■ WRIST AND HAND

Cost-effectiveness in the management of Dupuytren's contracture

A CANADIAN COST-UTILITY ANALYSIS OF CURRENT AND FUTURE MANAGEMENT STRATEGIES

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In Canada, Dupuytren's contracture is managed with partial fasciectomy or percutaneous needle aponeurotomy (PNA). Injectable collagenase will soon be available. The optimal management of Dupuytren's contracture is controversial and trade-offs exist between the different methods. Using a cost-utility analysis approach, our aim was to identify the most cost-effective form of treatment for managing Dupuytren's contracture it and the threshold at which collagenase is cost-effective. We developed an expected-value decision analysis model for Dupuytren's contracture affecting a single finger, comparing the cost-effectiveness of fasciectomy, aponeurotomy and collagenase from a societal perspective. Cost-effectiveness, one-way sensitivity and variability analyses were performed using standard thresholds for cost effective treatment ($50 000 to $100 000/QALY gained). Percutaneous needle aponeurotomy was the preferred strategy for managing contractures affecting a single finger. The cost-effectiveness of primary aponeurotomy improved when repeated to treat recurrence. Fasciectomy was not cost-effective. Collagenase was cost-effective relative to and preferred over aponeurotomy at $875 and $470 per course of treatment, respectively.

In summary, our model supports the trend towards non-surgical interventions for managing Dupuytren's contracture affecting a single finger. Injectable collagenase will only be feasible in our publicly funded healthcare system if it costs significantly less than current United States pricing.

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In Canada, Dupuytren's contracture (DC) is managed with open partial fasciectomy (PF) or percutaneous needle aponeurotomy (PNA).[1-3] Injectable collagenase has recently been approved for use in Canada and will soon be available.[4] Approximately 5000 patients were treated for Dupuytren's contracture in Canada during the 2009 to 2010 fiscal year, with about 95% undergoing PF.[5]

Trade-offs exist between these forms of treatment (Table I),[6-10] and there is no consensus regarding which is better for primary contractures.[10,11] PF is considered to be more definitive despite a higher morbidity.[2,8,9] A randomised controlled study has demonstrated a lower rate of recurrence and better release of more severe contractures following PF than PNA.[8,9] Both PNA and injectable collagenase leave the palmar fascia intact, which potentially reduces the chances of early and long-term success.[8-10,12,13] However, compared with PF, these two techniques minimise the time off work and the need for rehabilitation, making them more attractive to some patients.[1,8,9]

The introduction of new medical technology requires us to consider its economic impact. A United States (US) cost-utility analysis (CUA) compared these three methods of treating Dupuytren's contracture and found that none met the standard threshold of willingness-to-pay.[14] This analysis also revealed that injectable collagenase would need to cost significantly less than the US market price (> $3000 USD/injection[15]) in order to meet this threshold. Healthcare-related costs were the basis of this analysis and did not take into account costs incurred by the patient. Current health economics guidelines recommend inclusion of both health-care related and patient-incurred costs in order to provide a satisfactory representation of the overall cost to society.[16,17] This principle of cost utility analysis is certainly relevant to modelling decisions about the management of Dupuytren's contracture when one considers the morbidity of the procedure and the time required for rehabilitation, both of which have financial implications for the patient. The aim of this study was to conduct a cost-utility analysis of the treatment of this condition from the perspective of society, in order to identify the most cost-effective management strategy and to delineate the price at which injectable collagenase would be a cost-effective treatment in Canada.

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Table I. A summary of the major advantages and disadvantages of partial fasciectomy, percutaneous needle aponeurotomy and injectable collagenase

Procedure	Advantages	Disadvantages
Partial fasciectomy	Excision of palmar fascia - Lower rate of recurrence - Longer time before recurrence	Moderate peri-operative morbidity - Increased risk of complications - Surgical site tenderness - Risk of wound healing problems - Scarring can lead to new contracture - More follow-up required Costs: increased direct healthcare costs and costs related to patient recovery
Percutaneous needle aponeurotomy	Mild peri-procedural morbidity - Lower risk of complications - Minimal follow-up required Costs: Minimal direct healthcare costs and costs related to patient recovery	Only indicated for distinct cord Transection of palmar fascial cord - Increased risk of recurrence with residual abnormal fascia
Injectable collagenase	Mild peri-procedural morbidity - Lower risk of complications - Minimal follow-up required Costs: Minimal direct healthcare costs and costs related to patient recovery	Only indicated for distinct cord Limited information on long-term recurrence Risk of immediate failure - May require multiple treatments for successful release Costs: High cost of injectable collagenase in United States ($3000 to $5000 USD per injection)[15]

