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**Managing patients with developmental co-ordination disorder in dentistry:  
Developing an online resource for dental professionals by a review of the  
literature**

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**ABSTRACT**

**Aim:** To produce an online resource for dental professionals, advising them on ways to manage patients with Developmental Coordination Disorder (DCD).

**Method and Results:** Literature search into the management of patients with DCD, and how to produce a high-quality leaflet using specific key words. Using online databases, such as PubMed, the Cochrane Database and an internet search engine, an online resource in printable leaflet form was produced following a pilot readability assessment and review by those who work with individuals with DCD and a Special Care Dentistry special interest group. From the assessment tools used, the resource scored well in terms of readability and comprehension. The resource also received positive and constructive feedback from colleagues and those who work with individuals with DCD.

**Conclusion:** An online resource was produced for dental professionals, although further evaluation is required on whether it will be useful to the profession. The literature review suggests the need for more research to be carried out on the association between DCD and oral

health, and how dental professionals can manage those with DCD within a general dental practice.

**Key Words:** Dyspraxia, developmental co-ordination disorder, DCD, oral health, dentistry

## **INTRODUCTION**

Developmental Co-ordination Disorder (DCD), also referred to as Dyspraxia, is defined as a neurodevelopmental disorder in which the patient has poor motor coordination for their age, and delays in motor development<sup>1</sup>. Individuals struggle with either gross or fine motor skills, or both, and this has an impact on their daily functions. Difficulties with their motor skills is not due to an underlying medical condition, such as cerebral palsy, or low intelligence<sup>1</sup>.

DCD is often diagnosed in childhood by paediatricians and occupational therapists<sup>2</sup>. Between 5-15% of children have DCD, depending on the classification system used<sup>2-5</sup>. There is currently no universal test for diagnosing DCD. European guidelines for screening and assessment aid clinicians with diagnosis<sup>6</sup>. The most standardised test is the Movement Assessment Battery for Children between 3-16 years (MABC-2)<sup>7</sup>. Patients under the 5th percentile are diagnosed with DCD, although there is unclear reasoning for this cut off.

DCD can produce a range of symptoms which may impact dental care, including poor hand-eye coordination and motor planning, poor working memory and concentration, as well as hypersensitivity to sensations<sup>8</sup>. It is a spectrum motor disorder which affects some individuals significantly while in others the symptoms can be hardly noticeable. Generally patients with DCD can be well managed within general dental practices. However, they may require more help to achieve and maintain good oral health.

Individuals with DCD are more likely than not to have a co-occurrence with other conditions<sup>5</sup>.

Dental professionals should therefore consider DCD in those with associated disorders such as:

1. Attention Deficit Hyperactivity Disorder (ADHD);
2. Dyslexia;
3. Autism Spectrum Disorder / Condition (Autism);
4. Dyscalculia<sup>8</sup>.

As approximately 1 in 7 individuals may have DCD to some degree it is likely that clinicians will have patients reporting DCD and need easy access guidance on how to manage such patients. Current DCD related charities carry resources for other professional groups. This paper reports on the production process of developing an easy-access online resource for dental professionals, advising them on ways to manage patients with DCD in their practice. The aims and objectives were to:

- To understand the signs and symptoms of DCD and how they might impact on a patient's dental care.
- To provide guidance on how to work with patients with DCD.
- To produce an online dental resource for dental professionals in leaflet format.

Dental professionals have limited teaching at university about managing patients with DCD and currently only one article related directly to DCD in the dental literature<sup>8</sup>. A quick access guide to dental professionals on the subject was therefore seen as a useful starting block on providing more dentally -relevant information about these patients to dental professionals (see appendix 1 and 2).

## **METHOD**

### **Leaflet Content**

A literature search was conducted in PubMed, the Cochrane Database and Google scholar using the following search terms: (dyspraxia OR developmental co-ordination disorder OR DCD) AND (dentistry OR dental care OR oral health). Due to limited dentally related papers (n=1), the field of research was expanded to include: specific learning disabilities (e.g. autism), diagnostic criteria, and verbal dyspraxia. Figure 1 illustrates the search outcomes. Hand searching of references in identified studies provided further papers.

All sources included were assessed on quality and critically appraised<sup>9</sup>. The quality of the final papers included were assessed by their study type, relevance, sampling and context<sup>9</sup>. Expert opinion and the views of individuals with DCD on their dental experience was used to aid with the content of the leaflet due to the lack of dentally relevant papers.

