CLASSIFICATION TOOL IDENTIFYING KNEE ARTHROPLASTY CANDIDATES BASED ON KINEMATIC DATA AND GENDER

Youssef Ouakrim[1], Michael Dunbar[2], Alex Fuentes[3], Sara Whynot[2], Hilary Macdonald[4], Glen Richardson[2], Neila Mezghani[1,3]

[1]LICEF Research Center, TELUQ University, Montréal; [2]Dalhousie University, Halifax, Canada; [3]Laboratoire de Recherche en Imagerie et Orthopédie (LIO), CRCHUM, Montreal, Canada, [4]Nova Scotia Health Authority, Halifax, Canada.

Email:youssef.ouakrim@teluq.ca, neila.mezghani@teluq.ca

INTRODUCTION

Kinematic data has been shown to be a valuable input in automatic objective classification methods allowing diagnostic aid and disease severity rating in knee osteoarthritis (OA) [1]. The purpose of this study, using 3D knee kinematic data, is to design and assess the validity of classification algorithms capable of discriminating patients with knee OA deemed appropriate, or not, for total knee arthroplasty.

METHODS

After IRB approval, one hundred fifty tree (153) patients with moderate to severe knee OA were enrolled after being seen by an orthopedic surgeon and allocated to surgical candidate (SC) or non-surgical candidate (N-SC) groups. All participants underwent standard physiotherapy assessments, health surveys, and three-dimensional (3D) knee kinematics analysis (KneeKG™, Montreal, Canada) during self-selected, comfortable treadmill walking. A set of 69 biomechanical parameters, such as maximum/minimum ranges, varus/valgus thrust throughout the gait cycle or gait sub-cycles. were extracted from the 3D kinematic signals. Since previous studies reported gender differences in function and reported outcomes in knee OA patients [2], we developed two independent classification models to discriminate SC from N-SC patients, based on gender. Table 1 shows participants demographic characteristics.

Table 1: Demographic characteristics

	Male group (n=61)		Female group (n=92)	
	SC n=29	N-SC n=32	SC n=51	N-SC n=41
Age (year)	66.2±10	62.7±8.7	63.9±8.9	65.4 ±9.6
Height (m)	1.76±0.07	1.77±0.05	1.61±0.06	1.63±0.05
Weight (kg)	104.7±27.7	96.6±20.0	86.1±18.0	86.4±17.6
BMI (kg/m^2)	33.5±7.9	30.7±5.9	32.8±6.5	32.1±6.0

*Student t-test revealed no significant differences between S and N-SC groups in both male and female ($p < 0.05$)

Kinematic parameters with the most discriminative value were identified by incremental selection on a regression tree. A decision tree was chosen as classification method to facilitate clinical interpretation. The effectiveness of the classifiers is evaluated by receiver operating characteristic curve analysis, namely, the area under the curve (AUC), sensitivity (Se), and specificity (Sp) through leave-one-out cross validation procedure. The stability of the classifiers was also tested using 10-folds classification tests. The retained models are then validated using an additional distinct validation dataset containing 13 males and 18 females providing an unbiased evaluation of the classifiers.

RESULTS

Table 2 summarizes the classification performances of the two classifiers (one for male group and the other for female) obtaining the highest classification rate and stability measured on test dataset and Table 3 on the validation dataset. Two kinematics discriminant features were needed to classify SC and N-SC candidates for both males (valgus motion from heel strike to end of mid-stance and the absolute value of the flexion angle at heel strike) and females (the mean axial rotation during loading and add/abduction angle at the end of terminal stance).

Table 2: Classifiers performances on the test dataset

SC and N-SC	Se	Sp	AUC
Male group	82.7%	84.3%	0.84
Female group	74.5%	73.1%	0.74

Table 3: Classifiers performances on the validation dataset

SC and N-SC	Se	Sp	AUC
Male group	4/5	5/8	9/13
Female group	8/9	6/9	14/18

DISCUSSION / CONCLUSIONS

Results supports use of kinematics as objective data for clinical decision support for knee arthroplasty. Interestingly, discriminant features are different for males and females. The AUC is higher for male than for female (0.84 against 0.74). The good performance on the validation dataset show the stability of the models (9/13 and 14/18 of AUC). Future study will add clinical evaluation measures in the classification systems and other classification methods (Neural networks, SVM, etc.) will be assessed.

REFERENCES

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