

Appendix 1. Summary of the literature evaluating major joint injections.

Author/Year	Target	Study Design	Level of Evidence	Subject Type/Number	Accuracy Confirmation	Outcome
Zufferey 2011 ⁵¹	GH joint	Prospective, randomized, blinded comparison study of USGI vs. LMGI efficacy	Level 2	67 live human subjects	None	More pain relief at rest and more good responders in USGI at 2 and 6 weeks post-injection.
Migliore 2010 ³⁴	SI joint	Case series, USGI accuracy and efficacy	Level 3 = accuracy, Level 4 = efficacy	7 live human subjects	Color Doppler ultrasound	USGI = 100% accurate, all patients reported significant pain improvement at 6 month follow-up
Naredo 2004 ⁵⁴	GH joint	Prospective, randomized, blinded comparison study of USGI vs. LMGI efficacy	Level 2	41 live human subjects	None	USGI had greater pain relief than LMGI
Sibbitt 2011 ⁵⁶	Knee	Prospective, randomized comparison study of USGI vs. LMGI efficacy	Level 2	94 live human subjects	None	USGI were less painful, had more responders, provided more improvement and lasted longer than LMGI

Hanchard 2006 ¹⁷	GH joint	Cadaveric LMGI accuracy	Level 2	11 cadaveric specimens	Dissection	64-86% accurate
Pourbagher 2005 ⁴¹	Hip	Case series, USGI accuracy and efficacy	Level 1 = accuracy, Level 4 = efficacy	10 live human subjects	CT arthrogram	100% accurate, 80% of patients had less pain and improved function 6 months post- injection
Esenyel 2010 ⁶⁰	GH joint	Cadaveric LMGI accuracy	Level 2	25 cadaveric specimens	Dissection	96% accurate
Sethi 2005 ⁴³	GH joint	Human LMGI accuracy	Level 1	41 live human subjects	MRI arthrogram	26.8% accurate
Park 2012 ³⁶	Knee	Prospective comparison study of USGI vs. LMGI accuracy	Level 1	99 live human subjects	Arthrogram	USGI = 96% accurate, LMGI = 83.7% accurate
Kim 2010 ²⁸	GH joint	Cadaveric LMGI accuracy	Level 2	23 cadaveric specimens	Dissection	95% accurate
Tobola 2011 ⁴⁷	GH joint	Human LMGI accuracy	Level 1	106 live human subjects	Athrogram	45.5%, 45.7%, and 64.7% accurate, depending on approach
Johnson 2011 ²⁵	GH joint	Human LMGI accuracy	Level 2	42 live human subjects under anesthesia	Arthroscopic confirmation	91% accurate
Sethi	GH joint	Cadaveric LMGI	Level 2	40 cadaveric	Arthrogram	50% and 80% accurate

2005 ⁶¹		accuracy		specimens		⁶¹ depending on approach
Jo 2011 ²⁴	GH joint	Human LMGI accuracy	Level 1	256 live human subjects	Arthrogram	73.8% accurate
Lopes 2008 ³¹	GH joint, knee	Case series, LMGI accuracy and efficacy	Level 1 = accuracy, Level 4 = efficacy	71 live human subjects	Arthrogram	GH joint = 82% accurate, knee = 100% accurate, Significant improvement in pain
Jackson 2002 ²²	Knee	Human LMGI accuracy	Level 1	240 live human subjects	Arthrogram	71%, 75%, and 93% accurate depending on approach
Smith 2009 ⁴⁵	Hip	Human USGI accuracy	Level 1	28 live human subjects	Arthrogram	97% accuracy
Curtiss 2011 ⁹	Knee	Cadaveric USGI vs. LMGI accuracy	Level 2	20 cadaveric specimens	Dissection	USGI = 100% accurate, LMGI = 55% to 100% depending on injector
Ziv 2009 ⁵⁰	Hip	Human LMGI accuracy	Level 2	40 live human subjects under anesthesia	Intra-operative confirmation	77.5% accuracy
Souza 2010 ⁴⁶	GH joint	Human USGI accuracy	Level 1	180 live human subjects	MRI	92% accurate on 1 attempt, remaining 8% accurate on second attempt
Berkoff	GH joint,	Meta-analysis USGI vs LMGI	Level 2	13 studies (5 knee, 7	N/A	USGI knee = 95.8%

