



Advanced imaging adds little value in the diagnosis of symptomatic femoroacetabular impingement



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Disclosures - 1



- Daniel Cunningham, B.S.
 - I have no financial relationships to disclose
- Chinmay Paranjape, B.S.
 - I have no financial relationships to disclose
- Joshua Harris, M.D.
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Advanced imaging adds little value in the diagnosis of symptomatic FAI

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INTRODUCTION

- Femoroacetabular impingement (FAI) is an increasingly recognized source of hip pain and disability in young active adults [1]
- Providers supplement physical exam maneuvers with injection, magnetic resonance imaging (MRI), or magnetic resonance arthrography (MRA) [2-8]
- Diagnostic imaging represents the fastest rising segment of costs in US healthcare [9]
- Therefore, there is a need for value driven diagnostic algorithms.
- The purpose of this study was to identify cost-effective diagnostic strategies for symptomatic FAI, comparing history and physical exam (H&P) alone to supplementation with injection, MRI, or MRA.

HYPOTHESIS

- At a willingness of the healthcare system to pay of \$100,000, supplemental imaging modalities would be less cost-effective than H&P with injection or H&P alone in detecting symptomatic FAI

METHODS

Model overview

- The model was designed according to guidelines from the Panel on Cost-effectiveness in health and medicine by the US Public Health Service
- A simple-decision model run as a cost-utility analysis (TreeAge Pro 2016) was constructed to assess the diagnostic value added to H&P of the following in diagnosis of symptomatic FAI (Figure 1)
 - H&P + MRI, H&P + MRA, and H&P + injection

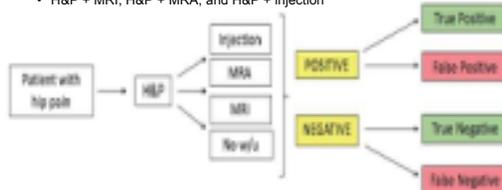


Figure 1: Diagnostic workup schematic showing undifferentiated patient with anterior mechanical hip pain. All patients start with history and physical. Some patients receive diagnostic imaging or injection. Progression to the end states of being found positive or negative for disease are based on history and physical findings with or without additional imaging or hip injection

- Diagnostic test accuracy, treatment outcome probabilities, and utilities were extracted from the literature as shown in Table 1

Table 1: Base case model parameters

Input Variable	Estimate	Low	High	Reference
MRA sensitivity	0.87	0.84	0.90	[5, 6]
MRA specificity	0.64	0.54	0.74	[5, 6]
MRI sensitivity	0.66	0.59	0.73	[5, 6]
MRI specificity	0.79	0.67	0.91	[5, 6]
Physical exam sensitivity	0.75	0.70	0.99	[3]
Physical exam specificity	0.92	0.00	1.00	[3]
Hip injection sensitivity	0.92	0.5	1.0	[6, 7]
Hip injection specificity	0.81	0.5	1.0	[6, 7]
FAI prevalence	0.55	0.22	0.68	[4, 10, 11]

METHODS, Continued

- Strategies were compared using the incremental cost-effectiveness ratio (ICER) with willingness to pay (WTP) of \$100,000/QALY (quality adjusted life year) [12]
- ICER represents differences in costs divided by differences in QALY for each strategy while WTP is a value that describes the societally-accepted economic worth of increased quality of life
- Direct costs were measured using the Humana database (Pearl Diver Inc.)
- Utilities were calculated as shown in Figure 2 based on conversions from Harris Hip scores as previously reported [13]

$$U_{\text{until definitive diagnosis}} = \sum U_{\text{non-definitive states}} \times U_{\text{non-definitive states}}$$

$$U_{\text{after definitive diagnosis}} = U_{\text{good hip}} \times U_{\text{remaining in time horizon}}$$

$$U_{\text{final state}} = U_{\text{until definitive diagnosis}} + U_{\text{after definitive diagnosis}}$$

Figure 2: Utilities were calculated based on the above equations. The overall utility was calculated based on the utility until definitive diagnosis added to the utility after definitive diagnosis.