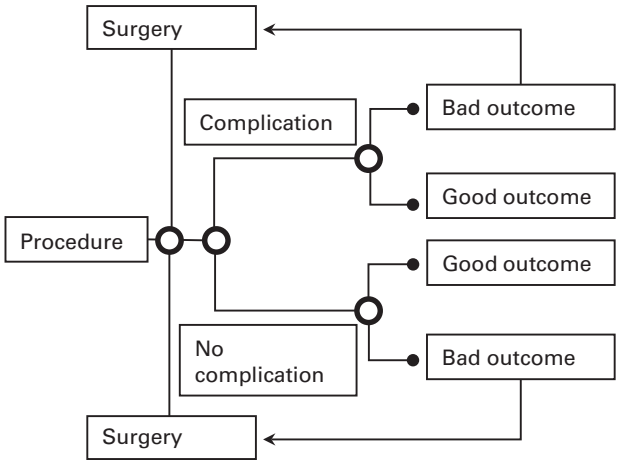

Fig. 1

Algorithm of decision analysis for single digit Dupuytren's contracture (Procedure: percutaneous needle aponeurotomy, partial fasciectomy or injectable collagenase; Complication: combined risk of common complications; Bad outcome: immediate failure or recurrence).

Materials and Methods

We developed an expected-value decision analysis model using the TreeAge Pro software package (Williamstown, Massachusetts), adhering to accepted recommendations for decision tree modelling and programming.[18] Our model compared the cost-effectiveness of open PF, PNA and injectable collagenase for the primary treatment of Dupuytren's contracture. Health states for all three treatment arms included successful (permanent relief of flexion contracture) or unsuccessful release, with or without complications. Unsuccessful release was either immediate with < 50% reduction of flexion contracture at the time of the procedure or delayed with recurrence after a set time following initial successful release. PF was the default salvage procedure after unsuccessful release (Fig. 1). Health states utility were adapted from previously published values (Table II).[15]

Considering the chronic, recurring nature of the condition, the time horizon of this model was 15 years, assuming that it started in men at a mean age of 63 years[1,10,12,13,19-22] with a mean life expectancy of 78 years.[23] Outcome measures included quality-adjusted life years (QALYs) and costs in 2011 Canadian Dollars.

The index case was the primary treatment of Dupuytren's contracture in a single finger. There were two main reasons for this: collagenase is only approved for use on one cord in one finger at a time[24] and the studies of outcomes following the use of collagenase report on only one finger at a time.[10,12,19]

We conducted a systematic review of the literature searching MEDLINE (1986 to March 2012, week 2), EMBASE (1986 to 2012, week 11), and the Cochrane Clinical Trials Registry databases using the search term "Dupuytren's contracture" limited to English language papers. We identified 828 papers, for which titles and abstracts were reviewed. Of these, 43 were formally reviewed. Papers were excluded when the indication for the procedure or the severity of the contracture was not specified, the quality of the methodology was sub-optimal, or the majority of patients (< 80%) did not undergo treatment of a single finger. This review was

Table II. Disutility and utility values for health states, based on Chen et al[1] (PNA, percutaneous needle aponeurotomy; CRPS, complex regional pain syndrome)

Health state	Baseline utility
Disutilities	
Partial fasciectomy	0.009
PNA	0.007
Collagenase Injection	0.006
CRPS	0.02
Digital nerve injury total	0.011
Digital nerve injury	0.002
Repair of digital nerve*	0.009
Utilities	
Dupuytren's contracture	0.987
Successful treatment with surgery	0.991
Recurrence following surgery	0.979
Successful treatment with PNA	0.993
Recurrence following PNA†	0.987
Successful treatment with injectable collagenase	0.994
Treatment failure with injectable collagenase	0.987

* all patients undergo surgical repair of injured digital nerve and the disutility for this would be similar to undergoing partial fasciectomy
† treatment failure after PNA or injectable collagenase would not be significantly different from their baseline pre-treatment status

conducted to establish baseline probability values for the three forms of treatment including immediate failure of treatment, recurrence and complications.

