Are different generations of Ceramic-on-Ceramic (CoC) implants more cost-effective than Metal-on-Polyethylene (MoP) implants in primary total hip arthroplasty?

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INTRODUCTION

Severe hip osteoarthritis (OA) is characterized by irregularities in the hip joint surface, deformities, pain, and loss of function, leading to limitations in daily activities and mobility and often requiring total hip arthroplasty (THA).

This study evaluates the cost-effectiveness of choosing between the third-generation CoC implants (3rd-CoCs) and the fourth-generation CoC implants (4th-CoCs), as opposed to Metal-on-Polyethylene implants (MoPs), which are covered by national health insurance, in primary THA. The coverage price of the MoPs was USD $1,221, but the CoCs required an average copay of $3,531 (SD±385.1), so the 3rd- and 4th-COCs cost 1.2 to 2.7 times more than the MOPs.

OBJECTIVE

To compare the 3rd- and 4th-CoCs versus MoPs in:

- Adverse outcomes
  - Revision
  - Postoperative complications
  - 90-day medical complications
- Healthcare costs
  - NHI payments
  - Implant copays

To calculate the incremental cost-effectiveness ratios (ICER).

- $ICER = \frac{\Delta\ Healthcare\ Costs}{\Delta\ Event{-}free\ survival\ rates}$

METHOD

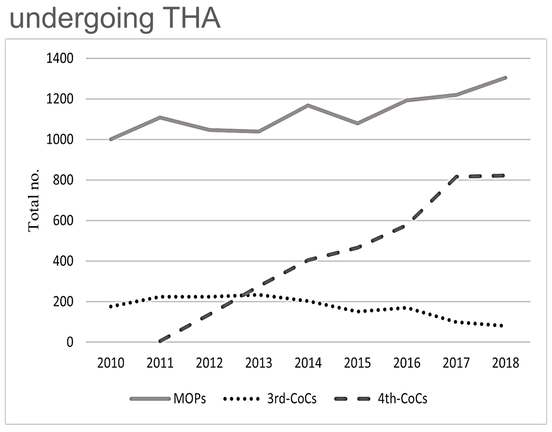
This retrospective cohort study used Taiwan's NHI claims data from patients from 2009–2019.

- Patients aged ≥ 50 who underwent unilateral primary THA with 1-year follow-up were included.
- A one-to-one match was employed to create comparable implant groups, using exact matching on age (±5), sex, procedure year, five major diseases, followed using propensity scores within a ±0.2 range to adjust for remaining confounders.
- Use event-free survival rates and hazard ratios (HR) to present adverse outcomes.
- Healthcare costs were using generalized linear models (GLMs) with a gamma log-link.
- ICERs were calculated by dividing individual-level incremental healthcare costs by incremental event-free survival rates, with 1,000 bootstrap iterations for robustness.

RESULTS

Figure 1 shows that the 3rd-CoCs were available in Taiwan before 2010, and 4th-CoCs have been available since 2011. The difference in price and availability were addressed by propensity score matching.

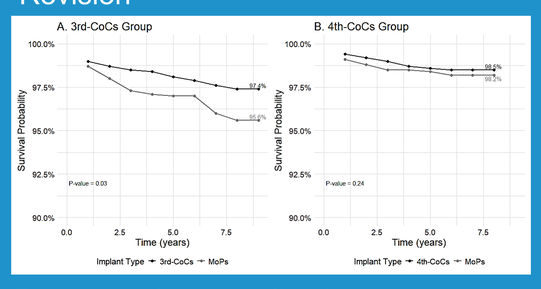
Figure. 1 Trends in the choices of patients undergoing THA



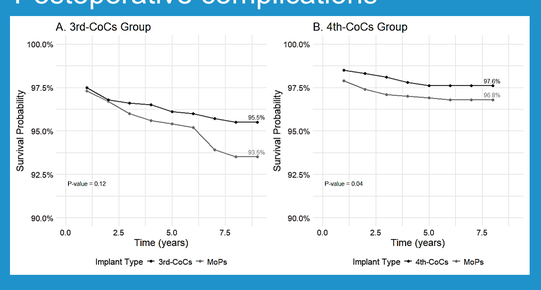
This cohort comprised 15,233 patients undergoing primary THA: MoPs(66.7%), the 3rd-CoCs(10.3%) and the 4th-CoCs (23.0%). After matching, both 3rd-and 4th-CoCs groups were balanced in terms of baseline characteristics with all SMD less than 0.1. The mean age of our samples was 65 years and 71% being women.