2012 ⁵	knee	accuracy and efficacy		shoulder, 1 both)		accurate, LMGI Knee = 77.8% accurate, USGI GH joint = 88.8% accurate, LMGI GH joint = 61.1% accurate, All 6 studies that evaluated efficacy showed better efficacy with USGI than LMGI
Esenyel 2007 ¹³	Knee	Cadaveric LMGI accuracy	Level 2	39 cadaveric specimens	Dissection	56%, 73%, 76%, or 85% accurate depending on approach
Toda 2008 ⁴⁸	Knee	Human LMGI accuracy and efficacy	Level 1	50 live human subjects	Arthrogram	62%, 70%, and 86% accurate depending on approach, accurate injections = better efficacy than inaccurate injections
Park 2011 ³⁷	Knee	Human USGI accuracy	Level 1	126 live human subjects	Arthrogram	75%, 95%, and 100% accurate depending on

						approach
Jang 2013 ²³	Knee	Human USGI vs LMGI accuracy	Level 1	128 live human subjects	Arthrogram	USGI = 95%, and 97% accurate depending on approach, LMGI = 78% accurate
Patel 2012 ³⁸	GH joint	Cadaveric USGI vs LMGI accuracy	Level 2	80 cadaveric specimens	Arthrogram	USGI = 92.5% accurate, LMGI = 72.5%
Sibbitt 2012 ⁵⁷	Knee	Prospective, randomized comparison study of LMGI vs. USGI injection efficacy and cost-effectiveness	Level 2	64 live human subjects	None	USGI had less procedural pain, aspirated more fluid, had better outcomes, and reduced health care costs
Gokalp 2010 ¹⁵	GH joint	Human USGI accuracy	Level 1	29 live human subjects	MRI arthrogram	96.7% accurate
Diracoglu 2009 ¹²	Hip	Human LMGI accuracy	Level 2	16 live human subjects	Arthrogram	66.7% accurate
Yoong 2012 ⁵⁹	Hip	Prospective human study of value of response to diagnostic USGI hip injection to predict good surgical outcomes for total hip	Level 4	138 live human subjects	None	93% of patients who had reduced pain from injection had a successful surgical outcome

		arthroplasty				
Im 2009 ²¹	Knee	Human USGI vs LMGI accuracy	Level 1	89 live human subjects	Arthrogram	USGI = 95.6% accurate, LMGI = 77.3% accurate
Rutten 2009 ⁴²	GH joint	Human USGI vs FSGI accuracy and procedural pain	Level 1	25 live human subjects	MRI arthrogram	USGI = 94% accurate first attempt, 100% accurate after second attempt, less painful than FSGI, FSGI = 72% accurate first attempt, 100% accurate after second attempt
Migliore 2011 ³⁵	Hip	Open, retrospective, study evaluating NSAID consumption following USGI with hyaluronic acid	Level 4	2343 live human subjects	None	48.2% decrease in NSAID consumption following USGI
Soh 2011 ⁵⁸	Shoulder (didn't specific GH joint vs subacromial, etc)	Meta-analysis of image guided injections vs LMGI	Level 1	2 studies	N/A	Image-guided injections had better outcomes than LMGI, but only 2 studies met inclusion

						criteria
Bloom 2012 ⁶	Shoulder (didn't specific GH joint vs subacromial, etc)	Cochrane database review of efficacy of USGI vs. LMGI or intra-muscular steroid injection	Level 1	5 studies	N/A	Initial analysis revealed significant difference in pain reduction at 6 weeks favoring USGI, but re-analysis after removing trials with inadequate blinding revealed no difference between LMGI and USGI
Jones 1993 ²⁶	Knee, GH joint	Prospective, blinded study of LMGI accuracy	Level 2	109 live human subjects	Arthrogram	LMGI GH joint = 10% accurate, LMGI knee = 64% accurate
Daley 2011 ¹⁰	Knee, GH joint	Systematic literature of injection accuracy	Level 1	27 studies	N/A	LMGI GH joint = 27%, 40%, 42%, 85%, 100% accurate depending on approach, LMGI knee = 70%, 83%, 85% accurate depending on approach

