



Cost Comparative Analysis of Dupuytren's Contracture Treatments

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Scholarly Report submitted in partial fulfillment of the MD Degree at Harvard Medical School

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Scholarly Report Title: Cost Comparative Analysis of Dupuytren's Contracture Treatments

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Title: Cost Comparative Analysis of Dupuytren’s Contracture Treatments

Purpose: Currently there is limited literature comparing the cost of Collagenase Clostridium Histolyticum (CCH) injections to surgical fasciectomy to treat Dupuytren’s Contracture (DC). The purpose of this study was to model and compare the cost of these two procedures.

Methods: The billing records of four orthopedic surgeons at a tertiary academic center were queried for current procedural terminology (CPT) codes for operative and non-operative treatment of DC. “Cost” was modeled using the reimbursement Medicare would have paid based on the 2017 fee schedule. The modeled cost of each CCH treatment was comprised of materials, surgeon reimbursement for the injection and the manipulation, and hand therapy. The modeled cost of surgery was comprised of anesthesia reimbursement, operating room costs, pathology fee, surgeon reimbursement and hand therapy.

Results: This study evaluated a total of 245 patients. There were 178 patients in the CCH injection group and 67 patients in the surgical fasciectomy group. The total modeled cost of treatment with CCH was 5,153.23 USD and the total cost of surgery was 6,137.41 USD ($p=.001$). CCH injection was less expensive than surgery regardless of whether one digit was treated, or multiple digits were treated ($p=0.005$).

Conclusion: In this cost model, CCH injection is a less expensive option to treat DC compared to fasciectomy.

Level of Evidence: II, Economic and Decision Analyses

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Glossary of abbreviations

- Dupuytren contracture: DC
- Collagenase Clostridium histolyticum: CCH
- Current procedural terminology: CPT
- Hand therapy: HT
- United States dollars: USD

My role and significance of the project

My involvement with this project was broad. I conducted a chart review of our patients to collect the appropriate data and ensure patients met inclusion criteria. I coordinated with the appropriate personnel to collect CPT codes and their respective Medicare reimbursement rate. Then I organized and translated the appropriate codes and equations into a cost estimate for

each patient, to establish our data base. I met with the statistician to discuss analysis. I conducted a literature review and was involved in writing each section of the manuscript.

This study compares the total costs of injection and surgery for the treatment of DC. CCH injections save patients the morbidity of surgery and so should the data show that each procedure costs about the same, the injection would be preferred. CCH injections can be done in the office, require less post procedure therapy, and achieve comparable results to fasciectomy and so it is increasingly favored by both clinicians and patients⁶⁻⁹. If surgeons are foregoing injections in favor of surgery based on the perceived expense of the injection, it is important to correct that perception.

On the other hand, there is an argument to be made that the injection might be the economical option. There is evidence, cited below, to suggest that OR time and extensive follow up may drive up the price of the surgery. The incidence of DC in the United States increased by 43% between 2007 and 2013 and the introduction of CCH in 2010 has only accelerated the incidence rate¹⁰. With an increasing burden on our healthcare system, it is important to treat DC effectively and economically. If injection is less expensive, it should be chosen for its economy as well as its efficacy.

Data has been reported which addresses the issues described above. Atroshi et al. found from their analysis of a retrospective cohort of 32 patients comparing the cost of fasciectomy and CCH that CCH was 33% cheaper, while outcomes were similar at 6 weeks after intervention³. They found that the OR time (about 1 hour per procedure) drove up the cost of fasciectomy. In a 2013 study, S. Mehta and H. Belcher followed a prospective cohort of 40 patients in the United Kingdom requiring DC therapy for a single digit, half of which received collagenase injections and half of which underwent fasciectomy¹¹. The total price of care including first consultation, materials (collagenase injection), operating room time, and physiotherapy follow-ups were added and compared across groups. The average cost of fasciectomy was £7115.34 (8,855.97 USD) while the cost of collagenase injections was £2110.62 (2,626.94 USD)⁴.

