Trends in Primary Proximal Interphalangeal Joint System and Revisions for Osteoarthritis of the Hand in the Medicare Database

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Abstract

Background: Proximal interphalangeal arthroplasty (PIPA) has been indicated for patients suffering from osteoarthritis (OA) or rheumatoid arthritis of the hand. Although there is extensive literature showing the outcomes of PIPA, there is paucity in the literature regarding trends of PIPA in patients with OA of the hand. The purpose of this study was to determine annual primary utilization and revision PIPA trends within the Medicare population with the use of an administrative database. **Methods:** A retrospective query was performed using the Medicare Standard Analytical Files from the PearlDiver database. Patients undergoing primary and revision PIPA with hand OA were queried using *International Classification of Disease, Ninth Revision*, and *Current Procedural Terminology* coding. Primary outcomes analyzed included annual and revision utilization of PIPA and demographic comparison of age, gender, and geographic location. Statistical analysis was primarily descriptive. An α value less than 0.05 was considered statistically significant. **Results:** The query returned 10191 patients who underwent primary and revision PIPA between 2005 and 2013. Calculated annual growth rate for primary and revision PIPA was 2.40% and -0.03%, respectively ($P < .001$). Patients between the ages of 70 and 74 years represented most of the patients undergoing a primary PIPA, whereas patients between 65 and 69 years most commonly underwent a revision procedure. Regionally, primary and revision PIPA were most commonly performed in the South. **Conclusion:** The data demonstrate an increased use of primary PIPA utilization for patients with OA, whereas revision PIPA decreased. The increased use indicates the increasing demand for PIPA in the United States.

Keywords: hand, anatomy, epidemiology, research and health outcomes, outcomes, biostatistics

Introduction

Osteoarthritis (OA) is a leading cause of musculoskeletal morbidity in elderly patients, with the hand being the most frequent site of OA development.^{1–3} According to the Framingham Offspring and Community cohorts study, the age-standardized prevalence of radiographic OA of the proximal interphalangeal (PIP) joint was found to be 13.5% and 16.5% in men and women, respectively, while symptomatic PIP OA ranged from 0.7% to 2%.⁴ Other etiologies of PIP joint arthritis include inflammatory arthritis and posttraumatic arthritis.⁵

Proximal interphalangeal arthrodesis remains the gold standard for treatment of PIP arthritis in those patients who have failed conservative management.⁶ Although arthrodesis minimally interferes with function of the index and middle fingers, fusion of the ring and little finger, which require

flexion, has been shown to be more disabling.⁷ Furthermore, studies have shown that patients undergoing arthrodesis of the finger may develop infections, nonunion, malunion, symptomatic hardware, nail abnormalities, screw cut out, osteomyelitis, and paresthesia.^{8,9} The significant postoperative complications and reduction in range of motion (ROM) following arthrodesis has resulted in further research advancing proximal interphalangeal arthroplasty

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Table 1. Annual Trends in PIPA Versus Revision PIPA in the Medicare Population From 2005-2013.

Years	Primary PIPA	Revision PIPA	Revision index, %	Revision burden, %
2005	892	40	4.48	4.29
2006	1069	57	5.33	5.06
2007	1056	55	5.20	4.95
2008	1133	58	5.11	4.86
2009	1148	60	5.22	4.96
2010	1184	50	4.22	4.05
2011	1124	44	3.91	3.76
2012	1065	39	3.66	3.53
2013	1078	39	3.61	3.49
Total	9749	442	4.53	4.33
CAGR	2.40%	-0.31%	-2.64%	-2.54%

Note. PIPA = proximal interphalangeal arthroplasty; CAGR = compound annual growth rate.

(PIPA) as joint replacement aims to maintain or improve movement while mitigating pain.¹⁰

Recent long-term outcome studies have shown PIPA to significantly reduce pain and improve ROM and grip strength.¹¹ Data have shown favorable outcomes of PIPA; however, there is a paucity in the literature discussing trends of PIPA utilization. The purpose of this study was to perform an epidemiological analysis on the use of PIPA among patients with hand OA within the Medicare population, with the use of an administrative database. Primary outcomes analyzed include: (1) annual trends in primary PIPA utilization; (2) annual trends of PIPA revision; and (3) demographic considerations such as age, gender, and geographic location.

