. 1985). Quadriceps tendon rupture was also seen in two patients. All three patients died within six months of surgery.

Vince et al reported 13 TKA in 9 patients with Parkinson's disease at time of surgery(Vince et al. 1989). All knees showed fixed flexion before the arthroplasty. Ten joints had a posterior stabilised implant; one revision joint arthroplasty required a customized stem implant and the other two cases underwent a total condylar I and II. Nine of 12 primary knee replacement achieved excellent scores Hospital for Special Surgery knee rating system within the first year and the other 3 had good scores. Even though complications such as urinary tract infections, deep vein thrombosis and pulmonary embolism were common, all patients recovered. The authors' advice that with careful consideration of age and severity of disease TKA; may improve the function of patients with Parkinson's disease by alleviating the pain, correcting flexion deformity and restoring movement.

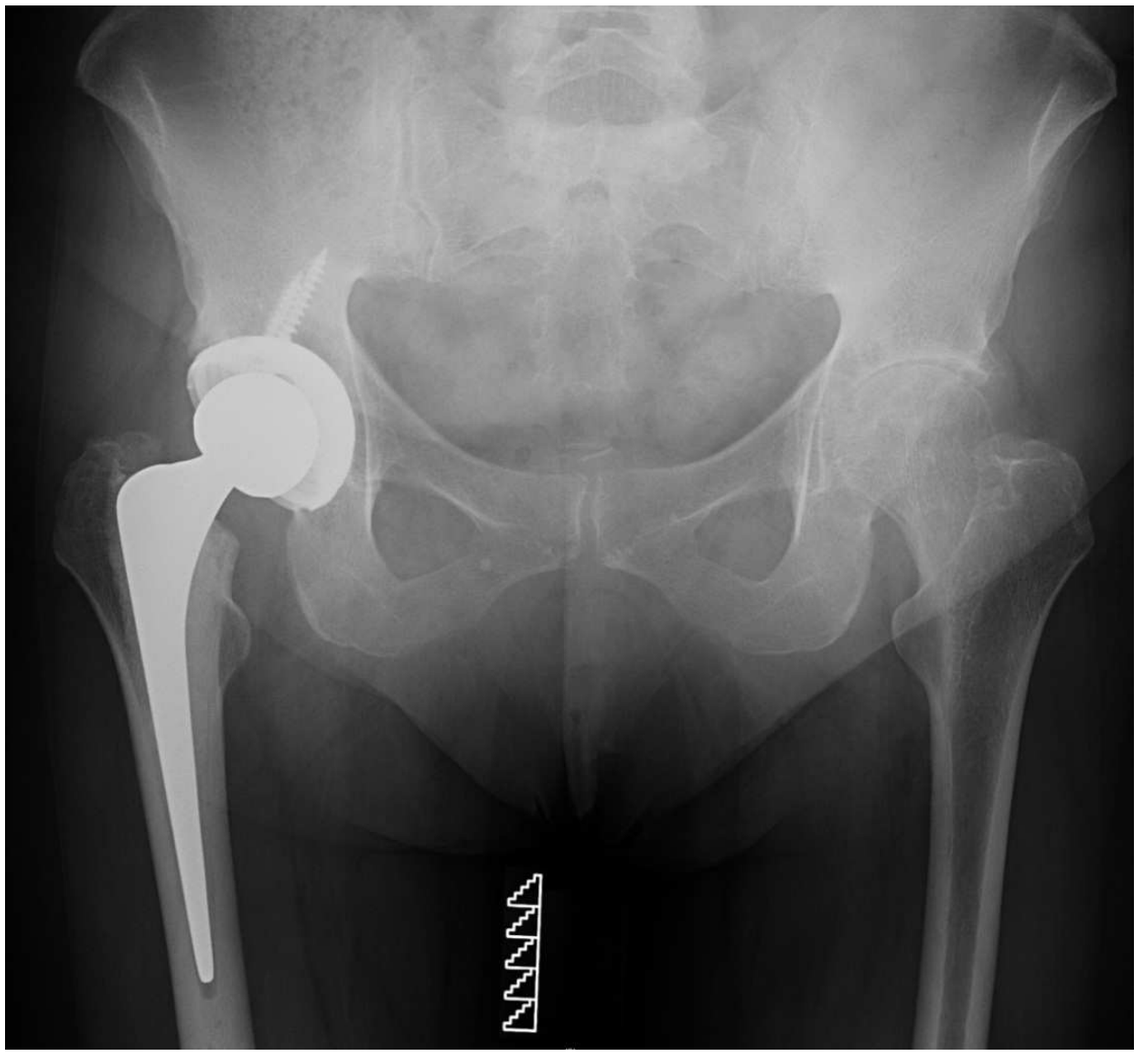

Fig. 2. Anteroposterior radiograph of the pelvis showing a right Hybrid (cemented stem/uncemented acetabular cup)THA and osteoarthritic left hip joint.

Duffy et al reported results from a retrospective review of 24 patients (33 knees) with Parkinson's disease who underwent TKA with patellar resurfacing(Duffy et al. 1996). All patients in this study continued levodopa/carbidopa up to the day of surgery and restarted it within 24 hours of surgery. Knee scores were assessed according to the Knee Society system at 2 months one year and mean follow up of 2.8 (2.2 - 6) years. Pain scores as determined by The Knee society scoring system, improved from a mean of 34 points before surgery to 89 points at the last follow up. On the other hand functional scores did not improve that much with 42 points pre – operatively to 68 points post operatively. Poor functional scores where reported due to progression of Parkinson's disease with increased imbalance, decreased muscle control, and increased rigidity(Duffy et al. 1996). In view of this the authors agree with Vince et al and recommend TKA in reliving the pain of arthritic knees in patient with Parkinson's disease(Vince et al. 1989; Duffy et al. 1996).