Our study is different from previous investigations. To our knowledge, there has not been an analysis done in the United States. Given our unique healthcare system it is critical to look at costs within the U.S. as there may be important differences. Our study will be modeled on the 2017 Medicare reimbursement rate. One indication that the European estimates do not translate to US healthcare is obvious from the Mehta and Belcher study. They estimated the average total

price of the injection to be \$2,626.94 USD, however in 2017, U.S. Medicare reimbursed at a rate of \$4,430 USD per vial of CCH. Taking into account the surgeon's reimbursement, the cost of the post injection manipulation and occupational therapy, the total cost of the injection will be even higher. It is apparent that previous estimates completed by European researchers may not be applicable to U.S. surgeons.

Furthermore, the recurrence rate is important to take into account because rates in the literature are variable and hard to estimate but impact the overall cost of a given procedure^{4,5,12}. Our study combined the cost of any two procedures within a 12-month period. The total course of therapy for a given digit within one year will be counted as one therapeutic event. This allowed us to take recurrence rates within the first year after therapy into account.

Understanding the cost of these procedures is of growing importance in the United States as there is a growing emphasis on economy and efficiency of health care delivery. There are gaps in our understanding of the cost to treat Dupuytren contracture and our study builds on other data suggesting that the CCH is less expensive than fasciectomy.

Introduction:

Dupuytren contracture is a condition characterized by the development of fibrotic nodules and cords of the palmar fascia that lead to joint contractures and may impair function. DC is a common disorder disproportionately affecting older men.¹ Symptomatic contractures can be treated surgically (fasciectomy) or with less invasive fasciotomy. Fasciotomy may be achieved mechanically through procedures such as percutaneous needle fasciotomy or enzymatically with collagenase clostridium histolyticum (CCH) injections.

Collagenase Clostridium histolyticum injections for enzymatic fasciotomy achieve comparable short-term outcomes to open fasciectomy, while saving the patient the morbidity of surgery, so it is increasingly favored by clinicians and patients.²⁻⁵

The relative cost of CCH and surgery has been compared in other healthcare settings, but to our knowledge no study has been conducted comparing the cost of these procedures within the United States.⁶⁻⁹ International studies have found that the costs associated with surgery, including operative time, anesthesia costs and extensive post operative therapy are cumulatively more expensive than the single cost of an injection.⁶⁻⁹ These studies, however, may not be applicable in the United States given the differences between our healthcare systems. The goal of this study was to compare the total cost of CCH injection to the cost of fasciectomy to treat DC in terms of 2017 US Medicare.

Methods

Patients

We conducted a retrospective study that modeled the costs associated with Dupuytren treatment at a single institution. All patients were treated by CAQ-certified hand surgeons at our institution. Patients were identified by current procedural terminology (CPT) code from billing records. The patients were analyzed as two cohorts: a surgical fasciectomy group (CPT 26121, palmar fasciectomy, CPT 26123, partial palmar fasciectomy, open 1 digit, and CPT 26125 partial palmar fasciectomy, open additional digit) and a CCH injection group (CPT 20527, injection, enzyme palmar fascial cord, 26341, manipulation, palmar fascial cord post injection single cord and J0775, CCH injection, 0.01 mg). Patients were excluded if their identified treatment was for a recurrence of DC previously treated by surgery. All treatments for a single hand that occurred within a 12 month timeframe after the index intervention, were combined into a single modeled

cost estimate for that patient. However, if a patient was treated more than once (by either surgery or injection) but more than 12 months after the initial treatment, only the first treatment course was included.

Demographics were collected from the electronic medical records, including age, sex, number of digits being treated, degree of joint contracture, primary joint and prior treatments for DC.