Materials and Methods

A retrospective query was performed using the Medicare Standard Analytical Files from the PearlDiver supercomputer (PearlDiver Technologies, Fort Wayne, Indiana). PearlDiver is a commercially available Health Information Portability and Affordability Act-compliant database used extensively for orthopedic-related research.¹² The database contains the records of more than 100 million patients and information such as diagnosis, procedures, complications, discharge disposition, length of stay, cost, reimbursement, and other information. As the database contains deidentified information, the study was exempt from the institutional review board approval. Patients in the study were queried with using *International Classification of Disease, Ninth Revision*, and *Current Procedural Terminology (CPT)* coding (Supplementary Table 1).

The database was queried for all patients with a diagnosis of hand OA who underwent primary PIPA with CPT code 26536. Patients who underwent a revision procedure were queried using CPT code 26320. Primary outcomes analyzed in the study included compounded annual growth

rate for primary and revision PIPA, annual revision incidence (RI), and revision burden of PIPA on the health care system. Revision burden was calculated as the ratio of revisions to the sum of primary and revision PIPA procedures, as mentioned in the previous studies.¹³

Statistical analysis was primarily descriptive and was performed using the programming language R (University of Auckland, New Zealand). An α value less than 0.05 was considered statistically significant.

Results

The query returned 10 191 patients who underwent primary PIPA ($n = 9749$) and revision PIPA ($n = 442$) between 2005 and 2013. Calculated annual growth rate for primary and revision PIPA was 2.40% and -0.03%, respectively ($P < .001$). Mean annual number of primary and revision PIPA procedures performed during the study interval was 1083 and 49 ($P < .001$), respectively (Figure 1). Pearson correlation coefficient showed the incidence of revision PIPA procedures decreased through the study interval ($R^2 = -0.77$, $P = .015$).

Patients between the ages of 70 and 74 years comprised of those undergoing primary PIPA (33.04%), whereas patients between 65 and 69 years comprised of those requiring a revision procedure (45.93%). Women represented the majority of patients who underwent primary (71.25%) and revision (86.65%) procedures. Incidence of primary (37.70%) and revision (40.27%) PIPA was most commonly performed in the South, followed by the Midwest, West, and finally, the Northeast (Table 1, Table 2).

Discussion

The PIP joint arthroplasty system has been indicated for patients who have failed conservative therapies such as self-management, behavioral changes, joint supports,

Figure 1. Annual trends of primary and revision proximal interphalangeal arthroplasty within the Medicare population from 2005-2013.

adjunct pharmacological treatments, topical nonsteroidal anti-inflammatory drugs, and intra-articular corticosteroid injections for PIP OA and rheumatoid arthritis (RA).¹⁴ The desire for increased joint mobility over stability and grip strength is redirecting the once mainstay therapy of arthrodesis to PIPA. The purpose of this study was to examine trends in primary and revision PIPA rates by analyzing a comprehensive Medicare database between 2005 and 2013. The study demonstrates that primary PIPA utilization for OA of the hand has increased within the Medicare population during the study period, whereas revision procedures have decreased.

The PIP joint OA is a common symptomatic complaint of the hand and has been shown to have a frequency in the population that ranges from 0.7% to 2%.⁴ In fact, the hand is the most commonly affected site of OA in general.³ Proximal interphalangeal arthroplasty has consistently produced satisfactory pain relief and increased joint mobility for most patients.^{8,15-27} It was once a mainstay treatment for RA, but with the introduction of disease-modifying antirheumatic drugs in the 1990s, the need for PIPA in this patient population has continually decreased in the recent decades. Nonetheless, reconstruction rates for the osteoarthritic hand have gradually increased.²⁸ In a prospective study of 43 patients by Daecke et al,¹⁹ patients with PIPA had good to excellent pain reduction regardless of the type of implant used. In a prospective study of 20 patients, Pettersson et al²⁹ found that patients with PIPA had 100% success in improving pain levels. In a 2-year follow-up study by Komatsu et al,³⁰ patients who underwent PIPA had significantly reduced visual analog scale scores and Disabilities of the Arm, Shoulder and Hand scores. Other studies comparing preoperative and postoperative Michigan Hand Outcomes Questionnaire scores, Patient Evaluation Measure, and Canadian Occupation Performance Measure scores found similar improvements in patients using PIPA. In a meta-analysis of PIPA outcomes by Yamamoto et al,¹⁴ 66%

of the articles ($n = 40$) cited improvements in their patient-reported outcome measurements with the use of PIPA.