Better event-free survival rates in 3rd- and 4th-CoCs than MoPs.

Revision



Postoperative complications



90-day medical complications

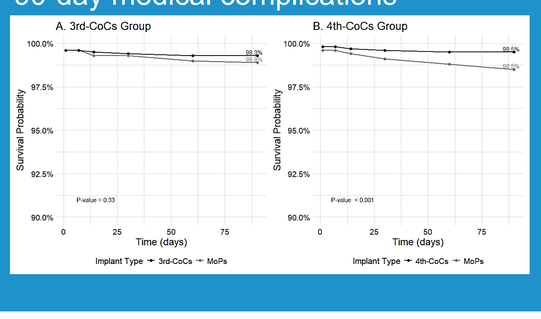


Table 1. Hazard ratios of adverse outcomes after adjustment of major covariates based on proportional hazard model.

	3rd-CoCs group (Ref : MoP)		4th-CoCs group (Ref : MoP)	
	HR (95%CI)[c]	P-value	HR (95%CI)[c]	P-value
Revision	0.53 (0.34-0.85)	0.01	0.86 (0.53-1.38)	0.53
Postoperative complications [a]	0.69 (0.49-0.99)	0.04	0.76 (0.54-1.08)	0.12
90-day medical complications [b]	0.63 (0.28-1.40)	0.26	0.29 (0.15-0.54)	< 0.01

a. Postoperative complications: revision, periprosthetic joint infection, dislocation, periprosthetic fracture.
b. 90-day Medical complications: pulmonary embolism, pneumonia, deep vein thrombosis, or sepsis.
c. Adjusting covariates: Age group, Insured status, Elixhauser comorbidity indices, Hospital ownership, Healthcare facility level, Hospital region, Bone cement, Modular neck stem, years of Specialty Practice, and surgeon's surgical volume in the year before surgery.

Compared to matched MoP, the 3rd-CoCs showed lower hazards for revision and for postoperative complications. The 4th-CoCs demonstrated a lower hazards for 90-day medical complications.

Table 2. ICERs of CoC implants compared with MoPs

	3rd-CoCs group[a] (1,161 pairs)			4th-CoCs group[b] (3,181 pairs)		
	ΔEvent-free survival (%)[a]	ΔHealthcare costs	ICER	ΔEvent-free survival (%)[a]	ΔHealthcare costs	ICER
Revision[b]	1.21	846	704.0 (688.5 - 719.6)	0.33	2,483	7,605.0 (7566.2 – 7643.8)
Postoperative complications[b]	1.09	846	794.1 (775.2 – 813.0)	0.78	2,483	3,188.39 (3176.7 – 3200.1)
90-day medical complications[c]	0.33	1,404	4,375.9 (4,338.6 – 4,413.2)	0.96	2,814	2,947.1 (2,940.4 - 2,953.8)

a. Event-free survival is an incremental event-free survival prediction of adverse events in implants, considered MoPs as reference.
b. The comparison of different regressor value was observed in median follow-up 6.0 and 3.3 years in 3rd and 4th CoCs.
c. The observed period was 90 days.

Positive incremental healthcare costs and event-free survival indicated that both CoCs exhibited lower incremental costs and higher incremental event-free survival compared to MoPs.

CONCLUSIONS

Real-world data in Taiwan demonstrated that for patients aged 50 years and older undergoing primary THA for OA, CoC implants provide superior event-free survival in specific adverse outcomes but at a higher total healthcare cost difference of US$846 for the 3rd-CoCs, and US$2,841 for the 4th-CoCs averaged over the 10-year study period.

Our findings suggest that 3rd-CoCs seem to be a cost-effective option. However, the cost-effectiveness of 4th-CoCs remains less certain, given the limited long-term data available and considering each healthcare system's willingness-to-pay threshold. Future studies with extended follow-up periods are needed to better assess the economic viability of newer CoC implants.

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For more info about other studies by Li-Jung Elizabeth Ku

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