Recurrence at three years was assumed,[1,10,12,13,19-22] and a one-year lag for salvage PF was assumed following unsuccessful release.

The cost analysis included healthcare and patient-incurred costs. Procedure-specific, follow-up appointment and anaesthetic costs were derived from the Ontario Health Insurance Program (OHIP) Schedule of Benefits.[25] Hospital-related costs, including the hospital facility, allied healthcare and hand therapy fees, equipment and pharmaceutical costs, were obtained through the financial departments of two tertiary level hand surgery units. The cost of collagenase was based on the current US Market price.[15] We made the assumption that the cost of collagenase in our model represented an entire course of treatment. Healthcare costs related to complications included the cost of salvage PF, repair of damaged digital nerves and additional hand therapy.

The two complications of treatment that we included were digital nerve injury and complex regional pain syndrome (CRPS). These are the most commonly reported complications that can have long-term effects for the patient and incur increased healthcare costs. In order to provide the most conservative cost estimate, we assumed that all patients would undergo repair of injured digital nerves and that CRPS resulted in one year of hand therapy on a weekly basis. Healthcare costs would cover the treatment, follow-up and additional therapy. Patient-incurred costs covered lost productivity associated with recovery from surgery and hand therapy appointments. Wound healing problems, infection and haematoma following PF or PNA were not included as potential complications based on the assumption that they are relatively short-lived and would not significantly affect the overall post-procedure utility value.[26]

Patient-incurred costs included parking costs and loss of income related to the procedure and recovery (0.5 days and ten days for non-surgical and surgical treatments, respectively)[27,28] and appointments for hand therapy and follow-up (0.5 days/appointment).

Longer recovery time and further therapy and follow-up appointments were assumed to occur after PF. The cost of time lost for the procedure, recovery and follow-up was accounted for by age- and gender-appropriate loss of income.[17] This was calculated based on Statistics Canada age- and gender-specific income data for males aged between 55 and 64 years.[29] All patients were assumed to require care from one person on the day of the procedure, which was accounted for by the cost of one day of lost wages. Parking was assumed to be $20 per hospital visit.

The internal validity of the model was tested using input of null or extreme values as well as conducting tests of replication.[16] Our model was cross-validated against the US expected value decision analysis model.[14]

Cost effectiveness analysis and incremental cost-effectiveness ratio (ICER) calculations were done using discounted outcome values. The ICER for each treatment strategy was compared with a set threshold of willingness-to-pay. When treatment strategies cost < $50 000 per QALY gained they were considered cost-effective and were considered affordable if the cost was < $100 000 per QALY gained.[30]

Variability analysis, a type of multivariate sensitivity analysis, is used to account for diversity in patterns of clinical practice.[16] In this analysis we allowed for PNA to be the salvage procedure for recurrence following primary PNA rather than PF, as this is common practice at our institution.

The validity of our model was also evaluated using deterministic one-way sensitivity analyses in order to test the key assumptions and model parameters. Sensitivity analyses assessed all model variables including the probability of complications, recurrence and immediate failure, health state transition times, utility values, the costs of hand therapy, fees, lost wages and collagenase. The probability of the failure of treatment and the development of complications were varied from 0% to 100%. The cost of a course of injectable collagenase was set at $3000, which is the approximate US market value,[15] and was varied from $0 to $3000. The time to recurrence was varied from one to five years for each treatment strategy.