Statistical Approach

First, simple descriptive statistics were calculated (e.g., means, standard deviations, proportions, etc.) for Tables 1 and 2. Then, t-tests were used for Tables 3 and 4, to determine whether there was a statistically significant difference in log transformed costs between the two groups. Finally, linear regression was used for Table 5, with log transformed costs as the outcome, injection vs. surgery as the main predictor, and adjusting for age, sex, number of digits treated, and year of procedure in the model

Cost Breakdown

To standardize the societal costs (reimbursement) of these procedures in the setting of variable years, insurance coverage and hospitals, we modeled the total expense of each procedure based on 2017 Medicare reimbursement for the codes billed. Hospital overhead (indirect costs) were not included in our calculation.

Fasciectomy Cost

To model the cost of surgical repair, total cost was broken down into five components: anesthesia reimbursement (using a time-based equation), OR cost (based on CPT facility rate), pathology fee (based on CPT code), surgeon reimbursement (based on CPT non-facility rate) and hand therapy (HT) costs (based on CPT code). HT costs were available for 47 of 67 patients (70.1%). For 29 patients whose HT was outside the system, the HT costs were modeled based on how they would have been billed in our system. Twenty surgical patients had no HT data available and we imputed their HT costs by using the mean HT cost among surgical patients with non-missing data. We confirmed in the EMR that all these patients had hand therapy ordered. No patient had a second surgery within the 12 month period.

CCH Injection Cost

To model the cost of CCH injection, the total cost was broken down into four components: cost of materials (Medicare reimbursement for each vial of CCH), surgeon

reimbursement for the injection and the manipulation (based on CPT code), and HT costs (based on number of visits and CPT code). Likewise, more than one injection that occurred within 12 months of each other and were intended to treat the same cord were considered a single therapeutic event. Therefore, the combined cost of each CCH treatment was used to estimate one course of injection therapy for that patient within one year.

Results

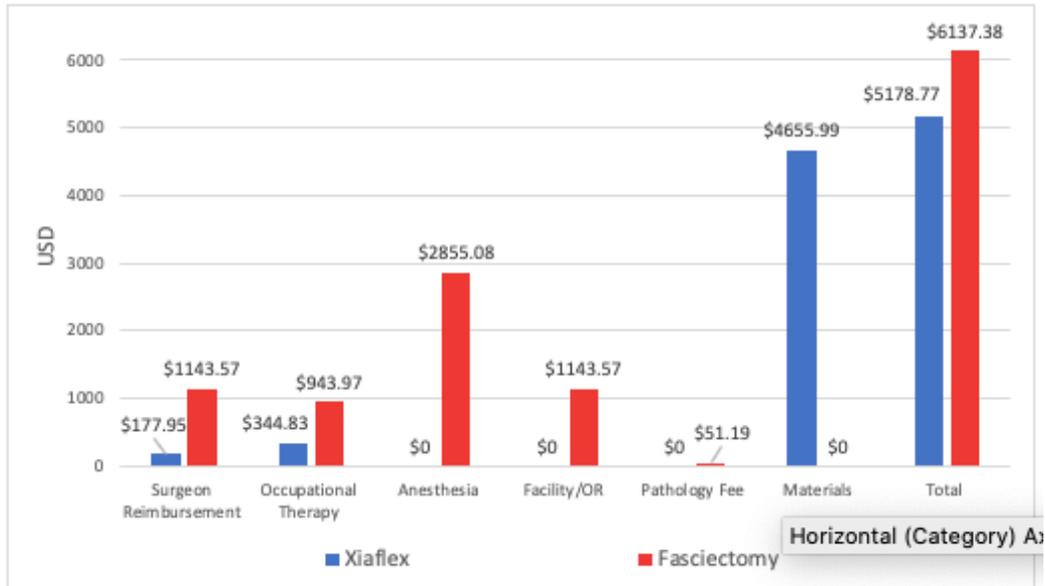
This study evaluated a total of 245 patients. There were 178 patients in the CCH injection group and 67 patients in the surgical fasciectomy group (Table 1). The CCH group included 144/178 (80.9%) men with a mean age of 65 years (range 43-91). The surgical fasciectomy group included 48/67 (71.6%) men with a mean age of 59 years (range 51-90). The total cost of treatment with CCH was 5,153.23 USD and the total cost of surgery was 6,137.41 USD (p=.001, Table 2 and Figure 1).