The goal of any joint arthroplasty procedure is 3-fold: to improve ROM, provide a stable joint, and decrease pain. For PIPA, the primary indication is pain.³¹ The ROM in patients with PIPA has also been studied extensively within the literature, with most patients having improved postoperative ROM to a variable degree.^{22,30,32-34} However, even when the postoperative ROM was equal to preoperative ROM or marginally better, there was pain improvement, and it was independent of the cause of arthritis or the type of implant used.³¹ Historically, the choice of implant and surgical approach was left up to the surgeon's discretion as each (surface replacement, silicone, and pyrocarbon) has its own advantages and complication profiles.²⁸ Several studies found no differences among the 3 implant types with regard to subjective and objective measures.^{19,27,35} However, recent data are leaning in favor of using the silicone implant via the volar approach, due to the decreased complication rates and improvements in pain in up to 98% of patients.^{14,31}

Surface replacement implants have shown a tendency for temporarily superior postoperative ROM, but markedly higher rates of complications and subsequent explantation when compared with the silicone spacer implant.^{22,23} Pyrocarbon implants, the newest type, have a modulus of elasticity similar to cortical bone, which, in theory, minimizes stress shielding and allows for bone in-growth. However, clinical evidence has failed to demonstrate this. Pyrocarbon implants have high rates of complications and revisions, contributing to the poorer outcomes observed in the literature.^{16,18,19,27,36} In fact, the rates of revision and salvage operations were nearly 4 times as high in the pyrocarbon group compared with silicone.¹⁷ Silicone implants, which act as a spacer, have been proven to have the lowest complication rates.¹⁴ Complications seen with silicone implants

Table 2. Primary and Revision PIPA Utilization by Age Groups Within the Medicare Population Between 2005 and 2013.

Demographics	Primary PIPA, %	Revision PIPA, %
Age, y		
Unknown	2.77	^a
<65	9.44	12.44
65-69	25.43	45.93
70-74	33.04	20.59
75-79	17.03	13.12
80-84	8.51	4.30
>84	3.79	^a
Gender		
Female	71.25	86.65
Male	24.96	11.99
Unknown	3.80	^a
Region		
Midwest	27.97	26.69
Northeast	9.95	11.76
South	37.70	40.27
West	24.38	21.26

Note. PIPA = proximal interphalangeal arthroplasty.

^aUnavailable data.

are most commonly related to implant degradation and subsequent inflammatory response to particle debris, but one can also see disruption of the radial and lateral collateral ligaments, as well as the inability to resist coronally directed forces, which make them the less ideal implant choice for the index finger.^{14,15,17,19,32}

The volar approach has gained popularity as the recent literature has demonstrated it to be associated with maintaining the integrity of the extensor mechanism. This allows early postoperative ROM exercises to be performed, which aims to prevent extension lag or contracture within the arc of motion.¹⁴ The main disadvantage of a volar approach is a failure to properly repair the volar plate, which can result in PIP joint hyperextension instability or swan neck deformity.¹⁹ Favorable outcomes of the volar approach have been published.^{14,24,32,35}

Today, silicone arthroplasty using the volar approach has become the most popular combination due to better outcomes in terms of predictable pain relief, improved postoperative ROM, decreased extension lag, and decreased revision rates compared with alternative approaches and implants. In the most recent systematic review, silicone arthroplasty with volar approach had the lowest rate of revisions. There is a clear difference in the number of revisions between silicone arthroplasty with volar approach and silicone or surface replacement arthroplasty with dorsal approach.¹⁴

Being a database analysis study, the study is not without limitations. The validity of the study and results are reliant on the accuracy of procedural coding within the database. This translates to the fact that miscoding and noncoding by

providers is a potential source of error. It is estimated that 1.3% of coding errors are currently present within the Medicare population.³⁷ Second, the study used only a single insurer's data in the analysis and may not represent a true cross-sectional representation of the number of patients undergoing primary and revision PIPA.³⁷ Finally, a selection bias may also be present as patients in the study may enter or exit the database as a natural manifestation.³⁷⁻³⁹ Despite these limitations, the study provides vital information to patients and providers on trends of primary and revision rates of PIPA.

Conclusion

This study demonstrates an increasing trend of PIPA system utilization for patients suffering from OA of the PIP joint during our study interval. Preserved or improved ROM, reduced pain, and advances in surgical approaches potentially explain the increasing use of PIPA than traditional joint arthrodesis. Due to the increasing elderly population with concomitant OA, we can expect the number of annual PIPA to continue to increase. Future studies are necessary to compare outcomes of patients with comorbid conditions undergoing primary PIPA.

Ethical Approval

This study was approved by our institutional review board.

Statement of Human and Animal Rights

This article does not contain any studies with human or animal subjects.

Statement of Informed Consent

As the information was obtained from a deidentified and Health Information Portability and Affordability Act compliant database, obtaining informed consent is not applicable.

Declaration of Conflicting Interests

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