Levi 2013 ³⁰	Hip	Retrospective Review of USGI accuracy	Level 4	11 live human subjects	Arthrogram	USGI = 100% accurate
Perdikakis 2012 ³⁹	GH joint	Prospective, randomized study comparing accuracy of USGI vs. FSGI vs CT-guided injection	Level 1	125 live human subjects	MRI arthrogram	100% accurate for all techniques
Catalano 2007 ⁷	GH joint	Human LMGI accuracy	Level 1	147 live human subjects	MRI arthrogram	LMGI 85% accurate
Smith 2006 ⁴⁴	Hip	Human USGI technique description	Level 5	1 live human subject	Arthrogram	100% accurate
DeMouy 1997 ¹¹	GH joint	Human LMGI accuracy	Level 2	8 live human subjects	MRI arthrogram	LMGI = 100% accurate
Luc 2006 ³²	Knee	Human LMGI accuracy	Level 1	33 live human subjects	Arthrogram	LMGI = 97% accurate
Lee 2009 ²⁹	GH joint	Prospective, randomized of LMGI vs. USGI efficacy for adhesive capsulitis	Level 2	43 live human subjects	None	USGI resulted in significantly more pain reduction, increased range of motion, and improved function than the LMGI
Elkousy 2011 ⁵³	Shoulder (didn't specify location [e.g., GH joint vs	Retrospective comparison study of USGI vs LMGI	Level 3	272 live human subjects	None	No difference in efficacy between LMGI and

	subacromial bursa, etc))	efficacy				USGI
Valls 1997 ⁴⁹	GH joint	Human USGI accuracy	Level 1	50 live human subjects	MRI arthrogram	USGI = 100% accurate
Micu 2010 ³³	Hip	Case control study comparing USGI efficacy vs. no injection	Level 3	61 live human subjects	None	USGI = significant pain reduction at 1 and 3 month follow-up, no pain relief in group that didn't receive injection
Sage 2012 ⁵⁵	Shoulder (didn't specify location [e.g., GH joint vs subacromial bursa, etc))	Meta-analysis comparing LGMI vs USGI efficacy	Level 1	6 studies	None	USGI = significantly more reduction in pain and night pain at 6 weeks, and improved shoulder abduction range of motion compared to LMGI. No between group difference was found in function.
Hermans 2011 ¹⁹	Knee	Systematic review of LMGI accuracy	Level 1	9 studies	N/A	LMGI = 67%, 72%, 85%, and 91% accurate depending on

						approach
Choudur 2011 ⁸	GH joint, hip, knee	Human USGI accuracy	Level 1	100 live human subjects	Arthrogram	USGI = 100% accurate
Kantarci 2013 ²⁷	Hip	Human USGI accuracy comparing 2 techniques	Level 1	59 live human subjects	MRI arthrogram	USGI = 100% accurate
Hurdle 2012 ²⁰	Knee	Case report of USGI accuracy in an obese patient	Level 5	1 patient	Joint fluid aspiration	USGI allowed accurate knee injection in an obese patient
Hartung 2010 ¹⁸	SI joint	USGI accuracy and efficacy	Level 1 = accuracy, Level 4 = efficacy	14 live human subjects (20 SI joints)	MRI arthrogram	USGI = 40% accurate, no difference in clinical outcomes between intra-articular and peri- articular injections
Balint 2002 ^{52*}	GH joint, Hip, Knee	Comparison study between ability to aspirate joints with LMG vs. USG	Level 2	30 live human subjects (32 joints)	None	Ability to aspirate joints with USG = 97%, ability to aspirate joints with LMG = 32%
Goncalves 2011 ¹⁶	GH joint, knee	Human USGI accuracy and efficacy	Level 4	31 live human subjects	None	USGI = 100% accurate by clinical evaluation, but not confirmed

						radiologically. All patients had improved clinically following the injection.
Porat 2008 ⁴⁰	GH joint	Human LMGI accuracy	Level 1	100 live human subjects	MRI arthrogram	LMGI = 99% accurate
<p>LMGI = landmark-guided injection, US-Ultrasound, vs = versus, USGI= ultrasound-guided injection, CT = computed tomography, MRI = magnetic resonance imaging, GH = glenohumeral, SI = sacroiliac, FSGI = fluoroscopically guided injection, NSAID = Non-steroidal anti-inflammatory drug, LMG = landmark-guidance, USG = ultrasound-guidance</p>						