Table 1. Characteristics of patients, overall and by group (injection vs. surgery)

	Overall (n=245)	Injection (n=178)	Surgery (n=67)
Age (mean, SD)	63.1 (10.0)	64.6 (9.4)	59.1 (10.6)
Sex			
Male (n, %)	192 (78.4%)	144 (80.9%)	48 (71.6%)
Female (n, %)	53 (21.6%)	34 (19.1%)	19 (28.4%)
Number digits treated			
1	168 (68.6%)	121 (68.0%)	47 (70.2%)
≥ 2	77 (31.4%)	57 (32.0%)	20 (29.8%)
Bilateral	81 (33.1%)	52 (29.2%)	29 (43.3%)

Demographic data of our cohort.

Figure 1.



Total and individual component cost of fasciectomy and injection group. Red columns represent cost of fasciectomy and blue columns represent cost of CCH injection.

Table 2. Total costs by group (injection vs. surgery)

	Injection (n=178)			Surgery (n=67)		
	Mean (SD)	Median	Range	Mean (SD)	Median	Range
Original total cost	5153.23 (1062.33)	4925.09	678.69- 9895.33	5855.62 (1631.40)	5805.48	3083.28- 11163.83
Total cost after imputing mean for missing OT costs*	5153.23 (1062.33)	4925.09	678.9- 9895.33	6137.41 (1549.68)	5898.89	3272.20- 11163.83

* 20 patients who had surgery were missing for OT costs; imputed mean OT costs for surgery

Total cost of each group using the original total cost and the estimates using imputed mean for missing OT costs.

The cost of CCH injection to treat one digit (n=112) was 4,936.57 USD and the cost of surgery to treat one digit (n=42) was 5,716.12 USD (p=0.005), for a difference of 779.55 USD. The cost to treat more than one digit by injection (n=50) was 5,600.03 USD, and the cost to treat more than one digit with surgery (n=18) was 7,140.16 USD (p<0.001, Table 3), for a difference

of 1,540.13 USD.

Table 3. Total costs by group (selecting first procedure for patients with more than 1)

	Injection (n=162)	Surgery (n=60)	p-value**
All patients			
Original total cost (mean)	5141.34	5844.40	0.006
Total costs after imputing mean for missing OT costs (mean) *	5141.34	6143.33	< 0.0001
Patients with 1 digit treated			
	(n=112)	(n=42)	
Original total cost (mean)	4936.57	5401.45	0.19
Total costs after imputing mean for missing OT costs (mean) *	4936.57	5716.12	0.005
Patients with ≥ 2 digits treated			
	(n=50)	(n=18)	
Original total cost (mean)	5600.03	6877.94	0.001
Total costs after imputing mean for missing OT costs (mean) *	5600.03	7140.16	< 0.001

* 20 patients who had surgery were missing for OT costs; imputed mean OT costs for surgery

** p-value from t-test based on log transformed costs (assuming unequal variances)

Total cost of injection versus surgery stratified by the numbers of digits treated.

Costs components common to both surgery and injection (surgeon reimbursement and OT costs) were compared. The mean cost of OT after the injection was 345.44 USD and the means cost of OT after surgery was 943.98 USD ($p < 0.0001$). Surgeon reimbursement for CCH injection was 178.48 USD and surgeon reimbursement for surgery was 1,143,58 USD ($p < 0.0001$, Table 4)

Table 4. OT and surgeon reimbursement costs by group (injection vs. surgery)

	Injection (n=178)			Surgery (n=67)		
	Mean (SD)	Median	Range	Mean (SD)	Median	Range
OT costs	345.44 (236.60)	335.59	0-1492.36	943.98 (969.04)	608.00	139.12- 5746.46
Surgeon reimbursement costs	178.48 (26.32)	160.80	75.05- 210.63	1143.58 (317.10)	924.84	661.52- 1917.12

Total costs which are common to both procedures, OT and surgeon reimbursement.