Results

Nine papers met the inclusion criteria.[1,10,12,13,19-22,31] A mean value of the results of the studies was used to generate baseline probabilities (Table III).[32] The base values for the probability of the failure of treatment including immediate

Table III. Summary of the probabilities of the failure of treatment and the development of complications for the different forms of treatment[1,10,12,13,19-22,31]

Variable	Probability	
	Baseline*	Range*
Open partial fasciectomy		
Probability of complication	0.05	0 to 0.12
Probability of complex regional pain syndrome	0.075	0.025 to 0.12
Probability of nerve Injury	0.02	0 to 0.05
Probability of recurrence	0.20	0.14 to 0.26
Percutaneous needle aponeurotomy		
Probability of complication†	0.01	0 to 0.05
Probability of complex regional pain syndrome	n/r‡	-
Probability of nerve injury	0.0027	0 to 0.0047
Probability of immediate failure	0.15§	0.15 to 0.22
Probability of recurrence	0.51	0.30 to 0.58
Injectable collagenase		
Probability of complication†	0.01	0 to 0.05
Probability of complex regional pain syndrome	0.002	0 to 0.003
Probability of nerve injury	n/r	-
Probability of immediate treatment failure	0.15	0.15 to 0.22
Probability of recurrence	0.21	0.17 to 0.23

* baseline probabilities are the mean of estimates from published studies
† conservative baseline value was used in base case analysis to reduce bias against partial fasciectomy
‡ n/r, not reported
§ assumed to be the same as for immediate failure rates with injectable collagenase

Table IV. Summary of baseline costs used in the reference case analysis for each form of treatment and main complications as used in the reference case and ranges in sensitivity analysis

Variable	Cost ($)	
	Baseline	Range
Open partial fasciectomy		
Patient-incurred cost	3859	487* to 3859
Hospital cost	2384	878† to 2384
Therapy cost	306	70‡ to 306
Percutaneous needle aponeurotomy		
Patient-incurred cost	397	60* to 397
Hospital cost	483	
Therapy cost	70	
Injectable collagenase		
Patient-incurred cost	501	80* to 501
Hospital cost	457	
Therapy cost	70	
Injectable collagenase cost/course of therapy	3000	0 to 3000
Complication-associated costs		
Digital nerve injury§	2747	1908* to 4859
Complex regional pain syndrome§	6780	1800* to 9387

* when lost wages/opportunity costs assumed to be $0
† cost of partial fasciectomy performed in minor procedures clinic. Assumed no anaesthesiologist, but with regional block
‡ therapy cost with only one post-operative visit
§ includes patient incurred costs and healthcare costs. Lower limits represent lower patient incurred costs with less time away from work

failure and recurrence for PF, PNA and injectable collagenase were 20%, 52% and 36%, respectively. The probability of immediate failure was 15% for collagenase and we assumed the same for PNA; however, we assumed that the probability of immediate failure for PF was 0%, with failure of treatment less likely following excision of the palmar fascia.

The mean costs over a fifteen year period were determined and incorporated healthcare-related and patient incurred components. The estimates of cost and ranges are outlined in Table IV. PNA was the most cost-effective option with an expected cost of $3990. Collagenase and surgery had expected costs of $6442 and $7975, respectively.

The mean discounted and undiscounted values over a 15-year period are shown in Table V. All treatment strategies had similar expected effectiveness due to the uniformly high utility values. Collagenase had the greatest effectiveness; however, this amounted to an additional 0.01 and 0.02 QALYs over PNA and PF (approximately one quality adjusted life week), respectively.

The cost-effectiveness analysis is shown in Figure 2 and Table VI. As the least costly option, PNA became the first comparator strategy in the analysis. Injectable collagenase followed PNA in the cost-effectiveness analysis, costing $284 383 per QALY gained over PNA. PF, as primary treatment, was dominated, meaning that there was a higher expected cost for a lower expected effectiveness compared with the other forms of treatment.

When PNA was assumed to be the salvage for recurrence following primary PNA, the expected, discounted outcomes for PNA were $2212 and 7.51 QALYs. This analysis increased the ICER for injectable collagenase to $891 171 per QALY, making it an unaffordable strategy when secondary PNA was a treatment option.

Our sensitivity analysis revealed few variables to which our model was sensitive. PNA lost preference to collagenase when the probability of complications reached 79%, when the probability of immediate failure of treatment with PNA reached 58%, combined with a probability of recurrence of 37%, or the probability of recurrence reached 84%, in combination with the probability of the immediate failure of treatment of 15%, which represent probability values outside the range reported in the literature for a single finger contracture. If the utility value for successful release after PNA was lowered to 0.989, collagenase was preferred. Lowering the utility value of collagenase slightly rendered it to be dominated.