### **Inclusion Criteria:**

- **Types of Literature included:**
  - Randomised Controlled Trials
  - Society webpages<sup>10-12</sup>
  - The National Institute of Dental and Craniofacial Research (2009)<sup>13</sup>
  - Mun-H-Centre<sup>14</sup>
- **Language:**
  - Texts available in English

Due to the similarities and association between autism and DCD, the National Autistic Society webpages were used<sup>12</sup>. Recommendations from dental guidelines for people with learning disabilities were adopted as they provided general methods to help those with physical disabilities, some of which could be applied to patients with DCD<sup>10</sup>.

### **Leaflet Design**

Following collation of patient management advice from the identified literature, an online resource was produced to guide dental professionals in the dental care of patients with DCD. A leaflet layout was chosen to enable key information to be accessed quickly by dentists and for easy distribution purposes. To avoid an assumption regarding the clarity and ease of reading, the

leaflet was constructed following a methodological process similar to developing patient materials based on clinical guidelines, and evidence from different sources such as Readability<sup>15</sup>, the NHS toolkit<sup>16</sup>, EQIP<sup>17</sup>, PEMAT<sup>18</sup>, and Sustersic et al<sup>19</sup>. An Easy Read version of the leaflet was not produced as the leaflet was aimed at dental professionals not patient groups. It was tested using the Flesch Reading Ease Score and Flesch-Kincaid Grade Level test available on Microsoft Word (MS Office Support). The Simple Measure of Gobbledegook Readability Formulae (SMOG)<sup>15</sup> was also calculated. Consent was obtained from the Mun-H-Centre webpage<sup>14</sup> to reproduce illustrative images for the online resource.

### **Leaflet Evaluation**

Following construction, a pilot leaflet was reviewed by relevant parties who work with individuals with DCD for additional feedback before subsequent adaptation:

- Three Special Care Dentistry (SCD) Consultants (one academic, two working within the UK Community Dental Services);
- One Medical academic expert in DCD;
- Two Occupational Therapy academics connected with the Dyspraxia Foundation, with research and practical DCD experience; and
- Parents of / individuals with DCD

Dental reviewers were recruited through professional relationships. The academic reviewers were contacted by email following online identification through literature and specialist society searches. The Occupational Therapy academics requested feedback from parents and individuals with DCD, whom they work with, to include in their response. Following feedback the leaflet was

consequently adapted before final review by a Consultant in SCD and a medical academic expert in DCD.

## **RESULTS**

### **Literature search**

Of the papers initially found, the majority of studies were excluded due to the title or abstract not being relevant to the aim of the project (see Figure 1). No case reports were identified in the literature review. Fifteen papers were included in the final literature search (see Table 1). Table 2 summarises aspects of organisational and motor coordination impairment individuals with DCD may have, and how that may impact on their dental care. None of the literature provided accessible information available to dental professionals on managing patients with DCD.

The key findings of DCD relevant to dental care include reduced motor function and poor concentration, memory and organisational skills<sup>22,24</sup>, and hypersensitivity to sensations<sup>8</sup>. Individuals may consequently struggle more with oral self-care and dental engagement. For this reason, standard preventative techniques were included in the leaflet, as well as ways in which dentists can adapt them to aid patient self-care.

Individuals with DCD can have poor organisational skills and memory and therefore may struggle with punctual dental attendance and benefit from appointment reminders<sup>22</sup>. People with



physical disabilities have been found to find information about access and transport important for independence<sup>32</sup> which may also be relevant to organising dental visits.

Some patients with DCD may be hypersensitive which can have an impact on oral self-care and the provision of dental treatment<sup>8</sup>; therefore oral desensitisation techniques and non-flavoured/foaming toothpastes are included in the leaflet.

Behavioural management problems (BMP) found in some patients with attention and learning problems<sup>29</sup> can have a negative impact on dental care and attendance. Some autistic patients who struggle to attend dental appointments can have increased dental anxiety<sup>11</sup>, and comfort items and music can be useful distraction techniques for some anxious patients with ASD<sup>12</sup>. To prevent dental anxiety as well as aid planning, a clear structure, continuity and explanation of treatment process is important<sup>10</sup> and may be relevant to patients with DCD. Visual supports (e.g. calendars and Social Stories™), which are physical and structured ways of communication, can help some patients with poor perception of time and memory and aid the preparation of dental visits/ procedures<sup>11,12,30</sup>.