Eight patients were identified who had multiple injections in the same hand within a 12 month timeframe. The mean cost of care for these patients in that 12 month period was 8,595.18 USD. The mean cost of injection for patients who required only one injection within one year (n=170) was 4,926.52 USD (Table 5, $p < 0.0001$).

Table 5 Total costs patient with ≥ 1 injection vs. 1 injection in same year

	Mean (SD)	Median	Range
1 injection per year	4926.52 (405.83)	4925.09	678.69-6083.86
≥ 1 injection per year	8595.18 (1830.58)	9302.99	4925.09-9895.33

p-value for t-test comparing log transformed costs = < 0.0001

Cost for patients who were in the injection cohort comparing those who had one injection per year, and those who had more than one.

Discussion

The number of encounters to treat DC in the United States increased by 43% between 2007 and 2013 and the introduction of CCH in 2010 has only accelerated the treatment rate.⁴ With an increasing burden on our healthcare system, it is important to treat DC effectively and economically.¹⁰⁻¹³ The goal of this study was to compare the cost of CCH injections versus fasciectomy. Our study demonstrates that CCH injections are a less expensive option than fasciectomy, to treat DC in the 12 month cost of care model.

Our study found that CCH is about 16% (984.18 USD) less expensive per treatment. This finding is consistent with previously published results.⁶⁻⁹ Atroshi et al. reported that in their

analysis of a retrospective cohort of 32 patients comparing the cost of fasciectomy and CCH that CCH was 33% less expensive, while outcomes were similar at 6 weeks after intervention.⁷ In a 2013 study, S. Mehta and H. Belcher followed a prospective cohort of 40 patients in the United Kingdom requiring DC therapy for a single digit, half of which received collagenase injections and half of which underwent fasciectomy.⁸ The total price of care including first consultation, materials (collagenase injection), operating room time, and therapy follow-ups were added and compared across groups. The average cost of fasciectomy was £7115.34 (8,855.97 USD) while the cost collagenase injections was £2110.62 (2,626.94 USD).⁸ Some of the differences compared to our study are likely due to both discrepancies in the healthcare systems serving these patients and the variations in estimating cost.

We observed that the cost of the CCH medication accounted for the majority of the cost of CCH treatment, contributing to 90% of the total cost of injection therapy (Table 6, Figure 1). The costliest component of surgery was anesthesia reimbursement (46% of the total cost), followed by surgeon reimbursement and OR fees (each 18.6% of the total cost), hand therapy (15% of the total cost) and lastly pathology fee (0.8% of the total cost).

Table 6. Cost breakdown per group

	Xiaflex (USD)	Fasciectomy (USD)
Surgeon Reimbursement	177.95 (3.4%)	1143.57 (18.6%)
Occupational Therapy	344.83 (6.7%)	943.97 (15.4%)
Anesthesia	n/a	2855.08 (46.5%)
Facility/OR	n/a	1143.57 (18.8%)
Pathology Fee	n/a	51.19 (0.8%)
Materials	4655.99 (89.9%)	n/a
Total	5178.77	6137.38

Total cost of injection versus fasciectomy broken down per individual component.

Our results are consistent with the literature. In other studies comparing the costs of these procedures, the cost of the CCH injection itself is similarly cited as the most expensive element of the course of injection therapy.^{7,8} As with our study, it has been observed that a large portion

of the costs associated with surgery related to the cost of the medical personnel (surgeon, anesthesiologist and other) and OR costs.^{7,8} Notably, we observed HT costs after surgery were almost 3 times more expensive compared to post injection therapy. This is consistent with the literature and our clinical experience as surgery requires longer, more intensive rehabilitation.^{7,8} Finally, we observed that another significant difference which contributed to the expense of surgery was surgeon reimbursement. Surgeon reimbursement for surgery was six times greater than surgeon reimbursement for injection.