Procedure specific costs for PNA and PF were analysed in the variability analysis described above. Patient-incurred costs were varied in the sensitivity analysis, which revealed no change in model preference between forms of treatment. Injectable collagenase met the $50 000 and $100 000 per

Table V. Gross and discounted expected cost and quality-adjusted life years (QALYs) for no treatment and for each form of treatment

Procedure	Expected cost ($)	Cost component		Expected QALY	Discounted cost*† ($)	Discounted QALY*
		Patient (%)	Healthcare (%)			
Open partial fasciectomy	9003.24			14.856	7429.27	7.5043
Healthcare costs	3373.00	62.6	37.4			
Patient costs	5624.28					
Percutaneous needle aponeurotomy	4826.27			14.870	3909.35	7.5097
Healthcare costs	2007.43	58.4	41.6			
Patient costs	2821.71					
Injectable collagenase	7911.84‡			14.890	6442.13	7.5186
Healthcare costs§	5560.62	29.7	70.3			
Patient costs	2419					

* annual discount rate of 0.05%
† cost of consultation (surgeon billing, facility fee and lost patient income for one half day)
‡ assumed all successful treatment with injectable collagenase required only one injection, while immediate failures had undergone three injections, with the according increase in hospital cost and patient-incurred costs. The pharmaceutical cost of injectable collagenase was assumed to represent one complete treatment course
§ cost of injectable collagenase included in healthcare costs

Table VI. Discounted incremental cost and effectiveness, and incremental cost effectiveness ratios (ICER) for treatment strategies for Dupuytren's contracture (QALY, quality-adjusted life year)

Strategy	Effectiveness (discounted QALY)	Incremental effectiveness	Cost ($)	Incremental cost ($)	ICER	Dominance
Percutaneous needle aponeurotomy	7.51	0	3909	0	0	-
Collagenase	7.52	0.01	6442	2533	$284 383/QALY	Undominated
Partial fasciectomy	7.50	-0.01	7975	1532	-	Dominated

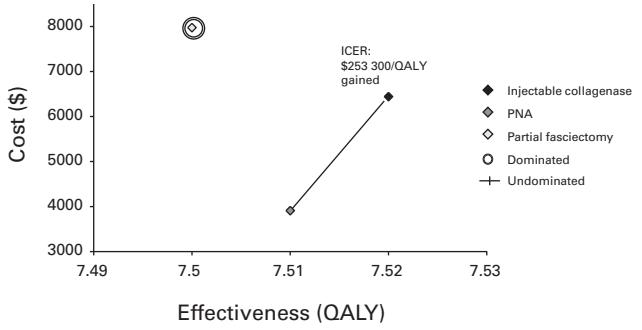

Fig. 2

Graph showing cost-effectiveness frontier for the forms of treatment of single digit Dupuytren's contracture with discounted values. The incremental cost-effectiveness ratio (ICER) is noted for percutaneous needle aponeurotomy (PNA) and injectable collagenase. Partial fasciectomy is dominated from the model (QALY, quality-adjusted life year).

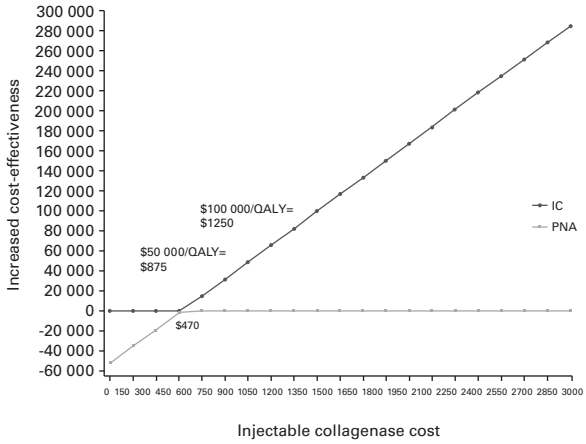

Fig. 3

Graph showing one-way sensitivity analysis of the cost of injectable collagenase for a total course of treatment. The threshold for affordability and cost-effectiveness are met when the cost for a total course of treatment with collagenase is reduced to $1250 and $875, respectively. Collagenase is preferred at a cost of $470 for a course of treatment.