RESULTS

Base Case Cost-effectiveness

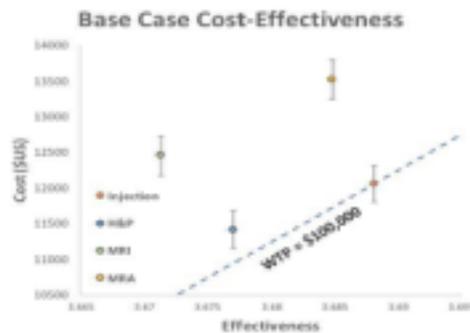


Figure 3: Cost-effectiveness analysis in the base case. MRI+H&P and MRA+H&P both represent dominated strategies in comparison to H&P+injection. H&P alone was undominated in comparison to H&P+injection.

Sensitivity analyses

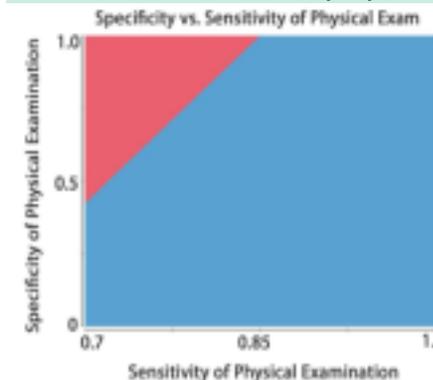


Figure 4: Two way sensitivity analysis demonstrating the impact of varying sensitivity and specificity of physical examination on the preferred diagnostic strategy at a WTP of \$100,000.

Table 2: Sensitivity analysis of variables affecting decisions within model. High injection sensitivity, physical exam specificity, and prevalence favored H&P + injection while high physical exam sensitivity favored H&P alone. Diagnostic strategies that included advanced imaging were not preferred in this analysis.

Variable	Threshold Value	Preferred Strategy Below Threshold	Preferred Strategy Above Threshold
Physical exam sensitivity	0.82	H&P + injection	H&P
Physical exam specificity	0.62	H&P	H&P + injection
Prevalence	0.24	H&P	H&P + injection
Injection sensitivity	0.85	H&P	H&P + injection

RESULTS, Continued

Cost-effectiveness acceptability curve

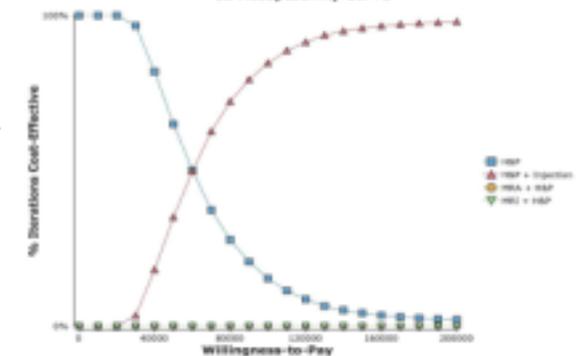


Figure 5: Cost-effectiveness acceptability curve that compares the proportions of iterations a strategy is cost-effective against the willingness to pay of the healthcare system. At lower WTP (<\$60,000), H&P alone represents a marginally superior method for diagnosis. However, at higher WTP values of the healthcare system, H&P + injection rapidly becomes the favorable method for diagnosis.

Threshold analysis: General orthopedist vs. Hip preservation specialist

Table 3: Threshold analysis of injection sensitivity and willingness to pay threshold in various relevant clinical scenarios. Low physical exam sensitivity and symptomatic FAI prevalence may represent parameters applicable to the general practitioner. High physical exam sensitivity and symptomatic FAI prevalence may represent parameters applicable to the hip preservation specialist. Injection in addition to H&P is favored in situations with injection sensitivity above threshold. Healthcare WTP is calculated at the exam sensitivity and disease prevalence shown in the "Input variables" column along with the threshold injection sensitivity.

Clinical setting	Input Variables		Output Variable Thresholds	
	Exam sensitivity	FAI prevalence	Injection Sensitivity	WTP
General practitioner's office	0.70	0.33	0.81	\$110,000
Hip preservation specialist office	0.925	0.68	0.94	\$299,000

CONCLUSIONS

- Adjunct use of injection was preferred in situations with WTP > \$60,000/QALY, low physical exam sensitivity, and high FAI prevalence
- Providers with low physical exam sensitivity in situations with low disease prevalence may most benefit from including hip injection in their diagnostic strategy.
 - With low disease prevalence and physical exam sensitivity, H&P with injection was the most cost-effective strategy
- Providers with high physical exam sensitivity in situations with high disease prevalence may not benefit from including hip injection in their diagnostic strategy.
 - With high disease prevalence and physical exam sensitivity, H&P with injection was only favored at exceptionally high WTP
- Providers should not routinely rely on advanced imaging to diagnose symptomatic FAI.

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