We investigated the modeled cost in two cohorts: patients who had one digit treated versus multiple digits. Surgical management was more expensive than CCH in both groups (Table 3). In our practice patients with multiple cords/digits infrequently require multiple vials of collagenase to treat. In our cohort, we identified only 8/178 (4.5%) patients who required multiple CCH doses but 50/178 (28.1%) patients were treated for multiple digits. Atroshi et. al addressed this issue, estimating that 20% of the patients in their injection group would require an additional injection in the same hand, and found that CCH was still less expensive per patient.⁷ In our study, the difference in cost between surgery and CCH to treat multiple digits was nearly twice that of treating a single digit.

Treating disease recurrence and complications is an important contributor to the overall cost of treatment. This study only accounts for the price of an initial course of therapy for each patient. In a 2012 systematic review, Werker et. al cites the recurrence rate of fasciectomy to be 12-73%.¹⁴ In a single, long term investigation of outcomes after surgery, Jurisic et. el estimate that recurrence of DC at a mean follow up of 7 years after fasciectomy is 73%.¹⁶ In a 2015, large, multi-center study, CCH recurrence defined as a $\geq 20^\circ$ worsening in contracture 5 years after the injection was found to be 47%.¹² The varying definition of recurrence makes estimating recurrence difficult and furthermore, complicates how it contributes to cost. It is clear, however, that both treatments have high rates of recurrence and further long term studies need to be completed in order to estimate its role in overall cost. Peimer et al conducted a 2015 review of data regarding complications associated with CCH injections versus fasciectomy. CCH injections were associated with fewer incidences of nerve injury, neurapraxia, complex regional pain syndrome and arterial injury but with increased occurrences of tendon injury, skin injury and hematoma.¹⁵ Further analysis is necessary for understanding how these adverse events effect the total cost for each patient.

Our study has several limitations. First, the “costs” in this study are modeled based on Medicare reimbursement rates, which are distinct from charges or actual costs to deliver the care. Second, this is a retrospective review and it is possible that some patients had other treatments within the 12-month time period outside our EMR system which were not captured in our analysis. Third, our results do not consider complications and recurrence rates beyond one year and thus costs of later care may alter the results. Fourth, almost 30% of our surgical patients had imputed HT costs and it is possible that actual costs would vary. Fifth, the study was conducted at a single tertiary care center. Finally, there are indirect costs to the patient that have not been considered such as the patients’ transportation costs associated with visits and time out of work.

This study demonstrates that CCH injection is a less expensive treatment of DC for both single digit or multiple digits as compared to surgical fasciectomy in a 12 month cost of care model.

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Appendix

Table 7. Sensitivity analysis of total costs by group, restricted to those who had procedures from 2015-2017 (selecting first procedure for patients with more than 1)

	Injection (n=162)	Surgery (n=17)	p-value*
Original total cost (mean)	5141.34	6323.16	0.001
Total costs after imputing mean for missing OT costs (mean) *	5141.34	6378.69	< 0.001

* p-value from t-test based on log transformed costs (assuming equal variances)

Table 8. Beta coefficients from linear regression models for total costs for injection vs. surgery, unadjusted and adjusted

	Beta coefficient (SE)	p-value*
Original total cost, unadjusted	-0.111 (0.035)	0.002
Original total cost, adjusted**	-0.135 (0.049)	0.007
Total costs after imputing mean for missing OT costs, unadjusted	-0.167 (0.034)	< 0.001
Total costs after imputing mean for missing OT costs, adjusted	-0.150 (0.048)	0.002

* p value from linear regression models with log-transformed costs as outcome

** Adjusted for age, sex, number of digits treated, and year of procedure