QALY gained threshold for the willingness-to-pay compared with PNA at a cost of $875 and $1250, respectively, for a complete series of injections. At a cost of $470 for a complete series of injections, collagenase became the preferred strategy (Fig. 3).

Discussion

Primary non-surgical management of Dupuytren's contracture is becoming more common.[2,8,9] Our model supported this trend, identifying PNA as the preferred technique. The sensitivity analysis demonstrated that this expected value decision model for the management of single finger Dupuytren's, which is a function of two main factors: the high utility values and the disparate cost of the three strategies. The high utility values for all health states

translated into very small differences in the expected outcome values (QALYs) between strategies that approximated one quality adjusted life week. The large disparity in expected costs between strategies combined with the small differences in the expected outcome values generated large ICER values, which only approached affordable thresholds with significant reduction in the cost of injectable collagenase.

Our results on the cost-effectiveness of the treatment of Dupuytren's contracture are consistent with findings reported in US cost-utility analysis by Chen et al,[14] despite differences in the design of the model, the target population and the design of the cost-analysis. We found greater overall costs per QALY gained, which is attributable to our inclusion of patient-incurred costs for lost opportunity and outcome value discounting. It was also not clear if the cost of complications and secondary treatments were accounted for in the US analysis. Overall, the general concept was maintained that the non-surgical management of Dupuytren's contracture is most cost-effective and that a discounted price of injectable collagenase is required to meet cost-effective thresholds.

An important component of our cost analysis was the incorporation of patient-incurred costs, and is a notable difference between this analysis and that previously published on Dupuytren's contracture.[14] Patient-incurred costs were a significant component of the overall cost for all forms of treatment. However, they were greatest for PF, reflecting the financial implications of greater morbidity and a longer rehabilitation regime.[9] PNA-associated costs are minimal as this requires little equipment and does not use operating theatre resources. Likewise the injection of collagenase does not require an operating theatre, yet the pharmaceutical cost is high at about $3000 per injection in the United States. A single Dupuytren's cord can be injected up to three times, which can become costly if there are several cords in each finger with several fingers requiring treatment. This would not be sustainable at this price in a publicly funded system and would not be justifiable for a small incremental gain in QALYs. Collagenase was affordable (< $100 000 per QALY gained) when it cost < $1250 for a complete course of treatment in one finger, but had to cost approximately a third of this ($470) to be more cost-effective than PNA.

The surgical treatment of Dupuytren's contracture was dominated in our model. This is consistent with past cost-utility analyses.[14] The main factor supporting PF is the lower recurrence rate; however, even with a recurrence rate of 0%, this strategy was not preferred by our model. This finding should not be interpreted to mean that PF should not be considered for the treatment of primary Dupuytren's contracture. PF may be the only form of treatment indicated in certain circumstances, such as diffuse disease or fixed metacarpophalangeal/proximal interphalangeal joint contracture, requiring a capsulotomy.[1] This is demonstrated in our sensitivity analyses, in that PNA loses preference when it has a > 58% chance of immediate failure or > 84% chance of recurrence, which one might expect in diffuse disease or with fixed joint contractures. In Canada, most patients with Dupuytren's contracture are treated with PF,[5] and our model indicates that the overall cost-effectiveness could be improved by employing PNA as a primary form of treatment when PF is not indicated. The reason that most patients are treated with PF is not clear.

Further, if PNA can be used in a repeated manner for recurrence following primary PNA, the treatment becomes much more cost-effective. Secondary PNA is used at our institution and has been described as common practice in the literature.[1,8,33] However, no comparison has been made between surgery and PNA for the secondary treatment following PNA. Considering its cost-effectiveness, this form of treatment should be compared with traditional salvage surgery in future studies. If PNA proved to be a reliable method of treating recurrences after initial PNA more clinicians may be encouraged to adopt this as a more cost-effective strategy.