Two case reports have highlighted potential problems following TKR (Erceg et al. 2000; Shah et al. 2005). Erceg et al reported a case of recurrent dislocation with a posterior

stabilized TKA in a patient with Parkinson's disease(Erceg et al. 2000). According to the authors, the recurrent posterior dislocation was mainly due to destruction of the cam of the polyethylene tibial insert caused by entrapped cement rather than progression of Parkinson's disease. Flexion contracture seems to be one of the most common complications after TKA in patients with Parkinson's disease (Oni et al. 1985; Duffy et al. 1996; Shah et al. 2005).
Shah et al describe a case which was effectively managed with a manipulation under anaesthesia and motor point blocks of the long head of the biceps femoris and semitendinosus with botulinum toxin type A(Shah et al. 2005). The authors recommend that motor block injection with Botulinum toxin type A may be a viable alternative to open hamstring release in treating flexion contractures in patients with Parkinson's disease(Shah et al. 2005). A summary of these papers is shown in Table. 3 (page 520).

Study authors	Study type	Arthroplasty (type + numbers)	Mean age (yrs, range)	Length of follow up (yrs)	Implant type/surgical technique	Outcome
Oni et al	case series	TKR(3)	76(72 - 83)	2	1 Stanmore , 2 Oxford meniscal TKA	Flexion contracture(3), quads rupture (2), death in 2 years(3)
Shah et al	case series	TKR(1)	61	6.5 months	N/A	Flexion contracture
Vince et al	retrospective	TKR(13)	70(64 - 75)	4.3(1-8)	Condylar type resurfacing arthroplasty, posterior stabilised TKA(10), Custom prosthetic (1), Total conylar I(1), total condoylar II(1), all cemented and all patella resurfaced	flexion contracture (5), patellar fracture 1, patellar subluxation(1), DVT(4), PE(2)
Erceg et al	case series	TKR(1)	65	1	PFC	Recurrent posterior tibial dislocation
Duffy et al	retrospective	TKR(33)	71	2.8(2.2 - 6)	cemented condylar TKA of a single design (press-fit condylar), Johnson & Johnson.	patellar subluxation (2), deep vein thrombosis (2), superficial infection (2), myositis ossificans (1), reoperation (4), patellar fracture (2), deep wound infection(2)

Table 3. Summary of the studies in patient with Parkinson's disease undergoing TKR.