### **Online Resource Design**

Health information materials should be clear and evidence-based<sup>20</sup>. The key messages of the online resource were:

- That patients with DCD can often be managed within a general dental practice;
- To explain the effects that DCD can have on dental care;

- To stress the importance of acclimatisation and preventative techniques; and
- To offer possible ways to aid oral self-care to DCD patients.

The online resource was designed as a leaflet for quick access of pertinent information. The aim of the leaflet was stated along with the author and date of production<sup>17,19</sup>. The text was clearly separated to make it more readable, with adequate line spacing<sup>15</sup>. A clear and distinct font size of 11+ was selected<sup>15,19</sup>, and bold type was used to highlight important points<sup>15-16</sup>. Information was presented logically, with a suitable layout<sup>17,19</sup>. A question and answer format was partly used to obtain interaction from the reader and to help break up text, as well as bullet points to increase readability<sup>16,19</sup>. Appropriate, non-offensive language was used<sup>21</sup>. Suitable and limited colours were selected to make the leaflet appealing but not to distract from the information itself. Relatable pictures were placed at the end of paragraphs<sup>15</sup>. Explanations of dental terms were omitted as the leaflet is aimed at those assumed to have appropriate prior knowledge. Generic names were used rather than branded products<sup>17,19</sup>. Useful sources for further reading were recommended at the end of the leaflet<sup>16</sup>.

### **Readability**

For assessment of the leaflet, readability tests were calculated. The leaflet's Flesch-Reading-Ease score was 40 and its Flesch-Kincaid Grade Level Test (MS Office Support) was 11.5. The SMOG formula was also carried out which is based on education level<sup>15</sup>, and the leaflet received a score of 16. The EQIP tool<sup>17</sup> was used to help assess the layout and quality of the leaflet. The leaflet

received a high score of 78.6%, indicating that the information was clearly presented and well written. PEMAT's<sup>19</sup> assessment topics were used to guide design, however a PEMAT score was not calculated, as it is aimed at information materials.

## **DISCUSSION**

### **Leaflet Content**

The aim of this project was to produce an easy access online resource for dental professionals managing patients with DCD. Ideally the majority of patients with DCD ought to be treated within general practices, provided they don't have any other significant co-morbidity, with a small minority requiring referral to secondary care services. For this project, the focus has been mainly on those with mild-moderate DCD.

DCD is not a limiting condition so patients can often improve their ability with certain tasks, but this can require patience and encouragement from those around them. Over time this can help increase independence and self-confidence. Those who have had childhood intervention often have better motor skills<sup>22</sup>. There is strong evidence to show that symptoms of DCD can continue into adulthood<sup>2,4,22-24</sup>, although the motor symptoms of DCD often become less apparent in adulthood which may be due to the discovery of coping mechanisms, work-arounds and avoidance techniques<sup>2</sup>. Advice on suitable oral hygiene measures and equipment should prevent alternative detrimental adaptations such as avoiding manual brushing or shortened ineffective

technique. There is varying presentation in adulthood, therefore the type of support needed may also differ for each patient.

Children affected by DCD are often diagnosed between 5 and 7 years old, however DCD can also go undetected or be diagnosed much later<sup>25</sup>. Dental professionals may have a role in referring patients early on if concerned over their dexterity. Verbal dyspraxia, a separate condition often associated with DCD, is where mainly children struggle to co-ordinate the oral muscles even though no nerve or muscle damage is evident<sup>26</sup>. It is important to refer these patients early on to a speech/ language therapist to prevent delayed development.

There is very little dental research on patients with DCD. Although Dougall and Fiske highlighted direct links between DCD and dental care, from the literature review it is evident that more research is required into how DCD directly affects dental care<sup>8</sup>. Poor oral health can affect one's quality of life whereas good oral health improves confidence and social integration<sup>27</sup>. Perceived difficulty in brushing teeth eases for most individuals with DCD as they get older<sup>22</sup>, this may be due to daily practice or that it is more easily taught than other tasks. Alternatively reported difficulty and objective assessment may differ due to detrimental adaptations. Further studies into the impact of DCD on dental care and oral health may help healthcare professionals understand which tasks patients with DCD struggle with, in order to provide them with the appropriate support.