There are several limitations of this study. First, our literature search included papers describing treatment to a single finger and revealed variability with respect to the definition and rates of recurrence as well as the timing.[1,10,13,19-22] In order to account for this, we performed sensitivity analyses with large ranges for recurrence and rates of complication and timing and found that our model was robust to changes in these variables. Secondly, our model may not be suitable for patients with many affected fingers. Logic dictates that the treatment of many fingers would come with a greater risk of complications and of failure of treatment. Our model was not sensitive to variation in these probabilities, which demonstrates that it could be applied to decision-making in the setting of many affected fingers. Thirdly, the costs of treatment may vary between institutions. Aside from the cost of collagenase, other costs were robust variables, to which our model was not sensitive. Finally, a significant component of the expected cost for all forms of treatment was patient-incurred. One component, for which we did not account, was lost opportunity costs associated with having a primary or recurrent contracture. This is not available in the literature. The lost opportunity costs that we did include were estimates based on national statistical information, but not on patient-reported outcomes. Unfortunately, there is currently no tool for evaluating costs reported by patients such as out-of-pocket costs and lost-time costs.

In conclusion, our study favours non-surgical primary treatment of Dupuytren's contracture affecting a single finger. PNA is the preferred treatment while injectable collagenase would be the preferred treatment only at a substantial reduction of its current US market price. Partial fasciectomy is not cost effective. For recurrent contractures following primary treatment with PNA, our study suggests that secondary PNA should be considered due to the considerable improvement in cost-effectiveness with this form of treatment.

Supplementary material

Three tables, detailing i) the studies concerning treatment of single-digit Dupuytren's contracture from which baseline data for reference were identified, ii) the cost analysis for primary procedure for Dupuytren's treatment and treatment-related nerve injury, and iii) the results from the univariate sensitivity analysis, are available with the electronic version of this article on our website www.bjj.boneandjoint.org.uk