Macauley et al have suggested a list of contraindications for total knee arthroplasty. These include any level of preoperative delirium, any contraindication to regional anaesthesia, re-operative fixed flexion deformity of greater than 25 degrees, a lack of a multidisciplinary team, and a Hoehn and Yahr rating greater than, or equal to, 3 (Table. 4. page 521)(Hoehn et al. 1967). They also propose that failure to respond to a diagnostic intra-articular infiltration

of bupivacaine as a contraindication(Macaulay et al. 2010). Specific pre-operative planning should include appropriate implant selection. Cruciate retaining rather than cruciate substituting prostheses should be used. In severe disease constrained knees or hinged prostheses should be considered. The need for these considerations has been highlighted by the reports of dislocated prostheses (Macauley et al, 2010).
Femoral nerve blockade is contraindicated following knee arthroplasty – early quadriceps motor block could predispose to early development of a knee flexion deformity. Continuous Passive Motion (CPM) is not recommended as this can exacerbate the rigidity experienced.

3.3 Shoulder

3.3.1 Shoulder hemiarthroplasty for proximal humeral fractures

One report has assessed the outcomes of shoulder hemiarthroplasty for proximal humerus fractures (Kryzak et al. 2010). Their retrospective review of seven patients with a minimum of two years follow-up suggested that the surgical outcomes for patients with Parkinson's disease are poor. Mean achievable abduction was 97 degrees, external rotation 38 degrees and internal rotation to the level of the sacrum. Although there was one non-union and one mal-union no patient required revision surgery. On a scale of 1-5 the mean pain score remained as high as 2.5 and the authors concluded that the benefit of this surgical procedure in patients with Parkinson's disease is marginal. Consequently patients need to be counselled regarding the poor prognosis in surgery with anticipated persistent pain and restriction of movement.

Stage 1	Not disabling, mild, unilateral symptoms (e.g. tremor, posture, locomotion, and facial expression).
Stage 2	Bilateral involvement, without impairment of balance. Possibly already a light kyphotic posture, slowness and speech problems. Postural reflexes are still intact.
Stage 3	Significant slowing of body movements, moderate to severe symptoms, postural instability, walking is impaired, but still possible without help, physically independent in ADL
Stage 4	Severe symptoms, rigidity and bradykinesia, partly disabled, walking is impaired, but still possible without
Stage 5	Fully disabled, walking and standing impossible without help, continuous nursing care is necessary

Table 4. The Hoehn and Yahr scale for staging Parkinson's disease (Hoehn et al. 1967).

3.3.2 Total shoulder arthroplasty

There are two studies reviewing patients with Parkinson's disease that underwent a total shoulder arthroplasty (TSA)(Koch et al. 1997; Kryzak et al. 2009)(Table 5. Page 522).
The first study by Koch et al, reviewed 15 patients between 1979 and 1990 who underwent TSA in the Mayo clinic, Rochester(Koch et al. 1997). There were 16 TSA performed in 15 patients suffering from Parkinson's disease that were prospectively monitored as part of the total shoulder arthroplasty registry with average length of follow up of 5.3 years. Six of the patients in the study group were deceased at the most recent review and the average follow up was 2.1 years. The authors report that only 25% of the group achieved excellent results, 12.5% were rated satisfactory and 62.5% rated unsatisfactory. They also reported a

significant reduction in external rotation after surgery. Three patients out of 15 required revision surgery, two for painful subluxation and one for glenoid loosening. The authors concluded that despite careful rehabilitation and medical management of Parkinson's disease, functional results are poor, particularly in patients older than 65 years of age.

Recently Kryzak et al have reported a series of 49 TSA performed in patients with Parkinson's disease for osteoarthritis of the shoulder(Kryzak et al. 2009). Mean age of patients at time of surgery was 69.7 years and 17 TSA were done in women while 32 were in men. Mean age of follow up was 8 years. Eight out of 49 shoulders were revised, three were revised in less than one year due to instability, four were revised due to loosening of the components and one due to periprosthetic fracture(Kryzak et al. 2009). The authors report a significant relief of pain with the average pain score decreasing from 4.6 pre-op to 1.8 post-op at last follow up. Overall they had 10 excellent (23%) results, 13 satisfactory (30%) results and 20 unsatisfactory (47%) results. The most common reason for unsatisfactory results were insufficient abduction, external rotation or a combination of both, instability requiring revision and continued pain.