Symptoms from other disorders can also affect patients with DCD, for example difficulty concentrating present in individuals with ADHD. Such patients who are unable to stay focused

whilst brushing their teeth may have an increased caries risk<sup>28</sup>, although concentration difficulties usually become less apparent as the individual matures<sup>22</sup>. Blomqvist et al<sup>29</sup> found that 54% of individuals with attention and learning problems also had behavioural management problems (BMP) noted in their dental records, compared to 37% of those without attention or learning problems. BMP can delay dental treatment and affect dental attendance. As a consequence, these children may not become accustomed to the dental setting, potentially leading to dental anxiety or poor co-operation. It is important to recognise these signs early on and put in place measures to prevent BMP should patients with DCD present with such signs or with related disorders.

There are more guidelines and resources available for treating patients with autism than for DCD. Ways to help and treat patients with autism could potentially be adapted and applied to those with DCD due to the similarities and association between the two conditions. Recommendations from 'The Dentist: Preparing for a Visit' were used to produce the online resource<sup>11</sup>. Social Stories<sup>TM</sup>, a resource used for autistic patients, can help describe dental procedures, develop self-care skills and include information about what to expect and why it is being done<sup>30</sup>. They may be helpful when explaining procedures to help patients develop a mental plan of the process, and act as a reminder before the appointment for patients with poor memory. Social Stories<sup>TM</sup> have been found to help patients with poor executive functioning<sup>12</sup>. A survey on how dental professionals in SCD manage patients with DCD would be a useful addition in improving the guidelines in the future.

Adults with DCD often continue to struggle with executive functioning, and this can even become more apparent<sup>22,24</sup>. Fifty five percent of people with DCD found it hard to organise compared to 7.1% of those without DCD<sup>2</sup>. One parent of a child with DCD mentioned that their child struggles to organise dental appointments<sup>22</sup>. Adults with DCD who have not developed coping mechanisms may therefore present as repeatedly late or unreliable patients. Collin et al found that running late (69.9%) and challenging patients (61.2%) to be in the top ten stressors reported by dentists, which could have a negative impact on the care patients with DCD receive, future access, or result in referring these patients to secondary care<sup>31</sup>. Adult patients with DCD will often find driving a challenge which may prevent them from easily accessing dental services not located near public transport<sup>24</sup>. As a consequence of physical access and potential withdrawal of services due to unreliability, individuals with DCD may not have easy access to dental services. It may be useful to ask patients how they plan to arrive to appointments and provide help if necessary, such as planning appointments to fit bus timetables or having easily accessible parking places<sup>32</sup>. In addition contacting beforehand to remind patients, or adapting to repeatedly late patients by planning the actual appointment for after the given appointment time may help patients timekeeping.

### **Leaflet Design**

Guidelines are available on good quality leaflet development, looking at the layout, readability, and understandability<sup>15-17,19</sup>. However available guidance and studies are aimed at information

materials for patients rather than professionals, so advice was adapted in light of the different target audience. The main difference was that the leaflet is aimed at those with expected understanding around the topic, rather than those with no prior knowledge. Several tools were used to assess the pilot leaflet, as recommended<sup>33</sup>. The leaflet does not include some EQIP criteria, such as space for note-making, quality of life issues, and explanations of dental jargon<sup>17</sup> as these were deemed unnecessary. Reading formulae are equations which measure how difficult a text is to read based upon sentence length, syllable count, or vocabulary indexes. Readability formulae do not consider other factors such as the background knowledge of the reader, or the layout of the text. The Flesch Reading Ease score (MS Office Support) is marked on a 100-point scale with higher scores meaning the text is easier to read. Most public information materials score between 60-70. The leaflet scored 40 indicating that it is a more difficult leaflet to read, but it should still be appropriate for dental professionals. The Flesch-Kincaid Grade Level Test (MS Office Support) scores text based on the level of readability for a U.S. school grader. The leaflet scored 11.5, indicating that a twelfth grader (17–18-year-old) ought to be able to understand the information. The leaflet received a SMOG score of 16 which is equivalent to the average reading level for the UK Daily Express newspaper. For this leaflet, a low Flesch-Kincaid or SMOG score may indicate that there is insufficient information provided. However, the scores received were deemed appropriate for the aim of the project.

## **Leaflet Evaluation**

It is recommended that leaflets are critically appraised by possible users and those in the related disciplines<sup>19</sup>. Although the leaflet received good feedback from advisors further research would be useful to evaluate its utility to dental professionals managing patients with DCD. The leaflet has been requested for professional guidance on a national DCD website ([www.movementmattersuk.org](http://www.movementmattersuk.org)), and is being assessed for inclusion on a national SCD site ([www.sigwales.org](http://www.sigwales.org)).