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

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References

1. **Foucher G, Medina J, Navarro R.** Percutaneous needle aponeurotomy: complications and results. *J Hand Surg Br* 2003;28:427–431.
2. **Desai SS, Hentz VR.** The treatment of Dupuytren disease. *J Hand Surg Am* 2011;36:936–942.
3. **National Institute for Health and Clinical Excellence (NICE).** NICE Interventional procedures overview of needle fasciotomy for Dupuytren's contracture. http://www.nice.org.uk/nicemedia/pdf/ip/177overview.pdf (date last accessed 31 May 2013).
4. **Health Canada.** Summary Basis of Decision (SBD) for XIAFLEX 2012. http://www.hc-sc.gc.ca/dhp-mps/prodpharma/sbd-smd/drug-med/sbd_smd_2012_xiaflex_147788-eng.php (date last accessed 31 May 2013).
5. **Canadian Institute for Health Information.** Aggregate Data on Dupuytren's Contracture Treatment in Canada for the 2009-2010 Fiscal Year. 2012.
6. **Watt AJ, Curtin CM, Hentz VR.** Collagenase injection as nonsurgical treatment of Dupuytren's disease: 8-year follow-up. *J Hand Surg Am* 2010;35:534–539.
7. **van Rijssen AL, Werker PM.** Percutaneous needle fasciotomy in Dupuytren's disease. *J Hand Surg Br* 2006;31:498–501.
8. **van Rijssen AL, ter Linden H, Werker PM.** Five-year results of a randomized clinical trial on treatment in Dupuytren's disease: percutaneous needle fasciotomy versus limited fasciectomy. *Plast Reconstr Surg* 2012;129:469–477.
9. **van Rijssen AL, Gerbrandy FS, Ter Linden H, Klip H, Werker PM.** A comparison of the direct outcomes of percutaneous needle fasciotomy and limited fasciectomy for Dupuytren's disease: a 6-week follow-up study. *J Hand Surg Am* 2006;31:717–725.
10. **Hurst LC, Badalamente MA, Hentz VR, et al.** Injectable collagenase clostridium histolyticum for Dupuytren's contracture. *N Engl J Med* 2009;361:968–979.
11. **Becker GW, Davis TR.** The outcome of surgical treatments for primary Dupuytren's disease: a systematic review. *J Hand Surg Eur Vol* 2010;35:623–626.
12. **Badalamente MA, Hurst LC.** Efficacy and safety of injectable mixed collagenase subtypes in the treatment of Dupuytren's contracture. *J Hand Surg Am* 2007;32:767–774.
13. **Gilpin D, Coleman S, Hall S, et al.** Injectable collagenase Clostridium histolyticum: a new nonsurgical treatment for Dupuytren's disease. *J Hand Surg Am* 2010;35:2027–2038.
14. **Chen NC, Shauver MJ, Chung KC.** Cost-effectiveness of open partial fasciectomy, needle aponeurotomy, and collagenase injection for dupuytren contracture. *J Hand Surg Am* 2011;36:1826–1834.
15. **Pollack A.** Bringing movement back to clenched hands. *New York Times* 2010 March 10, 2010. http://www.nytimes.com/2010/03/16/business/16handbar.html?_r=0 (date last accessed 8 May 2013).
16. **No authors listed.** *Guidelines for the economic evaluation of health technologies: Canada.* Third ed. Ottawa: Canadian Agency for Drugs and Technologies in Health, 2006.
17. **Weinstein MC, Siegel JE, Gold MR, Kamlet MS, Russell LB.** Recommendations of the Panel on Cost-effectiveness in Health and Medicine. *JAMA* 1996;276:1253–1258.
18. **Detsky AS, Naglie G, Krahn MD, Redelmeier DA, Naimark D.** Primer on medical decision analysis: Part 2: building a tree. *Med Decis Making* 1997;17:126–135.
19. **Badalamente MA, Hurst LC, Hentz VR.** Collagen as a clinical target: nonoperative treatment of Dupuytren's disease. *J Hand Surg Am* 2002;27:788–798.
20. **Badois FJ, Lermusiaux JL, Masse C, Kuntz D.** Non-surgical treatment of Dupuytren disease using needle fasciotomy. *Rev Rhum Ed Fr* 1993;601:808–813.
21. **Citron ND, Nunez V.** Recurrence after surgery for Dupuytren's disease: a randomized trial of two skin incisions. *J Hand Surg Br* 2005;30:563–566.
22. **Ullah AS, Dias JJ, Bhowal B.** Does a 'firebreak' full-thickness skin graft prevent recurrence after surgery for Dupuytren's contracture?: a prospective, randomised trial. *J Bone Joint Surg [Br]* 2009;91-B:374–378.
23. **Statistics Canada.** Health at a glance, April 2011.http://www.statcan.gc.ca/daily-quotidien/110415/be110415a-eng.htm (date last accessed 8 May 2013).
24. **Auxilium Pharmaceuticals, Inc.** Using Xiaflex. 2011. https://www.xiaflex.com/hcp/using_XIAFLEX.jsp (date last accessed 8 May 2013).
25. **Ministry of Health and Long Term Care – Ontario.** OHIP Schedule of Fees: Physician Services under the Health Insurance Act (September 1, 2011).
26. **Bulstrode NW, Jemec B, Smith PJ.** The complications of Dupuytren's contracture surgery. *J Hand Surg Am* 2005;30:1021–1025.
27. **Au-Yong IT, Wildin CJ, Dias JJ, Page RE.** A review of common practice in Dupuytren surgery. *Tech Hand Up Extrem Surg* 2005;9:178–187.
28. **Rahr L, Sondergaard P, Bisgaard T, Baad-Hansen T.** Percutaneous needle fasciotomy for primary Dupuytren's contracture. *J Hand Surg Eur Vol* 2011;36:548–552.
29. **Statistics Canada.** CANSIM Table 202-0407: income of individuals, by sex, age group and income source, 2009 constant dollars. http://www5.statcan.gc.ca/cansim/a26?lang=eng&retrLang=eng&id=2020407&paSer=&pattern=&stByVal=1&p1=1&p2=-1&tabMode=dataTable&csid=#F1 (date last accessed 8 May 2013).
30. **Ubel PA, Hirth RA, Chernew ME, Fendrick AM.** What is the price of life and why doesn't it increase at the rate of inflation? *Arch Intern Med* 2003;163:1637–1641.
31. **McMillan C, Binhammer P.** Steroid injection and needle aponeurotomy for Dupuytren contracture: a randomized, controlled study. *J Hand Surg Am* 2012;37:1307–1312.
32. **Naglie G, Krahn MD, Naimark D, Redelmeier DA, Detsky AS.** Primer on medical decision analysis: Part 3: estimating probabilities and utilities. *Med Decis Making* 1997;17:136–141.
33. **Lermusiaux JL, Lahalle S.** Needle aponeurotomy (fasciotomy) for Dupuytren's Contracture. *European Dermatology* 2009;4:15–18.