Study authors	Study type	Arthroplasty (type + numbers)	Mean age (yrs, range)	Length of follow up (yrs)	Implant type/surgical technique	Outcome
Kryzak et al	retrospective	TSA (49)	69.7 (54 - 87)	8 years	31 Cofield (Smith and Nephew, Memphis, TN), 13Neer (Kirschner Medical, Fairlawn, NJ), 4 Tornier (Grenoble,France), and 1 Biomet humeral components (Warsaw, IN), 26 Cofield (Smith and Nephew), 18 Neer (KirschnerMedical), 4 Tornier (Grenoble, France), and 1 Biomet glenoidcomponents (Warsaw, IN)	16.3% of shoulders revised, 88% survival free of revision, 23% had excellent results, 30% satisfactory and 47% unsatisfactory
Koch et al	retrospective	TSA (16)	49 - 84 years	5.3 (1.2 - 15) years	standard deltopectoral approach was used, 12 cases used Neer (Kirschner Medical, Fairlawn, NJ), 4 cases treated with Cofield (Smith and Nephew, Memphis, TN)	40% of patient were dead at the most recent review, 25% rated as excellent, 12.5% rated as satisfactory and 62.5% rated as unsatisfactory results. 3 patients required revision 2 for subluxation and 1 for aseptic loosening

Table 5. Summary of the studies in patient with Parkinson's disease undergoing TKR.

4. Summary

Parkinson's disease affects a not inconsiderable proportion of the population and it is inevitable that the orthopaedic surgeon encounters these patients in practice. Arthroplasty of the hip, knee and shoulder are frequently used to alleviate pain from numerous arthropathies and hip and shoulder arthroplasty utilized in selected fracture patterns around the respective joints.

We have highlighted specific areas that require attention in the pre-, intra-, and post-operative management of patient with Parkinson's disease undergoing arthroplasty procedures. Although outcomes following elective arthroplasty procedures are promising, outcomes after shoulder hemiarthroplasty for trauma are less than encouraging.

Despite this, there is a distinct lack of evidence in the literature for many facets of care. We encourage physicians and surgeons alike to optimise the medical and surgical management of patients with Parkinson's disease to ensure best possible outcomes.

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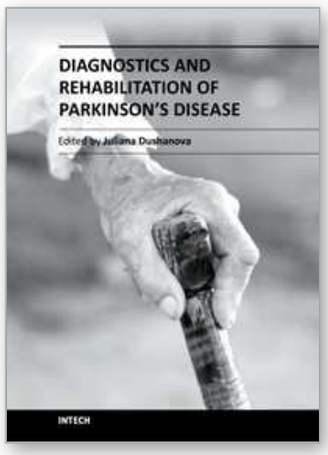

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Diagnostics and Rehabilitation of Parkinson's Disease presents the most current information pertaining to news-making topics relating to this disease, including etiology, early biomarkers for the diagnostics, novel methods to evaluate symptoms, research, multidisciplinary rehabilitation, new applications of brain imaging and invasive methods to the study of Parkinson's disease. Researchers have only recently begun to focus on the non-motor symptoms of Parkinson's disease, which are poorly recognized and inadequately treated by clinicians. The non-motor symptoms of Parkinson's disease have a significant impact on patient quality of life and mortality and include cognitive impairments, autonomic, gastrointestinal, and sensory symptoms. In-depth discussion of the use of imaging tools to study disease mechanisms is also provided, with emphasis on the abnormal network organization in parkinsonism. Deep brain stimulation management is a paradigm-shifting therapy for Parkinson's disease, essential tremor, and dystonia. In the recent years, new approaches of early diagnostics, training programmes and treatments have vastly improved the lives of people with Parkinson's disease, substantially reducing symptoms and significantly delaying disability. Written by leading scientists on movement and neurological disorders, this comprehensive book should appeal to a multidisciplinary audience and help people cope with medical, emotional, and practical challenges.

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