## **CONCLUSION**

A downloadable online resource in leaflet format was produced for dental professionals, after assessing the signs and symptoms of DCD and how they might affect a patient's dental care. The resource provides guidance on how to manage patients with DCD. To improve on the guidance provided, there is the need for more research to be carried on the relationship between patients with DCD and oral health, and what dental professionals can do to help those with DCD within a general dental practice setting. Further evaluation of the resource is required on whether it will be well received and useful to dental professionals in practice.



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## TABLES

Table 1: Papers included in the final literature search.

Reference Number	Paper	Study Type	Population Type (Children (<16 yrs))	Recommendations from Paper
1	American Psychiatric Association. 2013	Evidence-Based Practice Guidelines	All population types	Definition of DCD
2	Kirby, A., Edwards, L., Sugden, D., and Rosenblum, S. 2009.	Randomised Controlled Trial	Adults	The development and standardisation of the DCD checklist (ADC).
3	Lingam, R., Hunt, L., Golding, J., Jongmans, M., and Emond, A. 2009.	Randomised Controlled Trial	Children	UK prevalence of DCD in 7-year-olds.
4	Miller, L. and Macnab, J. 2001. Human Movement Science	Pilot Randomised Controlled Trial	Children	Cognitive treatment for DCD children
5	Wilson, H. 2005.	Systematic Review	Children	Assessment and treatment of children with DCD
6	Dougall, A., and Fiske, J. 2008. British Dental Journal	Evidence-Based Practice Guidelines	Patients with disabilities	Advice on management of special care patients
20	Kirby, A., Edwards, L., and Sugden, D. 2011.	Randomised Controlled Trial	Adult	Parents and young adult's views of DCD in adulthood.
21	Rasmussen, P., and Gillberg, C. 2000.	Randomised Controlled Trial	Adult	The impacts of ADHD with DCD in 22-year-olds.
22	Tal-Saban, M., Zarka, S., Grotto, I., Ornoy, A., and Parush, S. 2012.	Randomised Controlled Trial	Adults	Signs and symptoms of DCD in young adults
24	Williams, P. and Dip, V. 2013.	Evidence-Based Practice Guidelines	Children	Overview of developmental verbal dyspraxia

25	Fiske, J., Griffiths, J., Jamieson, R., and Manger, D. 2000	Evidence-Based Practice Guidelines	Long-stay patients/ patients in care.	Advice on oral care for long-stay patients/ patients in care.
26	Blomqvist, M., Holmberg, K., Fernell, E., Ek, E., and Dahllof, G. 2006.	Retrospective cohort study	Children	Oral health, dental anxiety, and behaviour management problems in children with ADHD
27	Blomqvist, M., Holmberg, K., Fernell, E., and Dahllof, G. 2004.	Retrospective cohort study	Children	Dental behaviour management problems in children with attention and learning problems
30	Arnold, C., Brookes, V., Griffiths, J., Maddock, S., and Theophilou, S. 2000.	Evidence-Based Practice Guidelines	People with physical disabilities	Guidelines for people with physical disabilities

Table 2: Aspects of DCD that might affect dental care<sup>6</sup>.

<b>DCD Symptoms</b>	<b>Effects on Dental Care</b>	<b>Management Options</b>
Poor hand-eye co-ordination	Difficulty brushing/flossing	Using a mirror whilst brushing/flossing, quiet environment with minimal distractions. Single use or self-threading floss holders
Poor motor planning	Difficulty working with a mirror/ manoeuvring toothbrush	Practice brushing techniques on models and at review appointments
Poor manual dexterity	Poor pen grip, inadequate toothbrush grasp	Toothbrush adaptation, electric toothbrush
Poor working memory	Difficulty remembering OHI, information and appointments, requires repetition	Written instructions and plans
Poor concentration	Shorter/ less effective brushing regime	Timers, dental apps
Hypersensitivity to sensations	Negative response to certain dental equipment and materials	SLS-free toothpaste, review fluoride varnish
Sensitive gag reflex	Difficulty carrying out certain treatment and brushing	Acclimatisation, distraction techniques during treatment
Poor planning/ organizational skills	Missed/ cancelled appointments, delayed/ missed payments	Appointment reminders (texts/ letters), phantom appointment times
Oral dyspraxia	Difficulty expressing language/ chewing and tongue movements	Referral to Speech and Language Therapist